STOPPING THE UNDERWATER DIVER THREAT

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A non-lethal, scalable deterrent solution

Updated from original article published in
Maritime Technology Reporter, October 2006,
"Security: Stopping the Diver, Undersea Threat"
J. Keil and R. De La Croix,

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Swimmers and divers can pose a serious threat to maritime assets, especially ships moored in ports or harbors or facilities located on the shoreline. The swimmer, with his exposure on the surface of the water, is an easier threat to deal with and is not the focus of this paper. A much more difficult problem is posed by the diver threat that can hide in the variable and complex waters associated with ports and harbors. As capabilities in countering other types of threats improve, it is reasonable to expect that adversaries will pursue new avenues of terrorism. Technology provided by commercially available underwater propulsion aids and new weapons add to the danger. Many companies have been developing systems that can detect, classify and localize underwater threats. However, current options to counter the threat once detected and localized are generally limited to such options as explosives and nets. Even more limited are options that provide a scalable deterrent capability, where the deterrent impact on the diver can be controlled. Key attributes of a diver deterrent system are shown in Table 1.

Table 1. Desired Diver Deterrent System Attributes

- Operate effectively in shallow waters
- Scalable deterrence – adjustable level/effect
- Rapid impact/influence
- Ability to address multiple intruders
- Flexible deployment options
- High reliability
- Low maintenance
- System size and weight
- Low cost
- Minimal to no environmental pollution
- Reusable asset (not consumed)
- Controllable Collateral Damage

A variety of personnel deterrence devices have been developed, with many of these targeted for the above water/in-air application. These devices include electrical, optical, and electromagnetic devices and chemical agents. The electrical and optical devices have marginal effectiveness underwater due to attenuation effects and dispersion. Even with high power their effective ranges are minimal. In addition, chemical agents are subject to dispersion effects, resulting in insufficient impact on the diver and the potential for collateral damage. Physical force using divers or mammals involves direct contact resulting in risk to the countering asset and requires accurate targeting information and precise location information. Response time in countering the threat can be a challenge. Restraints provided by such options as nets tend to be high cost and could interfere with both port operations and marine life movement. In addition, such restraints can be penetrated with relative ease. Projectiles against underwater threats represent a difficult challenge because of their limited range and the precise targeting information that is required, especially when fired from above the surface of the water.

Of all these deterrent options, acoustic systems offer the best and most flexible deterrent potential for several reasons. Acoustic energy propagates most effectively in water, especially at low frequencies, and hence can be more effective than other options. In water, the average acoustic impedance of the human body, specifically tissue, is comparable to the acoustic impedance of water. As a result, waterborne sound passes directly from the water into the human body. In contrast, airborne sound is reflected from the body due to the impedance mismatch between air and the human body. There is the suggestion that lower frequencies may yield greater deterrent impact at lower levels of intensity. However, the challenge created by this conclusion is to maintain a reasonable size, weight, and cost for the acoustic source required to generate sufficient low frequency energy.

A variety of low frequency acoustic source options exist. These options include electro-acoustic sources, sparker sources (also known as plasma sources), explosives and high-pressure air systems that discharge either water (waterguns) or air (airguns). A comparison of these various acoustic sources against the desirable deterrent attributes suggests that waterguns and airguns are best matched to the requirements. Both are similar in size and deployment flexibility and use high-pressure air as their energy source. Waterguns generate a water jet, which creates cavitation in the water where the airguns discharge the high-pressure air directly into the water. Because of this difference, the frequency content of the highest energy with a watergun is typically higher than the preferred low frequency region for deterrence whereas the predominant energy from the airgun is at the low frequencies.

Airgun systems offer a number of attractive attributes. They provide a great deal of flexibility in their output both in terms of intensity and in the specific signal characteristics. The level and rate at which pulses are transmitted are adjustable. If multiple guns are employed, tones can be superimposed on the broadband output at selectable frequencies. The wave trains that are generated can be sustained over time. An individual airgun provides an omni-directional beam pattern and therefore can address multiple threats approaching a high value asset from different directions. Airgun systems do not cavitate and hence operate effectively in shallow water environments where diver threats are likely to occur. Individual airguns can be assembled in a modular fashion into a variety of configurations and installation options matched to user needs.

The airgun and its ancillary equipment that make up the system are based on mature technology that has been used for many years in offshore seismic oil exploration. As a result their application for diver deterrence involves low development cost and risk. The airguns have proven cost effectiveness and exhibit high system availability and reliability. They have a long service life and have established maintenance and proven safety procedures in place.

HAI has developed a portable airgun system for swimmer deterrence shown below. This portable airgun system has four major components, each weighing less than 70 pounds. One case contains the airgun with a short jumper to connect it to the umbilical cable. Another case, either rigid or soft pack, contains the pneumatic, electrical, mechanical umbilical that connects the air gun to the air gun system controller. The third case holds the high pressure energy bottles. Case four contains the controller system which provides complete electronic and pneumatic control of the air gun and allows both manual and automatic (computer driven) control over the transmitted pulses and provides either local or remote operation of the system. The compactness of this system allows its use from various craft including small response boats with no or little changes to the boat.

The suitcases are portable and can be loaded, set-up and deployed by a single crew member. Employment on a manned boat does not require boat modifications and the only requirement is for deck tie points. Once deployed, the airgun can be towed at slow speeds. If transit speeds are required the airgun can be quickly retrieved and re-deployed when the desired location is achieved.

HAI Portable Airgun System

Control Panel

Energy Bottle Box

Umbilical in Bag

Air Gun

Photo's updated 02-01-2010

The portable airgun system is but one of many ship and port security configuration options that can be provided. Individual airguns can be combined into airgun arrays of various configurations and sizes to provide the coverage required to meet specific operational and deployment scenarios associated with various ships in ports, harbors or shoreline facilities. Airgun systems provide a scalable deterrence that can be achieved by various means such as the rate with which the pulses are transmitted, the use of increased air pressure to the airguns and use of an increased number of airguns that are fired either simultaneously or in rapid sequence.

Firing multiple airguns simultaneously will increase the deterrent effect or conversely increase the area of coverage for a given effect. A multiple airgun array can also be configured to create some directivity in the transmission vice an omni-directional pattern to mitigate collateral effects. The HAI airgun controller provides for precise control in the firing of the airguns, thereby maximizing the flexibility of the output. The system can also be operated using a wireless remote controller that avoids the need for a person to be collocated with the system control panel box at the deployment site.

Airgun systems can be deployed from a wide spectrum of platforms ranging from small response boats that are either manned or unmanned to larger arrays that can be deployed off piers, docks, moored platforms or from larger ships. The array configurations and sizes are flexible and can be tailored to the operational need and application.

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