Ohmsett Newsletter
Spring 2023

The Ohmsett Gazette

The National Oil Spill Response Research & Renewable Energy Test Facility

New Boom Design for In Situ Burn

It can be quite the sight to see, one we hope not to see often: a large swath of a boom in the open ocean containing a slick of oil set ablaze. In use for more than 50 years, in situ burning of surface oil is an effective tool for dealing with large-scale oil spills. Although fire booms have gone through extensive improvements and tests over the years to increase their efficiency, they still create thick black plumes of smoke and leave behind waterborne products of incomplete combustion due to insufficient oxygen and heat.

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What's Inside

Rapid Determination of Surface Oil Thickness

What if the technology used to map the subsurface ocean layer could be used in detecting and monitoring the physical characteristics of oil spills? That is the subject of current research being conducted by the Bureau of Safety and Environmental Enforcement and the United States Naval Research Laboratory with a series of evaluations using Light Detection and Ranging technology (LiDAR).

LiDAR is an active remote sensing system that sends light as a pulsed laser and measures the returned light to estimate the distances and intensity and shows promise for oil spill applications. "A rapid determination of the surface oil thickness is critical to the oil spill response community. It allows us to determine the appropriate response to minimize the impact of accidental releases," said Dr. Jay Cho, program manager with BSEE's Oil Spill Preparedness Division.

For two weeks in January/February 2023, researchers performed evaluations at Ohmsett for above-water LiDAR technologies. According to Cho, they wanted to evaluate the backscatter signal intensity, fluorescence, and polarization, to characterize surface oil slicks and

The LiDAR system was mounted on the auxiliary bridge above targets containing weathered crude oils to collect data.

subsurface oil/water emulsions. "This will help us develop software to enable automated, near-real-time processing and visualization of LiDAR data sets, emphasizing oil analyses."

Preliminary tests were conducted in the high bay for controlled baseline

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Using CFD to Predict Full-Scale Boom Performance

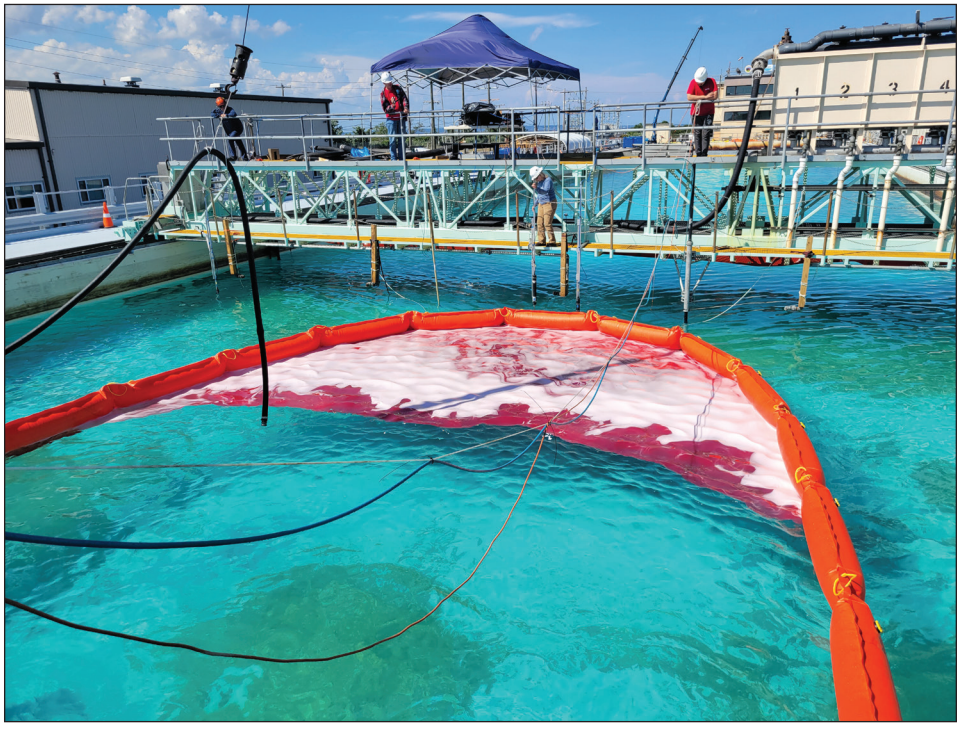
To increase industry knowledge on how computational fluid dynamics modeling may predict full-scale boom performance during testing, the Bureau of Safety and Environmental Enforcement and contractor Serco researched and compared several containment booms at various scales. The tests took place in the Ohmsett test tank over multiple weeks in August and December 2022. Each boom was measured for tow speeds at which oil entrainment occurred and results were compared to CFD modeling of the same systems.

