CASE STUDY

Customized Battery Solutions
in Oceanographic Data Collection

When natural disaster strikes, the environment can shift dramatically, in-turn affecting environmental and human existence. In order to prepare for the onset of potential natural disasters, particularly caused by one of the Earth's most powerful elements, water, it is of the utmost importance to monitor its boundaries and seasonal changes. For this reason the Slocum Glider was developed to collect critical oceanic data, and through these efforts the necessity of exceptional battery performance for ocean research technology was realized.

Photo: The Slocum Glider

The Application:

Developed in the early 1990's by Doug Webb, founder of Webb Research Corporation, currently known as Teledyne Technologies, and named after Joshua Slocum, the first man to single-handedly sail around the world, the Slocum Glider was built to collect oceanographic data such as salinity and temperature by changing buoyancy while moving in an upward and downward fashion. This glider, connected to a satellite network and programmed to patrol for months at a time, houses a variety of sensors which surface to transmit data to shore while downloading new instructions pertaining to factors such as direction and depth at programmed intervals and timeframes. Due to its innovative capabilities, the Slocum Glider is employed regularly by oceanographic surveying organizations around the globe.

Situational Analysis:

Traditionally, alkaline batteries were used to power the glider's data collection functionality; however Teledyne engineers wanted to extend endurance and provide capability for additional sensor suites. Thus, in line with Teledyne's goal to provide their customers with the most reliable products available for missions that require longer run times and powerful solutions, they turned to Electrochem.

Although the use of alkaline provided Teledyne with a lower unit cost, lithium primaries compare favorably when one analyzes "total mission cost." It was discovered that non-rechargeable lithium batteries, produced by Electrochem Solutions, offer nearly triple the energy density of 900 Wh/L, as opposed to alkaline batteries that possess only 320 Wh/L (see comparison chart on page two for more details). The use of a non-rechargeable lithium solution also encompasses the benefits of a lightweight product with longer shelf life and most importantly displays exceptional performance in extremely low temperature environments.

Engineers associated with the glider credit the Electrochem team for providing them with a trusted power solution that offers a fit form factor, low maintenance, and longer run times; ensuring mission success.

The Custom Solution:

Electrochem worked diligently to develop several custom multi-cell battery packs to fit the glider's unique form factor and meet standard safety measures to prevent pack shorting and thermal runaway. These designs included two large main packs and a small back-up pack for recovery purposes.

Lithium batteries are typically not permitted to ship live within the device they are intended to power; however customers prefer to ship the batteries installed in the vehicle to avoid the hassle of assembly on their end and eliminate human error as much as possible. In order to remain compliant and simultaneously meet the needs of the customer, Electrochem designed an enable circuit that provides a solid state disconnect driven by a waterproof shorting pin connection that is externally accessible at the aft end of the glider.

Photo: The Scarlet Knight's Atlantic Voyage
Photography By: Dan Crowell

This custom system allowed the battery to ship in a disconnected state within the glider; once the glider reached its destination, the only step left to take was the activation of the device.

The Trans-Atlantic Voyage:

In November of 2009, students at Rutgers University pressed the gliders range by completing the first Trans-Atlantic crossing of any autonomous under water vehicle (AUV). Modifications were made to both the Slocum Glider and the accompanying non-rechargeable lithium battery pack to fit the various elements of the application's shallow environment. Rutger's modified glider, referred to as The Scarlet Knight, traveled underwater for 221 days across 7409.60 km of ocean. The custom battery packs designed by Electrochem powered the electronics that enabled The Scarlet Knight to report its location and send collected data back to its base over 1,000 times throughout the mission.

Future Endeavors:

Many oceanographic devices are originally designed to be used as surveying tools, although many engineers often find use for these devices in military applications as well. Most recently, Teledyne was awarded a contract by the U.S. Navy Space and Naval Warfare Systems Command to develop a "littoral battle space sensing-glider" based on the Slocum Glider device. These gliders will once again collect data pertaining to the water's characteristics such as temperature and salinity, allowing the Navy to better understand the elements they face when conducting their underwater missions.

When working with oceanic devices for critical applications, it is crucial to have a reliable power source. Electrochem offers a solution by customizing systems to match the needs of our customers' unique applications. Engineers associated with the Slocum Glider and The Scarlet Knight credit the Electrochem team for providing them with a trusted power solution that offers a fit form factor, low maintenance, and longer run times; in the end, ensuring mission success.

The Facts:

A Comparison of Primary Lithium vs. Alkaline Chemistries

Chemistry Chart:	**Lithium**	**Alkaline**
Operating Temperature Range	-55° C to +200° C	-20° C to +54° C
Energy Density	14.7 Wh/in³ / 900 Wh/L	5.2 Wh/in³ / 320 Wh/L
Nominal Voltage	3.9 V / 3.6 V	1.5 V
Watt Hours (for D size cell)	59.0	22.5
Advantages	- Ideal in high shock and vibration environments - Very high open circuit & nominal load voltages - Lighter weight than Alkaline (lower pack weight, easier field service, easier handling) - Internally fused - Hermetically sealed – no risk of hydrogen generation or outgassing - Possible lower "total" cost	- Easier to transport - Easier to dispose - Lower unit cost
Disadvantages	- Requires knowledge of appropriate safety and handling	- Limited temperature range - Short life cycle - Low power density per cell - Not hermetically sealed - No internal safety fuse - Possible hydrogen outgassing

Source: Linden, D.; Reddy, T.B. (2002). Handbook of Batteries (3rd Edition). McGraw-Hill.