Ohmsett--The National Oil Spill Response Test Facility

The Ohmsett Gazette

Leonardo, New Jersey | Train with oil. Test with oil. | Spring 2005

Ohmsett Basin Wave Field Study

The Ohmsett facility is a unique test center for some of the most innovative oil spill recovery technologies in use today. A major feature of the test basin is the wave generator which produces various wave conditions that can be compared to those occurring in actual field settings.

In an effort to gain better knowledge of the Ohmsett test basin wave field and wave propagation, the Minerals Management Services (MMS) contracted MAR, Inc. and Bill Asher, senior oceanographer at the Applied Physics Laboratory, University of Washington, to conduct a wave characterization study. The study measured the physical properties of the waves generated in the test basin for a variety of wave conditions. The data will assist in the accurate determination of the performance of wave sensitive systems, devices, and technologies.

Several wave characterization studies have been conducted at Ohmsett in the past, but none have been this comprehensive. "The idea is that we need to know what is happening in the tank, such as how big and how fast waves are moving, for the testing of various oil spill technologies," Bill Asher

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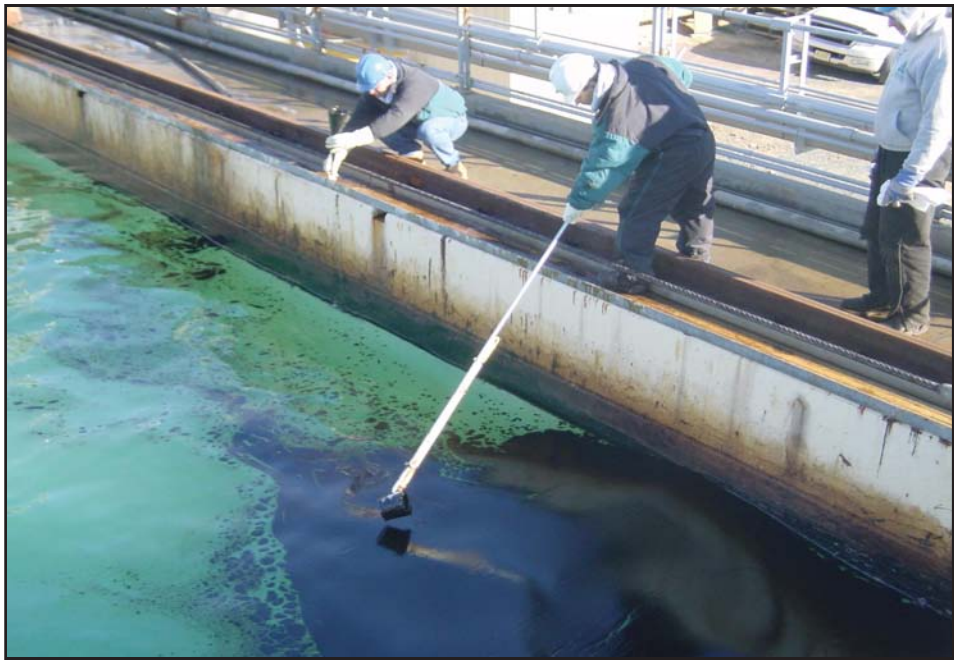
What's Inside

Development of Realistic Water-In-Oil Emulsions on a Large Scale



Technicians take samples of emulsions created in the Ohmsett test basin

The formation of water-in-oil emulsions is a potential hindrance in oil spill response planning, recovery operations, recycle operations and post-response remediation. Researchers have committed a great deal of resources to the study of emulsion chemistry and physical properties, mechanisms of formation and coalescence, persistence and transport, and environmental impact. Until now, they have used artificial means to supply the necessary mixing energy to form small quantities of water-in-oil emulsions with various "fresh" and artificially weathered oils. It was always a concern that these artificially-created emulsions may demonstrate very different characteristics than those formed in an actual oil spill.

Over the years, SL Ross Environmental Research Ltd. has conducted various tests in conjunction with MAR, Inc. at Ohmsett to evaluate the effectiveness of chemical dispersants, dispersant application techniques, and emulsion breakers in oil spill response operations. Recently, the Minerals Management Service (MMS) has funded SL Ross to conduct a research study at Ohmsett to develop ways to produce large batches of realistic emulsions that simulate those found at an actual oil spill after being on the water several hours to days. "We would like to develop a method of generating water-in-oil emulsions for use in large scale tests at Ohmsett," said Randy Belore, SL Ross project engineer.

