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Top Stories

New Inspection Technology for Warships Enhances Safety and Lowers Costs

By Gretchen Jacobson

The U.S. Navy's amphibious warships are specially designed to support assault operations from the sea against defended positions ashore. These combined-arm, crisis-response vessels are the primary landing ships for Marine expeditionary units. Flexible and adaptive, they are used to embark, transport, and land Marines and equipment during warfare and other missions.

The USS Whidbey Island*, headed to the Arabian Gulf in September 2006, is one of three amphibious ships installed with a new wireless corrosion monitoring system for ballast tanks. Photo by Mass Communications Specialist Christopher L. Clark, U.S. Navy.*

The USS *Whidbey Island*, an amphibious dock landing ship commissioned in 1985, is one such ship. In the aftermath of Hurricane Katrina, the Navy deployed it to bring badly needed military personnel and supplies to the devastated Gulf Coast.

To transport people and equipment from these warships, the Navy uses air-cushion and landing craft or amphibious vehicles, as well as helicopters and aircraft distinguished for their vertical takeoff and landing capabilities.

These assault vessels feature a flight deck and a well deck that can be ballasted and de-ballasted to support landing craft or adjust for other load shifts as needed. The ballast tanks take up significant space below deck, and depending on their storage requirements, are subject to severe corrosion risks.

The ballast tanks are constructed of carbon steel—a material that is difficult to maintain because it is vulnerable in harsh marine environments. Barrier coatings are used to protect the tanks, complemented by sacrificial cathodic protection (CP) using zinc anodes. But effective and safe inspection has been difficult, and hundreds of thousands of dollars are spent repairing a single tank when unchecked corrosion causes extensive structural damage.

"The tanks have widely variable maintenance concerns depending on their contents, size, location of ship operations, and numerous other factors," said Bill Groeninger of the U.S. Naval Research Laboratory. "This is why the traditional uniform, time-based inspections are a poor tool for identifying tanks in need of refurbishment."

Monitoring Tanks with a Wireless Corrosion Sensor

Groeninger and his team have been working with the Naval Sea Systems Command on a new, more efficient monitoring system to accurately determine the risk or the presence of corrosion in a timely manner. The resulting wireless corrosion

sensor, a technology that allows tank condition data to be measured and downloaded into a data logger without the need to physically enter the tank, is being tested on three amphibious assault ships, including the USS *Whidbey Island*.

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"The traditional inspection method of physically entering the tanks and conducting visual inspections of the coatings is expensive, involves numerous safety concerns, and is often unreliable," said Groeninger.

"OSHA and Naval regulations require cleaning, staging, and gas-freeing the tanks by certified engineers to ensure safe entry. In addition to being costly—inspecting a single tank can cost $15,000 or more—the subjective nature of the visual inspections may not provide consistent or accurate results."

To compound the problem, a tank located directly above another tank must be cleaned, freed from all gas, and entered before the bottom tank can be prepared, accessed, and inspected.

The researchers' wireless corrosion sensor, on the other hand, measures the tank's "state of preservation" without the requirements of opening, gas-freeing, and entering the structures. The system consists of silver/silver chloride reference half-cells, which measure the polarization (i.e., corrosion protection level) of the tank. It also includes an instrumented zinc anode, which allows for independent measurement of anode current output. Such output relates to the tank coating condition and CP system's life prediction.

The corrosion sensor system also features an integral data logging system for long-term data storage, as well as software that analyzes corrosion risk assessment, ranking, and trend analysis of single or multiple tanks aboard a ship.

The data logger, which automatically records voltage potentials and current values every 30 minutes, is connected to a wireless transmitter and mounted in a sealed unit inside the tank. The battery life of the data loggers is designed to be 15 years, based on the researchers' assessment that tank coatings are moving toward 20-year preservation cycles. Because the transmitters are unable to penetrate a fully enclosed steel structure, special gaskets made of neoprene are installed in the access hatches to provide an unobstructed path for the signal.

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A portable host unit, carried by the data collector, is positioned outside the tank. The operator uses the host unit to start a communication sequence with the tank-mounted data logger. This "wakes up" the logger and transmits the sensor data to the computer. Once the download sequence is complete, the transmitter goes back to sleep, conserving battery power until the host makes another inquiry.

The digital data is easily transferred to a laptop computer, where it can be viewed graphically or exported to corrosion analysis software to determine the actual tank coating and CP system conditions.

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"The data are plotted as potential versus time and anode output versus time," Groeninger explained. "This data analysis lets us know which tanks require immediate attention, those that may soon require maintenance, and those that are currently fine. Although the wireless corrosion sensor is successful in accurately identifying tanks in need of repair, it is equally adept at pinpointing those that don't, thus avoiding the unplanned and expensive inspections that were conducted visually in the past."

Fleetwide, the Navy inspects approximately 4,000 tanks each year, which costs around $32 million annually. When the costs of refurbishing and replacing tanks are included, protecting ballast tanks comes to more than $250 million per year. The researchers estimate that employing the wireless corrosion sensor would result in a return of investment of nearly 7 to 1.

"In addition to expanding the use of our system on ballast tanks fleet-wide, we anticipate other uses for the technology, including inspection of submarine tanks," Groeninger concluded. "Demonstrations on multiple platforms across the fleet have confirmed that this technology is a viable and preferred alternative to manned entry for tank assessments."