Carderock Testing New Oil Boom Fouling Release Material

New Material Reduces Biofouling, Simplifies Cleaning

PERSONNEL FROM THE Naval Surface Warfare Center, Carderock Division (NSWCCD) are validating the use of an environmentally friendly non-stick coating in conjunction with in-water cleaning to reduce the biofouling of oil containment booms.

An oil containment boom is a floating physical barrier used around ships and waterfront facilities to proactively contain oil and fuel spills. Permanently deployed oil booms are used extensively by the U.S. Navy around the world—in fact, the U.S. Navy is the world's largest user of permanent oil boom.

To maintain their effectiveness, booms must be periodically cleaned of marine biofouling such as barnacles and sea grass. This cleaning must be performed to ensure the boom is not weighed down by the fouling, which would reduce the boom's effectiveness as an oil spill containment barrier. Typically, the boom must be removed from the water and cleaned with a pressure washer.

To reduce manpower labor and time, NSWCCD personnel, with resources provided by the Navy Environmental Sustainability Development to Integration (NESDI) program under project number 489, are investigating the use of a prototype oil containment boom manufactured with a commercially developed, non-toxic, biofouling release material. The material used in this oil boom prototype has been well demonstrated in civilian applications.

The U.S. Navy is the world's largest user of permanent oil boom.

Boom segments as deployed prior to cleaning at Port Canaveral. Shown are Hank Loeb of Severn Marine Technologies (left) and Kody Lieberman, Florida Institute of Technology.
Abe Stephens

It has been shown to retard early stage accumulation of marine biofouling on netting for fish pens and security barriers, on the transducer faces of oceanographic instruments, and on acoustic streamers (towed arrays used for seismic surveys). This foul-release material has been similarly used to reduce marine biofouling and associated drag on autonomous ocean crossing gliders, a relatively new class of autonomous underwater vehicles.

On this NESDI-sponsored effort, oil boom prototype barrier segments were constructed by impregnating polyester fabric with a novel silicone foul-release polymer. This resulted in a highly resilient, durable material with a non-stick surface. The material's durability and flexibility makes it difficult for marine growth and barnacles to settle on and remain attached to the boom. In the long term, these material properties create a boom that can easily be cleaned by mechanical methods to a like-new condition. This cannot be achieved with currently-used stock boom, short of expending additional labor and harsh chemicals.

Because this foul-release oil boom prototype does not rely on biocides, it is nontoxic throughout its effective life cycle and disposal. At the end of its useful life, it can be buried or burned. With its ability to be cleaned so thoroughly that little if any bio-matter remains, it can also be safely recycled as filler material for other products.

NSWCCD personnel chose three sites for the demonstration and validation of the prototype boom:

1. Naval Magazine Indian Island on Puget Sound Washington
2. Naval Base Ventura County in Port Hueneme, California
3. Florida Institute of Technology/Center for Corrosion Biofouling Control (FIT/CCBC) in Port Canaveral, Florida

Beginning in April 2014, all three sites deployed oil boom prototype and stock test segments 10 to 12 feet in length along with smaller swatches of boom material samples.

Initial observations of deployed boom test segments during the first few months revealed that the foul-release-based booms shed marine biofouling more readily than the stock control booms during handling. Similarly, with ambient wave and wake action, there was less accumulation of marine growth observed on the treated prototype.

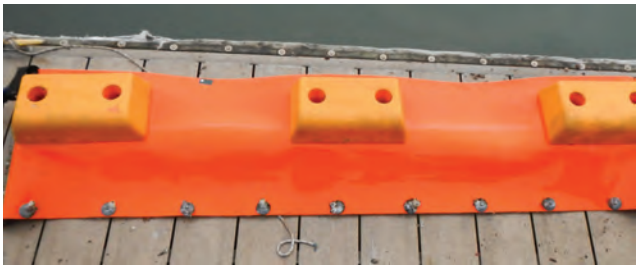
FIT/CCBC, being a hull-coating biofouling test site of record with Office of Naval Research, also fielded

Photo adhesion and shear force biofouling testing showed the prototype boom performed three to five times better than the stock boom.
Pat Morrow

numerous small swatches or coupons for shear force biofouling adhesion measurements. These tests attempt to measure the force with which barnacles and other biofouling matter adhere to a surface. Results of this testing indicated that biofouling adherence was three to five times lower in the prototype boom.