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Emulsions

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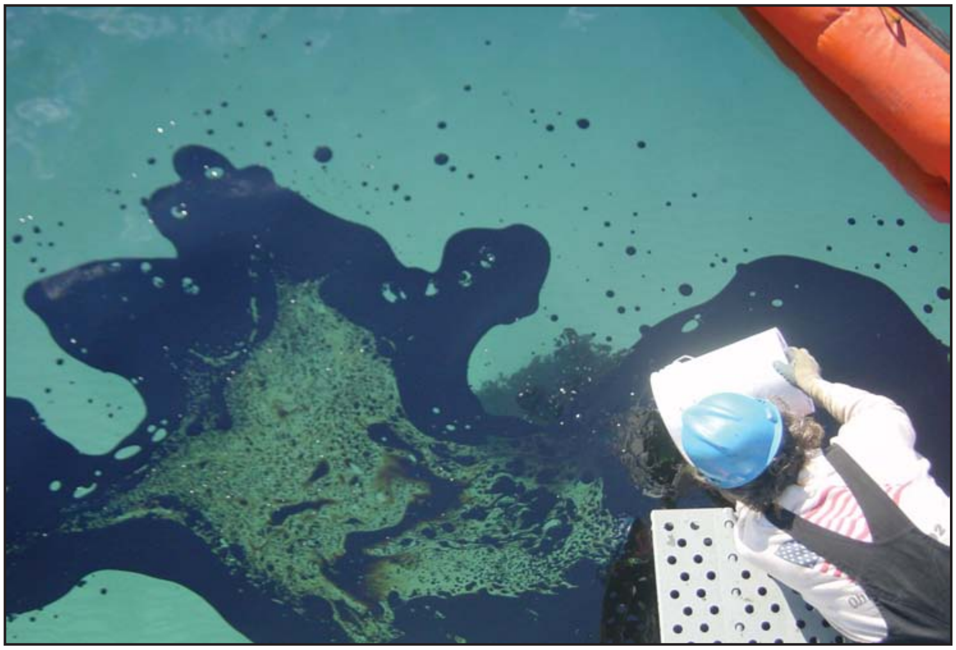
The first task in this study was to perform a literature review from past sea trials to gather existing data on real emulsion properties. According to Ian Buist, an SL Ross engineer, quite a number of at-sea trials have taken place in the United Kingdom and Norway. However, there is almost no data on the distribution of water droplet size in oil spill emulsions. "It is an important parameter in determining the characteristics of emulsions," said Buist.

Based on this review, S.L. Ross conducted small-scale laboratory tests at the SL Ross facility in Ottawa, Canada and subsequential large-scale tests at Ohmsett. In the laboratory, researchers designed and fabricated prototype emulsion mixing systems to see if they could produce realistic water-in-oil emulsions in large quantities. The best technique evaluated for producing the emulsions turned out to be a bladed mixer.



An Ohmsett technician places oil on the tank water during a study to determine what emulsions created at sea might look like based on emuslsions created in the test basin

In late December 2004 and early January 2005, the researchers gathered at Ohmsett for the larger scale study to determine what emulsions created at sea might look like based on the emulsions created in the test basin. IFO 120 fuel oil and Endicott crude oil were placed on the tank water and subjected to breaking wave conditions for periods up to 15 hours. The water content and viscosity of the emulsions were measured, and microscopic photographs of the emulsion samples were taken for droplet size analysis.

"If we succeed, we can produce batches of emulsions that, within a few hours, would realistically simulate an oil spill that has been at sea for a few days," said Buist.

With results from both tests, researchers were able to compare the lab techniques results to those actually created in the tank.

The tests also were intended to see if drum-sized batches of emulsions with properties similar to those formed on the Ohmsett tank could be produced using a bladed mixer. The results were promising and it appears that it is feasible to form realistic emulsions in quantities suitable for use in large scale testing programs at Ohmsett.