For the study, the selected booms represented those held in inventory and used extensively by Oil Spill Removal Organizations. "Two custom inflatable curtain booms and one custom internal foam curtain boom were supplied by Elastec and Abasco. The booms were designed to replicate standard curtain booms and were sized such that the 100% scale would be as large as practical for testing at Ohmsett and scaled down at either 50% and 25% or 60% and 33%," explained Kristi McKinney, BSEE program manager.

Each test series was conducted in calm conditions to minimize variables using two standard test oils of varying viscosities – Hydrocal 300 and Calsol 8240. Tethered between the main and auxiliary bridges, the apex of each boom was preloaded with oil and towed through the water. "Entrainment was identified visually during each test using underwater cameras located close to the boom apex. Overhead cameras and visual observation were used to confirm entrainment, especially as the boom exhibited gross loss of oil," McKinney said.

According to McKinney, this study will improve their understanding of the usefulness of CFD modeling for predicting towed oil boom entrainment and whether modeling could be used to accurately predict the performance of new boom designs. "In addition, the Ohmsett tests can help answer the question of whether scaled boom testing can predict results that may be expected out in the field while using full-scale containment boom systems."

The data is currently being analyzed and will be available on the BSEE website at the conclusion of the project.



Full-scaled booms were measured for tow speeds at which oil entrainment occurred and results were compared to CFD modeling of the same systems.

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LiDAR

testing before moving to the tank. "The experiment's goal in the high bay was to control the oil conditions better before we went to the outside tank, which offers conditions closer to a field experiment," said Cho.

Out on the Ohmsett tank, the researchers used weathered crude: Hoover Offshore Oil Pipeline System (HOOPS), emulsified HOOPS, and Alaska North Slope (ANS). Round metal targets were placed in the tank containing predetermined amounts of oil with various physical characteristics. The LiDAR system was mounted on the auxiliary bridge above the targets to collect data.

"Although the LiDAR measurement has some uncertainty in the amount of oil thickness, the LiDAR measurements relate to three thickness categories (0-0.5mm, 0.5-1mm, and >1mm) without ambiguity, which should help determine the appropriate response technology," explained Cho.

"With LiDAR, we can evaluate an oil volume if we obtain a large measurement statistic, like what would happen during an airborne survey. However, to demonstrate this capability, we would need to design a different experimental setup at Ohmsett to sample the horizontal structure of the oil slick. We need to conduct more testing before we can confirm this capability."

Evaluating Emerging Technology: TOST

When responding to an oil spill incident, the U.S. Coast Guard Federal On-Scene Coordinators and the spill responders must determine what new or emerging technology will be the best solution for the type of spill they are encountering. The challenge to making that determination is based on whether there is relevant data for the technology available during the incident. The best way to ensure reliable data exists is to conduct independent tests and evaluations of these technologies before an incident occurs. As a result, the USCG Research and Development Center partnered with the Bureau of Safety and Environmental Enforcement Oil Spill Preparedness Division to develop the Emerging Pollution Response Technology Evaluation Project/Testing of Oil Spill Technologies – TOST.

