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## Special Operations Technology

ONLINE EDITION

### Optimizing Underwater Warfare



**Underwater swimmers are deployed to different kinds of missions in different locations requiring different equipment. The diversity of missions carry one common consideration: not be detected.**

The war in Iraq is but one illustration of how armed adversaries affect the development of U.S. military equipment and tactics. Insurgents in Iraq exploited the vulnerabilities of unarmored and low-armored vehicles to attack U.S. troops with improvised explosive devices. When the U.S. up-armored its vehicles, the enemy upgraded its weaponry to penetrate armor. The U.S. then deployed vehicles that could resist the onslaught of those devices.

**Some of the equipment carried by underwater warriors are subject to much the same considerations.**

Underwater swimmers are deployed to different kinds of missions in different locations requiring different equipment. Some are deployed to mine clearing operations while others form special warfare units that target vessels or penetrate territory and execute a mission from the beach. The diversity of missions carry one common consideration: the desire not to be detected by an enemy.

For this reason, underwater special teams are not able to use standard SCUBA breathing apparatus. Exhaling from those devices leaves a trail of bubbles which would make the underwater squads prey to enemy attack much like the proverbial fish in a barrel.

In the case of mine clearing operations, detection by an enemy may be less of a consideration. Underwater explosive ordnance disposal teams used to strap SCUBA equipment to their backs, until mine developers placed sensors on the mines which could be set off upon detection of the bubbles exhaled by divers.

Instead, underwater warriors much make use of rebreathers, devices which provide pure oxygen, instead of SCUBA's compressed air on the inhale, and then capture the carbon dioxide on the exhale. Rebreathers do not leave bubbles for the enemy to track or to be sensed by the underwater mines.

But that is only the beginning of the specialized features required by underwater warriors of their breathing apparatus.

"In many cases, special forces require rebreathers that are acoustically silent," said Kevin Juergensen, CEO of Juergensen Defense Corporation in Addison, Pa., a developer and manufacturer

of components used in rebreathers. "This is quite difficult given the electronics that go into these kinds of devices. Many missions also require that rebreathers have no magnetic signature."

These requirements came about because the most sophisticated underwater mines now include acoustic and magnetic sensors. A Navy diver on an explosive ordnance disposal team without the right rebreather could set off the very mine he is attempting to disable.

"There is a lot of sophisticated ordnance out here now," said Juergensen. "Every time the Navy develops new equipment, the opposition develops something to counter it. Navy divers used to swim to a mine breathing through SCUBA gear. But the mines became equipped with sensors that could detect the bubbles. They also put magnetic sensors in mines, so the rebreathers had to be non-magnetic. There are now multiple sensors deployed on mines that are scanning for radio frequency activity and all kinds of other signatures.

"There has been a significant effort put into mine development technology in recent years that had to be met by improvements to equipment used by divers," Juergensen added. "Rebreathing systems have had to develop electronic controls to get around all of those kinds of threats."

### **Mission Critical**

The breathing apparatus utilized by underwater warriors, critical to the execution of the mission, has become an advanced piece of high technology. Some other equipment utilized by waterbound warriors may be less high tech but no less critical.

For Navy SEALs, who typically must swim two or three miles before executing their missions, "less is more" is the rule of thumb: they must be weighed down with as little equipment as possible and that equipment must be as light and as simple to operate as is practical. Physical conditioning, rather than advanced gadgetry, is the key to success of waterborne special operations.

"Adding a piece of equipment creates a drag going through the water that adds to the work load of the swimmer," said Mark Lonsdale, CEO of Specialized Tactical Training Unit (STTU), a Los Angeles-based company that trains military and law enforcement personnel in water-based special operations.

That additional workload could be the square or cube the effort required on dry land. "It is a significant workload for a guy swimming in cold water for two or three hours," said Lonsdale. "The focus should be on very basic equipment."

Equipment catalogs that cater to civilian special operations enthusiasts don't reflect the reality of the underwater swimmer, according to Lonsdale. "Some of them show whiz-bang GPS systems supposedly designed for Navy special warfare personnel," he said. "If a Navy SEAL carried all the equipment shown in one of these catalogs, he wouldn't be able to move. The idea is to trim down to the bare minimum to get to the target."

STTU, in addition to providing tactical training, also tests and evaluates equipment suited to different kinds of operations. "Since the diving equipment is such a critical part of the diver's life support system, it is important that this equipment be of the highest standard and rigorously tested," Lonsdale said. "The combat swimmer may already be loaded with a significant amount of mission essential equipment, such as load-bearing equipment, weapons, ammunition and communications devices. The diving suit and apparatus can be a considerable additional burden that will unnecessarily extend his swim time, causing fatigue and creating problems with thermal regulation."

Upon arriving at his destination, the combat diver must also be able to shed his diving equipment, move inland or scale the side of a ship, execute his mission, and then if necessary, return to his equipment and to the sea. "All of this makes for one of the most demanding mission profiles, so it is only logical that every item of diving and tactical equipment work to enhance the diver's performance and not hinder the mission," Lonsdale said.

STTU has been studying different equipment configurations with particular attention to creating a streamlined profile that minimizes drag and maximizes efficiency underwater. "We have also been

looking into the various problems associated with maintaining a comfortable thermal equilibrium, particularly where swimmers may be required to sweat and overheat in their dry suits, prior to long cold running times underwater," said Lonsdale. "Most swimmers want to go with the lightest, thinnest suit but they must also consider thermal conditions. Once the combat swimmer reaches his objective he may be so hypothermic and fatigued as to compromise his ability to complete the mission. On the other end of the spectrum, some dive teams have to operate in extremely hot climates with high water temperatures risking problems associated with hyperthermia and dehydration."