Wave Study

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said. In a test basin the size of Ohmsett's, several factors must be taken into account. For instance, higher frequency waves travel more slowly than waves of lower frequency, so that non-stationary interference patterns can be generated. Another factor is tank seiching, or the slow "sloshing" motion of the tank from end to end, which can affect the performance of the wave generator. It is important to know if such effects are significant so they can be accounted for when testing oil spill remediation technologies.

Testing took place November 9 - December 10, 2004, using an array of pressure transducers, capacitance wave gauges, and acoustic current meters that could be moved to various positions in the tank. Researchers tested the uniformity of the waves, mapped the significant wave height, and studied the stability of the wave field as a function of time. Preliminary data analysis showed that the wave generator produces the dominant wave at the drive frequency of the paddle, but there is a significant amount of wave energy at harmonics of the drive frequency. "Because more than one wavelength is propagating in the tank, measurement of wave properties at a particular tank location may not correctly reflect the conditions at other locations in the tank," Asher said.

During the wave characterization study, measurements were made along the length of the basin every 20 meters starting 40 meters from the northern end of the wave tank and continuing to within 20 meters of the southern end of the tank for a total of eight sampling stations with intrumentation spanning accross the width of the tank.

"We wanted to see if the waves differ in various locations within the tank, so we measured wave properties up and down the tank," Asher said. "Profiles started at one end of the tank, we turned the wave maker off, waited 30 minutes, then start it up again going back down the tank."

The data will be analyzed to provide a characterization of significant wave height, onset of wave breaking as functions of time, position in the tank, and wave paddle stroke frequency. With this information, Ohmsett engineers can provide clients with maps of specific wave field characteristics in the test basin, enabling them to provide test conditions based on the needs of a particular study.

Measuring Microwave Emissions of Waves (POEWEX)

For three weeks in November 2004, the University of Washington, Colorado State University, and the Naval Research Laboratory (NRL) returned to Ohmsett for another round of tests of the Polarimetric Emissivity of Whitecaps Experiment (POEWEX). During their previous two visits to Ohmsett, researchers focused on creating and testing an artificial beach, and conducted quantitative tests to examine wave turbulence, breaking waves, amount of entrained air, water pressure, and bubble action. The objective of this experiment, funded by the Integrated Program Office (IPO), was to measure the difference of the microwave emissions produced by breaking waves as a function of wind direction. Using a microwave radiometer, researchers measured the temperature of the water surface covered by a breaking wave. "The interesting thing is that the temperature you measure is a function of how you point the radiometer at the wave," said Bill Asher, University of Washington project coordinator. Asher went on to explain that the temperature of the wave was different depending on whether the breaking wave was moving towards the radiometer, away from it, or across its field of view. Futhermore, he stated that the temperature measurements can be used to estimate the wind speed and direction over the ocean.

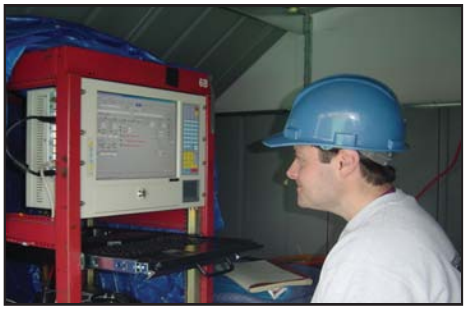
Ohmsett's test basin, with its wave generating capabilities and repeatability standards, was the perfect site for this type of testing. Researchers used an artificial beach made of concrete sections to create breaking waves in a particular location. The constant wave action made it possible to measure void fraction, bubble size distribution, turbulence, wave height and surface slope of the water. "Research data and testing of microwave radiometer systems are important as the need to measure the wind vectors from space for climatology research continues. The collection and dissemination of the data are related to weather prediction, ocean shipping and naval fleet operations," said Asher. The National Polar-Orbiting Operational Environmental Satellite System (NPOESS) is planning to use polarimetric microwave radiometers systems in space to measure wind speed and direction.

With the data collected from this round of testing, researchers will get a sense of how breaking waves affect the measurement of wind speed and direction. They will then be able to estimate the errors in the measurements from satellite mounted instruments. Further research may include off-shore tower tests and tests of different radiometer frequencies.