Since sorbents are widely used for oil spill incidents, the USCG and BSEE kicked off the TOST project in October 2022 with two weeks of testing to evaluate new and emerging Type I sorbents. According to Alex Balsley, RDC Project Manager, USCG RDC, Type I sorbents are specified in the ASTM F726-17 Standard Test Method for Sorbent Performance of Adsorbents as roll, film, sheet, pad, and blanket sorbents. "At Ohmsett, the project team tested relevant functional characteristics of a sorbent, including its maximum oil adsorption capacity, amount of water uptake, and buoyancy, to name a few."

To select the best candidates for Ohmsett testing, the project team started with a request for information and reviewed each submission using RDC's Oil Spill Response Technology Evaluation Guidance document. "The first requirement for the sorbent was that the Technology Readiness Level had to be at least TRL 6 (meaning a full scale prototype has been demonstrated in relevant environments) to be considered new or emerging and is almost ready for commercialization," explained Balsley. "The project team also looked at many other factors, including completeness of the submittal, previous test data/results, and types of oil targeted. In the end, the team decided that four of the adsorbents submitted met the necessary requirements to warrant additional testing at Ohmsett."

Using load cells to document weight changes at set intervals, the team also measured the final tear force of the sorbents.

The four adsorbents chosen to be tested using the ASTM F726 Laboratory Tests and the BSEE/Ohmsett Field-Scale Sorbent Protocol were: Earthwise's Oil-Only Heavyweight Pads, MFNS Tech's OHM Sponge, AquaFlex's Open Cell foam, and Imbibitive Technolgies' Imbiber Fiber which are based on their Imbiber Beads product. "All adsorbent samples were tested using the same protocols, except we tested the adsorbent's reusability only with the AquaFlex Open-Cell foam. AquaFlex provided a manual wringer system, and due to the test/evaluation agreement between RDC and AquaFlex, the wringer could only be used for AquaFlex's product," said Balsley.

During the tests, the project team used diesel and Hydrocal 300 (similar to medium crude oil) to determine the sorbent's effectiveness with light to medium crude oil types and collected important data about each adsorbent's ability to adsorb oil and repel water in quiescent and mix-energy conditions. "The team followed the ASTM F726-17 standard to measure maximum oil capacity and adsorption rate. Oil and water adsorption was measured using the BSEE/Ohmsett Field-Scale Sorbent Protocol," Balsley explained. "The team also looked at the physical characteristics of each sorbent and was able to make qualitative observations about their ability to be retrieved in the field when saturated with oil. The experiments ended by collecting data on reusability only with AquaFlex's Open-Cell foam."

After a complete analysis of the data, a final report will summarize the

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MPRI Study to Understand Oil-in-Water Emulsions

The Bureau of Safety and Environmental Enforcement and the Ohmsett Facility are international research members of Fisheries and Oceans Canada, a Multi-Partner Research Initiative whose mission is to foster an integrated, global research network with government agencies, academia, response organizations, the oil industry, indigenous communities, and other oil spill science and response experts. A recent MPRI research project focuses on studying and understanding the chemical and physical characteristics of water-in-oil emulsions. A portion of this study compares the oil-in-water emulsion production, testing, and characterization protocols developed by different research groups in the U.S., Canada, and Norway.

In addition to their involvement with MPRI, BSEE, and Ohmsett have been studying the production and characterization of oil-in-water emulsion formation for several years to enhance Ohmsett's capabilities for oil spill response research. These activities included creating detailed protocols to carefully craft "recipes" for customized and repeatable emulsions at lab-scale, bench scale, and large-scale testing in the Ohmsett wave tank.

During Phase I of this MPRI study in the winter of 2022, several participating labs, including the Ohmsett lab, emulsified identical sets of oils and characterized the resulting emulsions. "The goal was to determine if the various emulsion protocols produce emulsions with similar or differing physical and chemical properties," explained Karen Stone, BSEE Response Research Branch chief and principal investigator for the effort.

