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Powering Subsea Operations

Rechargeable Battery Modules Keep AUVs on Task

By Leon Adams • Bob Melvin

Subsea applications are getting smarter and going untethered. Untethered subsea operations that are advancing the industry require batteries that are safer, smarter, smaller, lighter, provide more capacity, deliver more power, and are highly reliable with longer life.

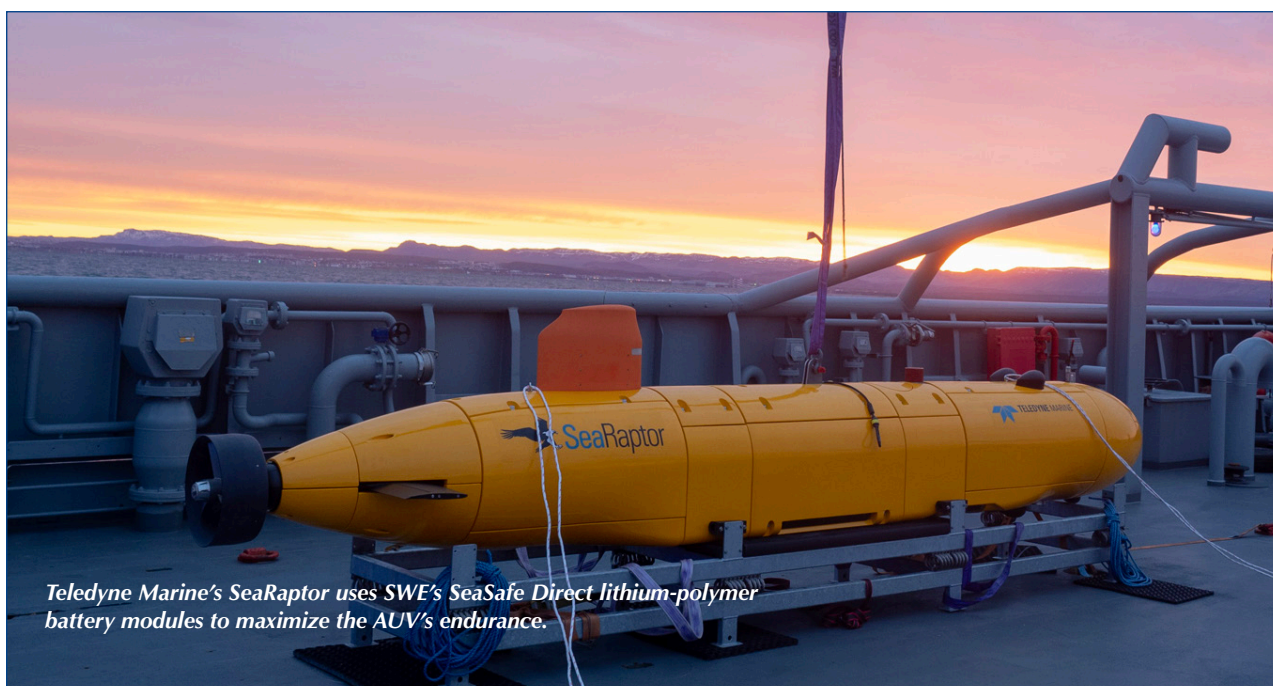
Improvements in batteries to meet these needs is happening, turning battery modules into an enabling technology for keeping AUVs in service and motion for longer missions.

When it comes to underwater vehicles, rechargeable battery module systems that can easily be swapped on deck to speed the unit's return to the water and next mission are key. One example is the Teledyne Marine SeaRaptor AUV design that uses Southwest Electronic Energy Corp.'s (SWE) SeaSafe Direct lithium-polymer battery modules to maximize the AUV's endurance, as was re-

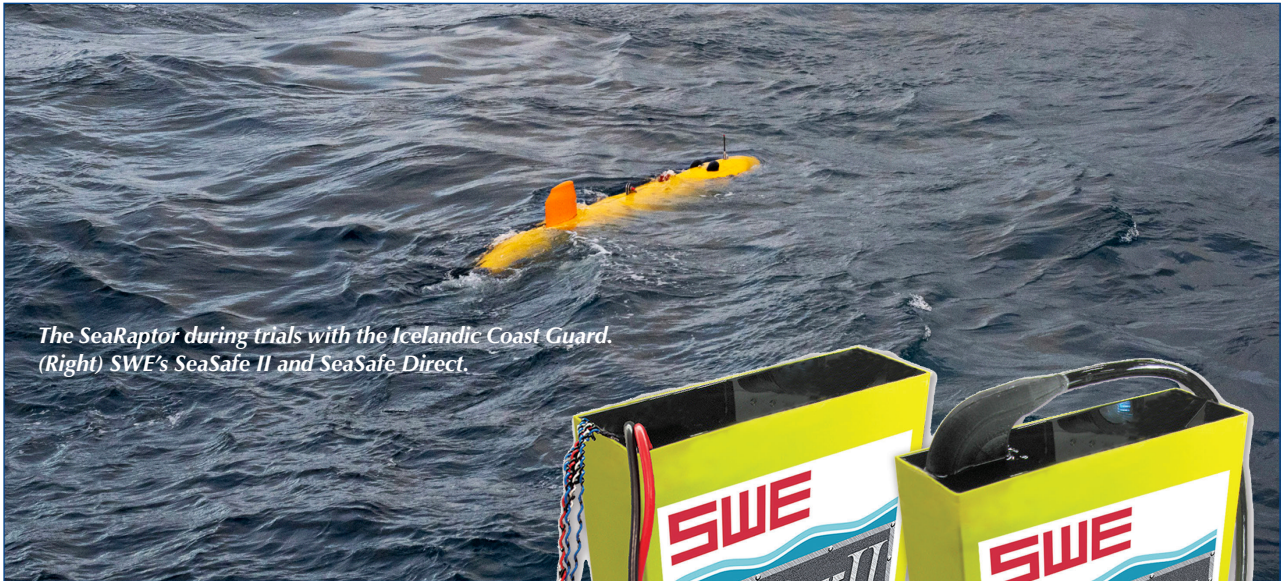
cently demonstrated during testing operations with the Icelandic Coast Guard Vessel Þór in 2018.