Microwave Sensors

National Polar-Orbiting Operational Environmental Satellite System (NPOESS) program is managed by Integrated Program Office (IPO) and employs personnel from the Department of Commerce, Department of Defense, and NASA. The NPOESS is a satellite system used to monitor global environmental conditions, and collects and disseminates data related to weather, atmosphere, oceans, land, and near space environments.

Current microwave radiometer sensors used by NPOESS that POEWEX researchers are concerned with are the Conical Scanning Microwave Imager/Sounder (CMIS) and Windsat. CMIS collects global microwave radiometry and sounding data to produce microwave imagery and other meteorological and oceanographic data. The types of data produced include atmospheric temperature and moisture profiles, clouds, sea surface winds and all-weather land/water surfaces. Windsat is a fully polarmetric sensor in orbit which measures the ocean surface wind vector.



Above: Troy vonRentzell, Naval Research Laboratory engineer, records data sent by the microwave radiometer

Left: A suite of microwave radiometers is suspended above an artificial beach to measure the turbulence and speed of breaking waves

NOFI Trömso Tests Prototype Boom System

In November 2004, Mr. Dag Nilson, research and development manager at NOFI Trömso, came to Ohmsett to test the performance of a prototype, protected-water boom system. The project was sponsored by the Canadian Coast Guard, who was represented on-site by Senior Response Officer Ron McKay.

The objective of the in-tank research was to determine how various configurations and depths of below-water skirts affected boom performance in dynamic situations as it was towed through the water. During the tests, booms with various lengths of float, and different shapes of skirting were used. As each boom was towed, it would come to a hydrodynamic steady state where the boom would take its shape.

After each boom was tested intact, it was split in the center and tested in a guideboom configuration. Using the same tow point, towline length, and speeds of towing, researchers observed the apex, overall shape of the boom, and the flow of water over and under the boom in five different configurations. These observations were used to determine the best configuration for performance of each system.

The NOFI Trömso prototype boom system's performance is put to the test

Researchers at NOFI will use the data and video records to improve the boom system, and plan to conduct increasingly rigorous tests and entrainment studies with the next generation.

Final Skimmer Manufacturer Puts Their Device to the Test

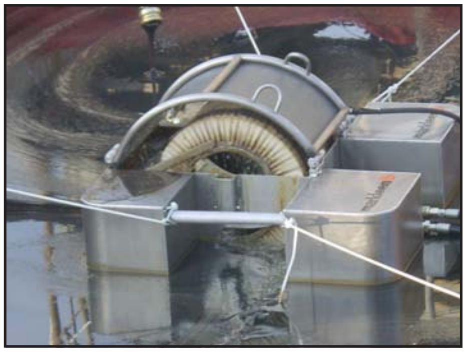
During three blustery days in December, researchers were at Ohmsett testing and evaluating a Quali Tech Environmental stationary skimmer. It was the last in a series of five skimmers to be tested. The collected test data will be submitted to the U.S. Coast Guard for obtaining an Effective Daily Recovery Capacity (EDRC) rating for the skimmer.

There are two ways to obtain an EDRC rating; using the name plate capacity on the skimmer, which is a calculated number the manufacturer assigns to it, or to conduct an actual test with the skimmer, such as the one Quali Tech Environmental held at Ohmsett.

The Ohmsett test was conducted with a stationary skimmer that could be used with a drum or brush adaptor. "In the series of short tests, we wanted to know how quick the skimmer was removing oil from the test area," said James McCourt, MAR, Inc. project engineer. "We matched the oil distribution rates to the recovery rates while maintaining a constant thickness of oil in the test area. The target oil thickness was 25 millimeters."

The skimmer was tested using two different viscosity oils; Calsol 8240 and Hydrocal 300. In a 21-foot square boomed recovery area segregated by a 24-inch boom of applied fabric, the test area was preloaded with oil to create a specific slick thickness. The target viscosity of the oil in the test area was 20,000 and 200 centPoise (cP) respectively. The light oil was tested in two thicknesses, 10 and 25 millimeters, in calm water as well as regular waves, with the target wave height of 18 inches using a 3.5 second wave peroid.