Phase II took place at Ohmsett on Sept. 12–23, 2022, where the tank-generated emulsions of source oils from the previous lab tests were compared for variation in their properties. "The lab and tank-scale protocols established by Ohmsett offered the only realistic wave tank environment with natural ultraviolet energy," commented Stone.

The Ohmsett staff developed a new capability enabling them to assess three oil emulsions in the tank simultaneously. The oil slicks were kept physically and energetically isolated using three parallel tracks of oil containment boom along with controlled surface currents while running waves unimpeded through the test area and the slicks.

"This current research focuses on determining if the methods utilized by various laboratories to create stable emulsions matter in the resulting emulsions. Furthermore, it addresses whether photooxidation, caused by the sun's ultraviolet energy to create stable emulsions, plays a role in making the emulsions more difficult to remediate."

To understand the effects of various conditions for emulsification, the Ohmsett and BSEE staff created emulsions on open water in the Ohmsett wave tank. In the controlled saltwater environment, they created real-world conditions that included wave action and sea turbulence, exposure to natural weathering conditions, and including exposure to sunlight to affect photooxidation.

The staff developed a new testing capability that enabled them to assess three oil emulsions in the tank simultaneously. The oil slicks were kept physically and energetically isolated using three parallel tracks of oil containment boom along with controlled surface currents while running waves unimpeded through the test area and the slicks. At night, the emulsions remained isolated using subsurface turbines called "ice eaters." The main bridge was able to pass over the oil test area to provide access for observation and sampling.

Samples of the surface oil emulsions were collected and analyzed to determine the role of photooxidation in emulsion stability and to characterize other important physicochemical properties impacting recovery operations during oil spill disasters.

According to Stone, the results of this study will aid in calibrating NOAA's spill trajectory models and help the global oil spill response community better understand the recovery mechanisms required for emulsified oils during spill events.

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Restricted Burning Tongue

BSEE conducted research, including half-scale tests, to determine if a boom configuration of less than three meters would reduce airborne pollutants in the plume and the amount of waterborne burn residue. In October 2022, under a contract with BSEE, Elastec of Carmi, Ill., brought its modified fire boom equipped with an oil feed gate to Ohmsett to test its performance.

The new boom technique called the Restricted Burning Tongue is designed with a gate (fire break) at the mouth of the boom leading to a rigid stem of the fire boom to provide a controlled area for burning. BSEE Response Research Branch Chief Karen Stone describes the design as a wine-glass formation where the cup of the boom system collects the oil. Once sufficient volumes are achieved, the gate at the apex of the boom is opened to allow the oil to spill into a long narrow stem where it will be ignited. "The narrow geometry allows air to reach the core to promote complete combustion. What's really exciting is that OSROs [Oil Spill Removal Organizations] can use fire boom already in their inventory and not need to make additional investments."

While no actual burns were conducted at Ohmsett, the gated system was exposed to multiple wave conditions. "The objective was to determine if oil within the gated boom system would behave in a manner conducive for burning as well as measure other properties to aid in the future ignitions such as the extent of the oil, oil thickness, and the best location within the slick to ignite the oil," explained Stone.

The boom stem and gate system were rigged to the Ohmsett main bridge with two 50-foot lead sections of fire boom with the opening set 50 feet apart. Using a base stock refined test oil (Hydrocal 300), non-burning tests were conducted to observe seakeeping characteristics under tow and how the oil is transported through the gate and within the boom stem. The system was tested in calm and wave conditions. Cameras were set up in multiple locations on the boom itself and on the North Bridge to capture visual documentation of the boom's performance.

"The boom system passed with flying colors and the system underwent burn tests at a specialized test facility," said Stone. "BSEE and Elastec will demonstrate the technique during controlled offshore burn experiments being sponsored by the Canadian government."

A new boom technique called the Restricted Burning Tongue is designed with a gate (fire break) at the mouth of the boom leading to a rigid stem of the fire boom to provide a controlled area for burning.