The bottom line is that dive outerwear should be the lightest and thinnest available, consistent with prevailing mission conditions.

Navy SEAL units and other special warfare commandos generally get to choose their own wet suits, masks, and fins from among a handful of approved products, according to Lonsdale. In the case of the mask and wet suit, the major consideration is individual fit. In the case of fins, leg strength is the critical factor.

"As the swimmer gains more experience," Lonsdale explained, "he may go for stiffer and longer fins as his leg muscles adapt to the stresses involved with the swimming."

In the case of the dive mask, the lens should sit close to face and should maximize peripheral vision, Lonsdale said. It should minimize the air volume within the mask itself and not contain any shiny metal on its frame. Diving masks approved for U.S. military use include a large single tempered glass lens and a black silicone frame.

Lonsdale also suggests a nose piece that allow divers to hold their noses while clearing their ears. Masks equipped with purge valves are frowned upon. "The mask should contain a minimum of moving parts," said Lonsdale. "Mask manufacturers that include valves are trying to create solutions to nonexistent problems. The dive mask should be simple, rugged, and reliable."

Divers also carry navigation aids, unusually an integrated unit known as a TAC board. These devices typically include a timer, compass and depth gauge, as well as a lit board which can be written on with a grease pencil. They also contain a source of illumination for underwater readings.

TAC boards approved for combat are compact in design and readable even in the poorest visibility and include a writing board made of ABS plastic, a light, rigid material. TAC board manufacturers have been making their products smaller and lighter in weight in recent years. The latest version of a popular TAC board among Navy SEAL and Army Special Operations Forces is almost one-half the size and one-third lighter than its predecessor.

### **Combat Rebreathers**

Rebreathers remain the key piece of underwater warfare equipment and differ from SCUBA gear in several important elements. "Basic SCUBA equipment is very simple and almost idiot proof," said Lonsdale. "It is relatively inexpensive and it is hard to get hurt if you follow the golden rule of not holding your breath.

Combat rebreathers, by contrast, "quite simply have the ability to kill you dead quickly," Lonsdale added, without extensive training in their use or if they malfunction.

Rebreathers deliver high concentrated oxygen as opposed to the compressed air of SCUBA equipment. Because exhaled air cannot be released, lest the bubbles compromise the diver, the rebreather apparatus is a closed circuit system which recycles the oxygen and directs the carbon dioxide to a separate canister where it is absorbed chemically.

"There is a risk for toxicity from both the oxygen and the carbon dioxide," Lonsdale explained. "These are high-risk factors that are not present in open circuit SCUBA equipment."

Not surprising, rebreathers also cost a great deal more than SCUBA gear. Ordinary SCUBA equipment could cost around \$1,000.00. High-end rebreathers can go for 15 to 20 times that price.

Sophisticated rebreathers also regulate the swimmers decompression. Underwater pressure is higher than surface air pressure. At certain depths the amount of air forced into the bloodstream can be dangerous unless the diver stops to decompress on the way up.

Combat swimmers generally operate at shallower depth than EOD disposal units. Therefore, decompression is less of a factor and will involve different time parameters than deep EOD divers.

Juergensen Defense Corporation Mark V eCCR (electronic Closed Circuit Rebreather) Control System accommodates the decompression needs of both special warfare and EOD operatives with the flip of a switch.

The rebreathers now used by the United States Navy Special Warfare Command and the Navy Explosive Ordnance Disposal unit, is the Mark 16 Mod 3 underwater breathing apparatus and the Mark 16 Mod 2 underwater breathing apparatus, respectively, manufactured by Carlton Life Support Systems. Both of those products are powered by the Juergensen unit.

Contracts were issued for the equipment under the Navy's "Next Generation Underwater Breathing Apparatus" (NUBA) program. The United Kingdom's Royal Navy, the Australian Navy and NATO also make use of equipment that incorporates the Juergensen component.

"The equipment is able to change decompression modes when the rebreather is used for different purposes," said Kevin Juergensen. "EOD divers sometimes work at depths of up to 100 meters. They are approaching mines, cataloging, and diffusing devices, and things of that nature. Special warfare commandos swim much closer to the surface of the water. Special warfare types are all about being transported to some area two or three miles from the target, and doing some reconnaissance work or hurting some bad guys and getting out of there." Special warfare commandos typically swim at a depth of 20 to 25 feet, according to Lonsdale.

"What we did in the electronic development of this component was to come up with a system that was configurable for either mission set," said Juergensen. "It was a huge technical achievement because no one ever had done it before. We also added a number of other features," the specifics of which are classified, "that help the divers fulfill their missions. The benefit of our control system is that it can be used for mixed missions. EOD or special warfare missions can operate on the same platform."

The Mark 16 rebreather now used by the U.S. Navy also has a reduced magnetic signature and is allowed to be used with virtually any kind of ordnance manufactured today, according to Juergensen. "Acoustically it is extremely quiet and can be used around acoustically sensitive ordnance as well." The device also meets the requirements of NATO's Standard Agreement.

Juergensen also said a significant amount of effort also went into reducing the rebreathers electromagnetic interference signature and testing on the device showed that it passed "with flying colors."

"This is a rebreather that is going to serve the Navy well for the next 10 to 12 years," he said.