During the test, recovered fluids from the skimmer were sent directly to calibrated collection tanks where collection time, volume measurements, and oil/water samples were taken and analyzed in the Ohmsett laboratory. This data was used to determine the recovery rates and recovery efficiencies for each type of oil.



The Quali Tech Environmental stationary skimmer being tested to determine its maximum oil recovery rates and corresponding oil recovery efficiencies

New and Innovative Equipment and Technologies for the Remote Sensing and Surveillance of Oil In Ice

Continued interest in oil exploration and development in Alaskan offshore areas has become a strong motivating factor for the Mineral Management Services (MMS) to support the testing of new and innovative equipment and technologies for the remote sensing and surveillance of oil in and under ice.

Current methods involve drilling holes at intervals or in spaced grid patterns. This very labor-intensive method produces high error rates and involves serious safety issues. An ideal method would be an airborne system that would determine if oil is present, and map the boundaries of contamination.

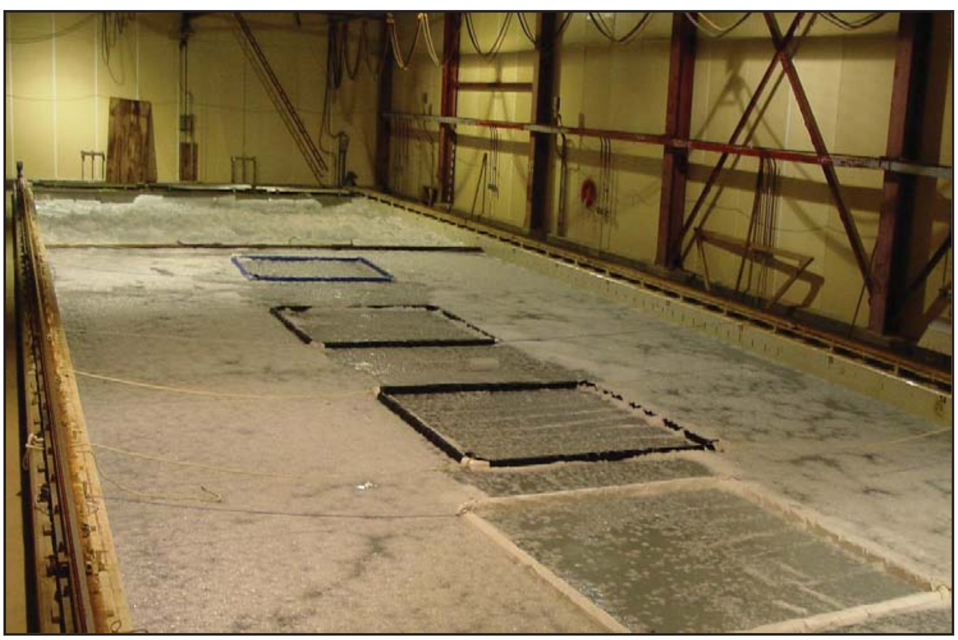
In November 2004, researchers assembled at the US Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, New Hampshire to test remote sensing technology systems to determine whether off-the-shelf remote sensing technologies and sensors can detect oil under ice in a controlled environment. The ultimate goal is to use these findings to develop reliable ground-based and airborne surveillance systems that could be deployed under a variety of oil-in-ice scenarios.

The project was managed by DF Dickins Associates Ltd. in association with MAR Inc., Boise State University, Exploration Technologies Inc., Shell Global Solutions (US), and the University of Glasgow, and Polaris Applied Sciences, Inc., and funded by MMS, Alaska Clean Seas (ACS) and Statoil ASA. Six drums of South Louisiana crude oil were donated and shipped by ExxonMobil.

CRREL was chosen as the test site because it is one of only a few facilities in the US with ice basins capable of forming a sea ice sheet under controlled conditions large enough for the project, and with the ability to use crude oil during the testing. The conditions at CRREL were ideal because the ice growth with urea water replicates the brine channels found in natural sea ice.

Ohmsett engineers and technicians provided support for this project. Technicians developed seven skirted boom test frames at the Ohmsett facility and assembled them at CRREL where they were positioned in the test tank and frozen in place. Once the ice reached six inches in thickness, MAR technicians worked with CRREL personnel to inject oil into the first three skirted boom test rings. After the cessation of ice growth, oil was injected under the ice in the four remaining skirted boom test rings.