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Testing Oil Spill Technologies: TOST

findings from Ohmsett and provide recommendations that could help responders understand the potential limitations of each adsorbent material. "All vendors have agreed to make the data available to the public. The results should help them better understand specifically how their products performed," said Balsley. "The RDC and BSEE OSPD are planning to continue a second round of evaluation in 2023 with a different technological focus area. We are still discussing ideas, but once the technology area is selected, we are likely to return to Ohmsett near the end of 2023."

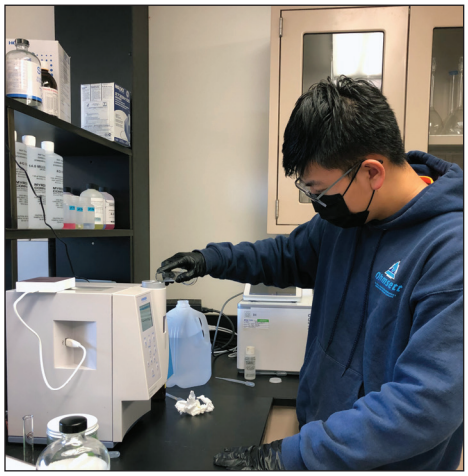
Meet our High Tech High STEM Interns

Ohmsett participates in High Technology High School's student mentorship program where a senior elects to intern at a company of their choice, and receives high school credit for work completed during that time. High Tech High, as it is affectionately called, is located in Lincroft, N.J., and is a nationally recognized Blue Ribbon specialized school concentrating on math, science, and technology.

After a two-year break due to COVID-19 and our tank refurbishment, we have once again had the pleasure of hosting students. At the start of the school year in September 2022, Michael Gao joined the team to learn about oil spills and the laboratory analysis performed on the recovered fluids.

Michael is enrolled in Advanced Placement chemistry and multi-variable calculus. While he is unsure of what his major will be in college, he is considering math, environmental engineering, or computer science.

During his mentorship at Ohmsett, he assisted in instrumentation calibrations, lab analysis, and water sampling during testing. He stated his AP chemistry classes have been very helpful for the lab analysis and water sampling.



Michael Gao, a senior at High Tech High School, spent his internship at Ohmsett assisting in instrumentation analysis and water sampling.

When Michael's mentorship ended in January 2023, Patrick Keenan's began in February. Patrick is a rising senior at High Tech High where his curriculum mostly focuses science technology, engineering and math. He is assisting in the Ohmsett on-site oil water lab where he analyzes water samples collected during testing. Additionally, he is helping build our lab-based dispersant effectiveness testing capability.

With an eye toward a mechanical engineering degree, Patrick has received early acceptance to Auburn University, Ohio State University, Baylor University, Texas A&M University, and Arizona State University.

At the end of each student's mentorship, they are required to develop a presentation for their class that includes information about the placement, the projects worked on, and how it will guide their future study.

High Tech High senior, Patrick Keenan assists with building Ohmsett's lab-based dispersant effectiveness testing capability.

Hands-on Spill Response Training

Confidence comes from knowing response personnel can handle just about anything that happens during a spill. To provide the knowledge and training for effective spill response operations, Ohmsett has partnered with Texas A&M National Spill Control School to offer hands-on Oil Spill Response Strategies and Tactics training.

This year, the course was held March 7-10, 2023. In the classroom, attendees learned about recent developments in the science of oil spills and response operations. Following the classroom instruction, students received hands-on training in the tank operating skimmers while recovering real oil and observed a side-by-side comparative dispersant demonstration.

