

STREAMS OF INFORMATION

A SMALL COMPANY DEVELOPS A BREAKTHROUGH SENSOR USED
IN SHIPS' BALLAST-WATER TREATMENT SYSTEMS

After developing chlorine and bromine generators for swimming pools in the late 1980s, Michael Silveri launched a small company in 1994 that created sensors for hot tubs and pools. His early modest success hardly foreshadowed his next undertaking: devising cutting-edge technology for a water-treatment sensor at the behest of the U.S. Navy.

Silveri, whose Halogen Systems, Inc. is based in Incline Village, Nevada, was introduced to the project through a Small Business Innovation Research (SBIR) solicitation. The Office of Naval Research (ONR) was looking for a better solution for a critical issue: biofoul control. The ensuing research and development process ultimately rendered an answer to another vital maritime necessity: ballast-water treatment.

Ships take in ballast water from oceans across the world,



picking up invasive species that, when released later, have the potential to wreak havoc on ecosystems and industries, costing billions of dollars and causing unquantifiable environmental damage. To counter the spread of invasives and to meet international standards, vessels implement a range of treatment systems, including some that use chlorine as a disinfectant. Ships also require desalination systems, which use chlorine and face biofouling challenges.

But the chlorine in water-treatment systems must be precisely measured to ensure sufficient disinfectant potency and again following neutralization before the effluent is released back into the sea. The sensor responsible for the measurement also needs to measure salinity, withstand difficult environmental conditions, and preferably need little maintenance. The Navy's SBIR solicitation sought a sensor capable of producing real-time chlorine-detection data to be used in feedback control for ships' hypochlorite generators and dechlorination pumps in desalination systems.

Silveri saw not only a challenge to help the Navy but also a commercial opportunity. When a shipping industry representative said the solicitation's lofty goals were impossible, Silveri only grew more determined. "He told me, 'Big companies haven't been able to do it. We don't really think you can do it,'" Silveri said. "Incidentally, they're now a customer."

Halogen Systems dove into its research and developed a series of product iterations before testing a prototype at the Naval Facilities Engineering and Expeditionary Warfare Center's Seawater Desalination Test Facility in Port Hueneme, California. Bill Varnava, a mechanical engineer who headed up the facility, called the



Port Hueneme lab "unique" in its use of natural seawater from the harbor.

Seawater has a relatively complex chemistry, and is more corrosive than freshwater, all of which complicates development of water-treatment technology. The Navy wanted a sensor that could measure chlorine with pinpoint accuracy in this volatile environment, according to Varnava, and do it quickly.

"That was the challenge presented to the industry," he said. "It was a technical problem we couldn't solve in conventional ways."

Chief among its criteria, the Navy emphasized the need for real-time data. Varnava said the standard way to measure chlorine is by adding a reagent and then judging the color. The pinker it is, the more chlorine it contains.

"But that takes a certain amount of time, and is cumbersome," Varnava said. "That's the value of the sensor—it gives you real-time

feedback."

Halogen's final product, which emerged through a years'-long SBIR-supported process, 2009 to 2015, is the Ballast Water Total Residual Oxidant Sensor (TRO). The reliable sensor rapidly measures salinity

and both chlorine and bromine. It's installed directly into the ballast pipe and doesn't need reagents or membranes. Nor does it require much maintenance given its self-cleaning electrodes and built-in resistance to biofouling.

Silveri says Halogen's product is the only "flow-independent" sensor available, meaning that it isn't affected by flow in the ballast pipe. "That was another attraction to the Navy because they have varying flow rates," Silveri said.

Halogen's technology has found an eager market outside the military.

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Michael Silveri



Halogen Systems' display unit, above left, and their measurement module, above right, together help create a much-needed, real-time data collection system for ballast effluence.

As of April, 2019, more than 1,200 had been installed on commercial ships. Silveri says the technology also has non-oceanic potential, including in municipal water systems. Halogen has been in conversations with water utilities about initiating a pilot program.

The SBIR program was invaluable, according to Silveri, providing resources and time to “mature” his original crude sensor platform into a viable product. “The SBIR helped resolve a lot of the issues that we had, enhancing the operation and the accuracy,” Silveri said. “It really helped us take it home.”

Silveri also said access to the desalination testing facility was critical, not only for developing the sensor but also marketing it later. “The affiliation with the Department of Defense gave us credibility in dealing with our commercial customers. We were a brand new company, so that credibility was essential,” he said.

Varnava has been involved with the SBIR program for about 15 years through developing topics, reviewing proposals, and overseeing contracts. “It’s a great program and a way to

spur innovation,” he said.

Varnava also added that the SBIR program “does a great job of getting technology to a certain point,” after which the company can take it to market or utilize other government programs to advance it. “You have to take the long view on the SBIRs. It can take a long time. But there’s a lot of synergy and spinoff that can come from that. SBIR allows you to investigate new ideas to see if there’s potential or merit. You advance the technology, and you don’t know what that can spin off into or enable.”

Varnava also appreciates that the SBIR program promotes innovation among small businesses, with the federal government taking on the bulk of the risk. “Generally I think that’s where the best ideas come from,” he said. “Large corporations tend to be rather conservative in their approaches. They want sure things.

“I’ve seen a wide range of small businesses do very interesting and innovative stuff over the years,” he added. “They generate new products and jobs, and provide an economic benefit to their communities.” 🌱



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SBIR contract: N00014-11-C-0248 • Agency: Navy • Topic: N092-152, Total Residual Oxidant Sensor