Two primary remote sensing technology systems were tested: Ground Penetrating Radar (GPR) and an ultra-sensitive ethane sensor.



Seven skirted boom test frames were injected with oil, then frozen in place at the CRREL facility in New Hampshire

Ground Penetrating Radar has been used successfully in previous arctic studies to image sea ice thickness and map subsurface geology in frozen rivers. Radar results show a clear reflection from the ice/water interface in both the smooth ice and rough ice areas over the full range of antenna frequencies (including airborne runs up to three meters above the ice surface). Well-defined frequency, phase, and amplitude anomalies were observed where oil was known to be present at the ice/water interface and trapped within the ice. The agreement of experimental results with initial modeling indicates the potential to accurately predict GPR response to a variety of arctic spill scenarios and radar parameters in the future. The overall results clearly demonstrate the potential for detecting oil under sea ice with GPR.

The LightTouch™ ethane gas sensor uses a Tuneable Diode Laser Spectrometer (TDLS), that can measure real-time concentrations to an accuracy of ~50 parts per trillion, approximately 200 times better than gas chromatographic measurements. Results show measurable, but very low, levels of ethane flux being transmitted through the ice sheet within the oiled areas. Although the ethane flux from oil trapped under these artificial, test-tank conditions was extremely small, the ice coring data demonstrated that the oil and light gases, such as ethane, had penetrated nearly to the surface of the ice within the 14 day program duration (initial spill to final day of testing). Given longer times and natural ice conditions providing additional gas migration pathways, it appears likely that an airborne LightTouch™ detection system would be capable of detecting ethane emissions associated with a real oil spill.

The results of this initial project represent a significant breakthrough when viewed against decades of previous work, resulting in few if any practical solutions to the oil-in-ice detection problem. Follow-on work was recently funded by MMS and the original partners to demonstrate the radar system over thick sea ice at Prudhoe Bay (April 2005), develop software to automate the signal processing and interpretation, and begin planning for possible field tests with oil under natural ice in 2006.

Heavy Oil Detection with Laser Fluorometers

The capability to detect and track an oil spill is limited, especially for heavy oil which can exhibit a variety of physical characteristics during a spill. This became apparent during a recent oil spill in Buzzards Bay, Massachusetts. With no systems in place to track the spill overnight, the oil came ashore before equipment could be deployed. According to Kurt Hansen of the U.S. Coast Guard Research and Development Center (RDC), a nighttime tracking system may have helped determine that the spill was larger than first suspected and allow for deployment of early response efforts which could have reduced the cost of cleanup and the environmental impact.

Representatives from the U.S. Coast Guard RDC were at Ohmsett January 10-28, 2005 to test and evaluate three laser fluorosensing systems that have been shown to have the capability to detect oil spills at night as well as under the water surface. The companies and systems that are capable of this type of work are: the NASA Airborne Oceanograhic LIDAR (AOL-3), a commercial system by Laser Diagnostics Instruments International, Inc. (LDI3), and a fluorescence LIDAR being developed by Science & Engineering Services, Inc. (SESI) for the Defense Advanced Research Projects Agency (DARPA).

"We want to learn more about laser systems that can consistently look under the water's surface during most conditions," said LT Joshua Fant, USCG. "This research and development should help in reducing the cost of oil spill cleanup and its impact on the shore, by detecting it out at sea using lasers, and cleaning it up prior to impacting sensitive shorelines."

The Coast Guard's current systems are Forward Looking Infrared (FLIR) cameras that can track oil in the early states of a spill and side-looking radars (SLAR) that can detect surface oil. Both are environmentally limited and produce a high rate of false positive data.

"Oil spills sink after a couple of days and can not be detected with conventional methods," Fant said. "The laser systems that are being developed can be mounted in aircraft to detect oil spills from 500 to 1000 feet."

Testing for all three systems consisted of testing oil on the surface with two oils and under the surface with three oils, as well as the use of fluorescent dyes. Measurements were taken of the depths the systems could reliably detect the laser induced fluorescence of oil in water, and if the systems could differentiate the types of oils.