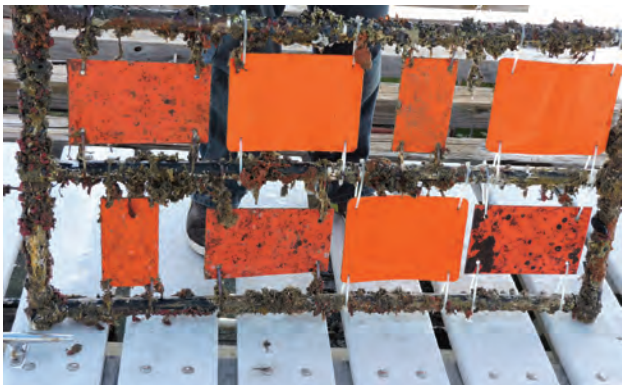
The first cleaning tests were conducted at Port Canaveral after the prototype boom was in the water for nine months. This two-part effort started with a test to determine the reduction in cleaning time that could be achieved by using oil booms with foul-release coating.

Stock boom segment after cleaning.



Foul-release boom segment after cleaning.

Test coupons of stock and treated boom as shown before cleaning.
Kody Lieberman



Test coupons after cleaning. The prototype boom coupons are shown on the top row, second and fourth coupons from the left, and on the bottom row, third coupon from the left.
Kody Lieberman

In the second test, a portion of each test boom, both stock and foul-release prototype, underwent in-water cleaning using a pressure washer operating from a small skiff with the boom segments moored along a floating dock.

The out-of-water cleaning tests showed the time required to clean the foul-release based boom was reduced by 52 percent when compared to the stock boom of similar design. Additional testing further indicated that in-water cleaning is likely practical and has significant potential for labor savings on the order of 80 to 90 percent.

This is mainly because in-water cleaning eliminates much of the labor required to remove the boom from the water. In-water cleaning could further reduce the overall inventory of required oil boom, because any boom removed for cleaning must be immediately replaced with another boom.

Another significant result showed that the prototype boom belting displayed comparable damage resistance to the stock boom during pressure washing at nominal working pressures of 3,000 pounds per square inch. However, some minimal care was required in handling and cleaning to avoid damaging the foul-release-coated floats. In-water cleaning efforts demonstrated the practical advantage of reducing the wear and tear associated with handling and hauling the booms for out-of-water cleaning.

The ad hoc in-water cleaning tests at Port Canaveral demonstrated that the prototype boom remained clear of fouling better than existing booms, and further demonstrated that it is practical to remove an acceptable amount of fouling to maintain the proper performance of the prototype foul-release boom. However, fouling still occurs and periodic cleaning will be required.

More field testing is planned to develop additional methods for efficient in-water cleaning. The focus will continue to be on reducing environmental impact and determining whether more or less frequent cleaning is warranted with the use of these booms. The idea of more frequent cleanings would be to clean often and lightly before heavy and hard fouling becomes well established. The benefits of less frequent cleanings are lowered labor costs and less wear and tear from handling. With the foul-release material, the projection to date has been the ability to clean easier, faster, and less often.

The Basics About the NESDI Program

THE NESDI PROGRAM seeks to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.

The NESDI program is the Navy's environmental shoreside (6.4) Research, Development, Test and Evaluation program. The program is sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by the Naval Facilities Engineering Command out of the Naval Facilities Engineering and Expeditionary Warfare Center in Port Hueneme, California. The program is the Navy's complement to the Department of Defense's Environmental Security Technology Certification Program which conducts demonstration and validation of technologies important to the tri-Services, U.S. Environmental Protection Agency and Department of Energy.

For more information, visit the NESDI program web site at www.nesdi.navy.mil or contact Ken Kaempffe, the NESDI Program Manager at 805-982-4893, DSN: 551-4893 or ken.kaempffe@navy.mil.

For a one-page summary of this project, visit the NESDI web site, select "Projects" then select the "Fact Sheet" link for project 489.


Fact Sheet

Oil Boom Biofouling Control by Mechanical Intervention and Material Technologies

Initial observations of deployed boom test segments revealed that the foul-release-based booms shed marine biofouling more readily.

Two different types of untreated stock boom were tested alongside the foul-release boom. Unexpectedly, there was an observed improvement in the performance of the textured stock boom over the smooth stock boom. The reasons for this are being considered for further investigation.

More long-term study is needed regarding cleaning savings and material longevity before a more detailed estimate can be made of the effective return on investment. At present, this material offers significant improvement in performance for a cost premium.

It was found during the Florida cleaning trials that cleaning effectiveness could be improved through ergonomic alterations to the wand of the pressure washer as well as fixtures for securing the boom during cleaning. These and other lessons learned will be applied at the Navy sites on the west coast.

Upon completion of cleaning tests at the California and Washington locations, more conclusive performance information will be available. Thus far, from the combined results of in-water observations and the recent cleaning tests at Port Canaveral, the foul-release material performance is encouraging.

Matthew Naiman
Naval Surface Warfare Center, Carderock Division
301-227-4981
DSN: 287-4981
matthew.naiman@navy.mil

Tim Hunt
Naval Surface Warfare Center, Carderock Division
301-227-4313
DSN: 287-4313
timothy.hunt.ctr@navy.mil