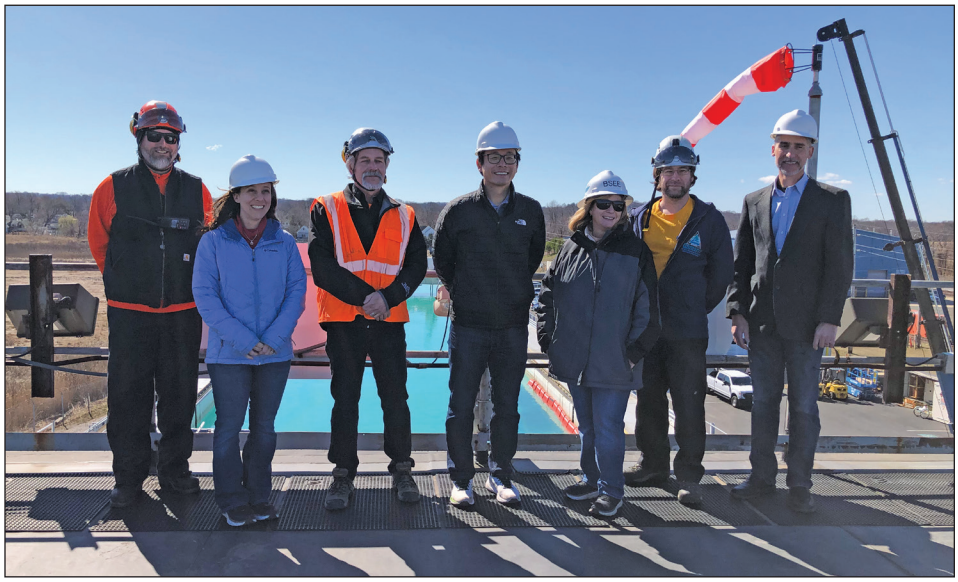
The next course will be held Sept. 19-22, 2023. Register online at https://www.tamucc.edu/research/nscs/course-offerings/course-schedule.php

Hands-on Oil Spill Strategies and Tactics training includes operating skimmers to recover real oil.

BSEE Deputy Director Tours Ohmsett

We had the pleasure of hosting the Bureau of Safety and Environmental Enforcement's Deputy Director Paul Huang and Environmental Protection Specialist Juliette Giordano for a tour of the facility. Applied Research Associates' Ohmsett technical staff provided an overview of the oil and water chemistry lab before a guided tour of the tank that included an oil spill dispersant demonstration. While observing the demonstration, BSEE Response Research Branch Chief Karen Stone explained the application of dispersants during oil spill operations. The tour ended with a panoramic view of the New York skyline, the New Jersey shoreline, and the wave tank from the roof of the Ohmsett tower building on a sunny, but chilly March day.

Paul Huang and Juliette Giordano view a dispersant demonstration from the main bridge.



The BSEE Deputy Director's tour included a panoramic view of the New York skyline, the New Jersey shoreline, and the Ohmsett the wave tank.

From left to right: Ohmsett Health and Safety Specialist/Engineering Technician, Tom Schmidt; BSEE Environmental Protection Specialist, Juliette Giordano; Ohmsett Facility Manager, Tom Coolbaugh; BSEE Deputy Director, Paul Huang; BSEE Response Research Branch Chief, Karen Stone, Ohmsett Senior Mechanical and Test Engineer, Grant Coolbaugh; Applied Research Associates, Inc. Vice President, Doug Meegan.

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Oil Spill Response Research & Renewable Energy Facility

The Ohmsett Gazette is published biannually to update our readers on testing, training, and research activities at the facility.

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Where Will Your Technology Take You?

Prototyping is an important step in new product development for oil spill technology, marine energy systems, and blue technology. Whether it is to explore new designs or refine existing technologies, Ohmsett can assist in testing for maximum results in performance, survivability, autonomous operation, maneuverability, and sensor integration.

In the relatively controlled and repeatable test environment of the outdoor wave tank, developers have access to expertise and tools for scaling new technology and validating engineering expectations under varying flow, position, and load conditions.

- Full-scale testing with oil
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- Containment boom & barriers
- Sensors
- Wave energy converters
- Protocol development
- Controlled marine environment
- Accurate and reliable results

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