The first system tested was Airborne Oceanagraphic Lidar (AOL-3) developed by NASA. AOL-3 is a remote sensing instrument carried onboard aircraft and incorporates several sensors including a dual wavelength active laser fluorosensor, several passive down and up looking spectrometers, and a thermal infrared temperature sensor. The AOL-3 also carries spectrometers similar to the type used by satellite sensors that measure the color of the sunlight reflected from the ocean. NASA uses this system and other LIDAR sensors for oceanography projects that measure chlorophyll as well as the topography of sea ice, glaciers, and icecaps.

"Plant chorophyll in the ocean consumes dissolved carbon dioxide to build cell material. Eventually the cell material ends up in the bottom of the ocean, removing that carbon dioxide from the atmosphere. This makes remote measurement of chlorophyll a valuable tool to monitor global warming," said Jim Yungel, remote sensing scientist

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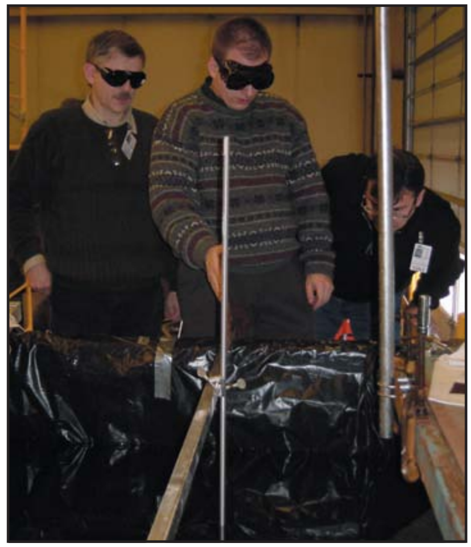

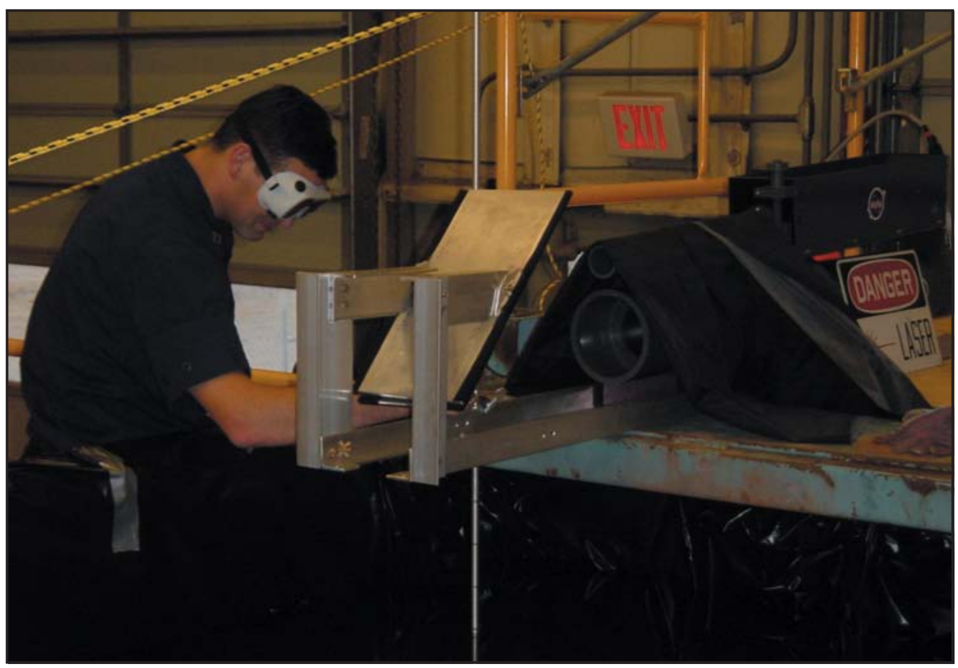

Top: Representatives from Laser Diagnostics Instruments International, Inc. (LDI3) prepare to test their Light Detection Ranging systems (LIDAR) in a test tank

Below: LT Joshua Fant of the United States Coast Guard sets up a laser for the Heavy Oil Detection evaluation

Heavy Oil Detection

Continued from page 6

for NASA. “We were able to modify the NASA chlorophyll sensing system and adapt it to oil because both chlorophyll and oil glow when hit with laser light.”