The SeaRaptor, an AUV approximately 5.5 m long, is suitable for applications such as search and recovery, salvage, exploration, deepwater construction, marine archaeology and oceanography. It has a maximum speed over 4 kt. While its endurance depends on speed and the exact configuration of the AUV, the SeaRaptor can typically survey for 24 hr. at 3 kt. with a standard configuration. The standard battery configuration comprises 13- to 16-kWH lithium-ion rechargeable SeaSafe Direct modules from SWE, and the energy can be increased to 20 kWh to meet the extra demands of longer duration missions or additional sensors.

The vehicle's operating criteria require the batteries to power all of the AUV functions, from control to motion



Teledyne Marine's SeaRaptor uses SWE's SeaSafe Direct lithium-polymer battery modules to maximize the AUV's endurance.



The SeaRaptor during trials with the Icelandic Coast Guard. (Right) SWE's SeaSafe II and SeaSafe Direct.



to communication to payload sensors. The ability to change batteries with ease on deck without reconfiguring the SeaRaptor is critical for efficient mission execution. The SeaSafe battery modules can be accessed behind an easy-to-remove panel and replaced with a freshly charged module or recharged relatively quickly. The battery modules are pressure tolerant to 6,000 m, allowing for diving deeper and staying deep longer to support important mission objectives.

During the testing operations on the Icelandic Coast Guard Vessel *Pór*, the SeaRaptor carried out 10 hr. of surveys in shallow and deepwater to validate the sensor performance and navigational accuracy. For continuous surveying, the battery modules can be hot swapped in 20 min. While the AUV is in the water, the battery modules can be recharged over a period of about 4 hr. The SeaRaptor performed flawlessly during the testing operations, locating the wings of a B-24 bomber of the 1940s.

Meeting Subsea Power Needs

Such operations would have been a major challenge without some revolutionary changes in subsea batteries. Many electrical subsea operations are tethered and powered by costly umbilicals. Untethered subsea vehicles previously used sealed lead-acid batteries, which made them heavy and bulky, or batteries contained within 1-atm-pressure vessels, which made them more expensive and heavier as they strived for deeper depth ratings.

In 2013, Southwest Electronic Energy Corp.'s SeaSafe battery brought revolutionary changes to the market. The first commercial pressure-tolerant lithium-ion polymer subsea battery module known as SeaSafe became available after SWE worked on the design in conjunction with Woods Hole Oceanographic Institution. The radically lighter and smaller battery delivered efficiency gains in installation times and vastly improved performance. In 2017, SWE made available the SeaSafe II, which incorporated lessons learned, reliability improvements and American Bureau of Shipping (ABS) certification.

The powerful, pressure-tolerant SeaSafe II battery modules are easy to install in a pressure-balanced oil-filled (PBOF) container, which is smaller, lighter and lower cost than a pressure vessel.

In response to industry demand to eliminate the PBOF container for additional convenience, SWE developed the SeaSafe Direct, which has been available since 2017. It can be placed directly into the water without requiring the PBOF container.

The SeaSafe II and SeaSafe Direct are powered by large lithium-ion polymer cells that are specially engineered into modules managed by the SWE-patented Battery Management System (BMS) to provide 30 V at 28 Ah or other size options. They are able to operate in water depths to 6,000 m. Multiple SeaSafe modules can easily be connected together to meet the voltage and power needs of various applications.

These autonomous battery modules are easy to use and are designed for use in subsea vehicles, oceanographic systems, and deepwater oil and gas infrastructure.

Supplying electric power or running hydraulic power from the surface can be expensive and motion constraining, but single or multiple linked battery modules can economically and safely be placed in water as deep as 6,000 m to store and provide energy locally for operations such as actuating valves on subsea equipment like Christmas trees and blowout preventers.

The batteries have been used in short-duration, high-power-demand applications and long-duration, low-power-demand situations. Applications include

“Single or multiple linked battery modules can economically and safely be placed in water as deep as 6,000 m”

AUV propulsion, control and instrumentation; in remotely located infrastructure equipment for valve control and possible pipe shearing; and in oceanography sensing setups, such as those for monitoring the salinity and temperature of ocean water over a period of time.

Compared to lead-acid batteries, SeaSafe battery modules weigh one-quarter, deliver longer mission times, provide up to four times more energy, and can take thousands of charges. SeaSafe battery modules also function for up to eight times the life cycle of traditional sealed lead-acid batteries, which may provide many years of service and eliminate classic and costly battery-failure headaches.

Each module includes the BMS to safeguard the battery. The integrated BMS automatically manages and tracks the safety, reliability, charge and discharge of the

batteries and reports technical information on demand. Immediate feedback on the status of the battery system enables the operator to confidently respond to an emergency requiring battery power.

As subsea needs continue to evolve, safely and economically squeezing more power and lifetime out of battery systems has never been more important. SWE's SeaSafe Battery modules deliver. **ST**

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