The second system tested was the LDI3 Fluorescence Lidar System (FLS), based on Laser-Induced Fluorescence (LIF) spectroscopy. LDI3 FLS series of LIDARS are versatile, multi-purpose remote sensing devices, well suited for delineation and profiling of oil spills in water and on the ground, oil pipeline leak detection and oil exploration, characterization of plankton in sea and lake water, and sediment dynamics studies from ships or airplanes.

“The system is rugged and highly resistant to noise due to floating debris, waves, and weather and natural lighting conditions. With FLS we can analyze oil on and under the surface of water, and differentiate between heavy oil, lighter oil, diesel fuel, gasoline, and oil dispersants in the range of concentrations from 0.5 parts per million (ppm) to solid surface slick, which is important during disaster response activities and clean-up operations,” said Alexandre Vorobiev, project manager for LDI3. “FLS Lidars are highly modular and can be used with any suitable laser source.”

“Among its strengths and unique features is the number of wavelengths simultaneously available for sensing. Fully automated gathering, real-time processing and visualization of data allows for base survey routing decisions on the real-time assessments of the situation on the ground,” Vorobiev said.

A complementary system, the Instant Screener, was demonstrated during the tests. It is a compact laboratory sample fluorescence analyzer based on Spectral Fluorescence Signature (SFS) technology used for characterization of fluorescence of liquid and solid samples in either batch or flow-through mode.

“The Instant Screener can be used for characterization of sub-surface oil contamination or plankton studies,” Vorobiev said. “It directs a light beam of different colors through water samples and analyzes the response spectrum which immediately reflects minute changes in the concentrations of certain chemicals, such as oil products and oil dispersants, in the sample.”

The final test was by SESI. Their current LIDAR system called UBTL (Ultraviolet Biological Trigger LIDAR), transmits ultraviolet light from a solid state laser and a laser diode. It is used to detect chemical and biological agents by sensing characteristic visible wavelength fluorescence of bio-aerosols and can collect data in temporal and spectral modes simultaneously. It was developed under the DARPA Semiconductor Ultraviolet Optical Sources (SUVOS) Program directed by LTC John Carrano. If research and testing prove that UBTL can detect oil, chemicals, and biological warfare agents, and work during both nighttime and daytime, it could be installed on aircraft for multiple uses.

The Coast Guard Research and Development Center plans to consolidate the information gathered from the testing conducted at Ohmsett and present it to Coast Guard Headquarter’s Office of Response (G-MOR). The testing results and contributions from other sensor analyses will allow the Coast Guard to determine the direction for increased oil and chemical detection capabilities. The Coast Guard anticipates testing at least one of the systems in the Ohmsett wave tank later in 2005 for more advanced potential uses.

Catch Us At These Conferences!

International Oil Spill Conference
May 15 - 19, 2005
Miami Beach, Florida

Clean Gulf Conference & Exhibition
November 9 - 10, 2005
Galveston, Texas

Interspill 2006
March 21 - 23, 2006
London, England

The Ohmsett Gazette is published by Ohmsett--The National Oil Spill Response Test Facility--to update our readers on activities at the facility.
For info call: (732) 866-7183.

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2005 Ohmsett Training Schedule

May 2 - 6, 2005	USCG Oil Spill Responder Technician Training (1 of 3)
June 6 - 10, 2005	USCG Oil Spill Responder Technician Training (2 of 3)
June 20 - 24, 2005	Ohmsett Training (with Texas A&M University Corpus Christi)
Aug.15 - 19, 2005	USCG Oil Spill Responder Technician Training (3 of 3)
Aug. 22 - 26, 2005	USCG National Strike Force Training Course
Sep. 12 - 16, 2005	Alaska Clean Seas Training Program (1 of 2)
Sep. 19 - 23, 2005	Alaska Clean Seas Training Program (2 of 2)

To register for a training session, call the Ohmsett training coordinator at 732-866-7183 (ext. 12) or visit the Ohmsett website at www.ohmsett.com for course descriptions, fees and registration forms.

Ohmsett

Oil Spill Response Research

TESTING TRAINING RESEARCH

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