FEMA TechNote

U.S. Department of Homeland Security

SAVER

System Assessment and Validation for Emergency Responders

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. The SAVER Program conducts unbiased operational tests on commercial equipment and systems and provides those results along with other relevant equipment information to the emergency response community in an operationally useful form. SAVER provides information on equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL).

Information provided by the SAVER Program will be shared nationally with the responder community providing life- and cost-saving assets to federal, state, and local responders.

The SAVER Program is supported by a network of technical agents who perform assessment and validation activities. Further, SAVER focuses primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?"

For more information on this and other technologies, please see the SAVER website or contact the SAVER Program Support Office.

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Side-Scan Sonar

Law enforcement and search and rescue personnel are often faced with the difficult task of conducting underwater searches for weapons, submerged vehicles, drowning victims, and other objects of interest. To conduct underwater searches, emergency responders typically deploy underwater cameras and search and rescue divers. However, these search methods can be time-consuming and cover a limited area. In addition, search and rescue divers may have to contend with an assortment of hazardous conditions such as a lack of visibility and entanglement in underwater debris. In an effort to overcome these operational challenges, emergency responders may use side-scan sonar.

Side-scan sonar provides the user with an underwater image and can be used in any body of water such as a lake, river, or harbor. Side-scan sonar is appealing to emergency responders because of the ability to:

- Cover a wide search area in a short amount of time.
- Evaluate the area for potential hazards prior to divers entering the water.
- Deploy divers only after the object of interest is located, thereby limiting undue risk to divers' safety.

Technology Overview

Sonar uses underwater sound waves to detect and identify submerged objects. Unlike downward looking sonar, which transmits sound pulses in a narrow cone shape towards the sea floor, the sound pulses from side-scan sonar travel downward and sideways in a 90 degree fan shape. The wide pattern of sound waves used in side-scan sonar makes the technology ideal for scanning large underwater areas quickly and efficiently.

Side-scan sonar systems include a towfish, tow cable, and sonar display and processing unit. The towfish is a torpedo-shaped object that is towed underwater by a boat. Towfish vary in size, shape, and weight depending on their intended use. Law enforcement and search and rescue teams commonly use a smaller, lightweight towfish that can be deployed quickly in an emergency situation. These towfish are capable of scanning up to a 1000 meter swath in a single pass, which permits emergency responders to search large areas quickly. The size of the swath scanned is determined by the sonar's scanning range, operating frequency, and the distance between the towfish and the water's bottom.

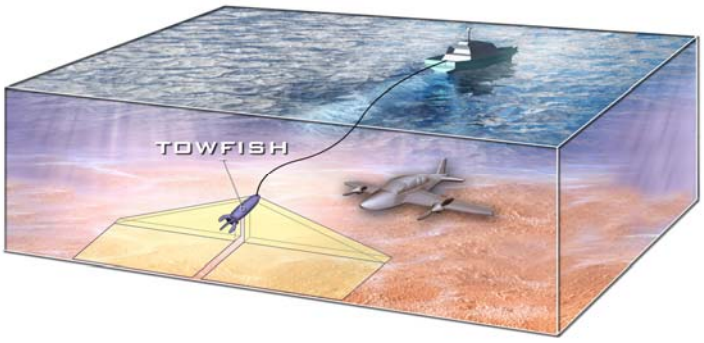

Figure 1 Side-Scan Sonar Searching for a Submerged Airplane

Inside the towfish, electronic components called transducers emit and capture sound waves. The sound waves emitted from the transducers are called *pings*. When a ping strikes an underwater object, the signal—called an *echo*—is reflected back to the transducer. The echoes are then processed by the sonar system for display to the operator.

The towfish is connected to the boat by a tow cable. The tow cable consists of reinforced coaxial or fiber optic cable for signal transmission. The tow cable can be deployed with a mechanical winch or by hand and tied to the boat. To complete the signal transmission, the tow cable is connected to either an interface processing unit or to a computer. Some systems use an interface processing unit to process the signal information before it is sent to the computer. Other systems process the signal information at the computer. Through the use of sonar-specific software, the echoes are recorded and processed into an image of the scanned area.

The strength of the echoes will vary depending on the composition of the objects that are scanned. Solid objects such as rocks, submerged vehicles, or sunken boats will return stronger echoes. A lake bed or river bottom consisting of mud or sand will return weaker echoes. On the computer display, stronger echoes are seen as lighter colored images while weaker echoes appear as darker colored images. Below is an example image of a submerged automobile lying upside down as detected by emergency responders using side-scan sonar.

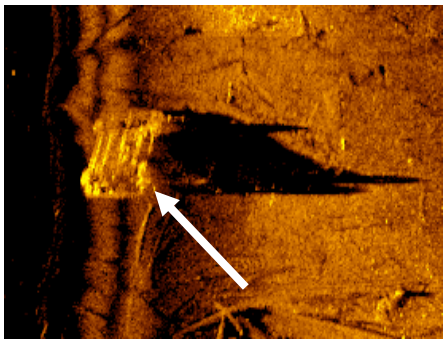

Figure 2 Side-Scan Sonar Image of a Submerged Automobile

The quality of the displayed image is affected by the number and frequency of the pings that are emitted by the transducers, as well as by the strength of the received echoes. Generally, using a transducer with a higher frequency will produce sharper images with greater resolution. However, using a higher frequency transducer will also reduce the area that can be scanned in a single pass. Using a lower frequency transducer will allow for a greater area to be scanned, but image quality will be reduced.

Towfish can be equipped with single frequency or dual frequency transducers. This allows the operator to vary the image quality and scanning area. For example, in a dual frequency towfish, a lower frequency can initially be used to scan a large area for an object of interest. When the object of interest is located, the operator can switch to the higher frequency to obtain greater visual detail of the object.

Applications

The U.S. Coast Guard and state and local public safety dive teams use side-scan sonar to inspect dams, piers, bridges, and the undersides of ships for explosive devices. Search and rescue personnel use side-scan sonar to locate submerged automobiles, airplanes, boats, and drowning victims. For example, in 2007, the Dakota County, Minnesota, Sheriff's Office used side-scan sonar and dive teams to locate and recover a drowning victim. Through the use of side-scan sonar, the sheriff's deputies were able to locate the victim within 40 minutes of placing the equipment in the water.

In addition, underwater accident sites involving airplanes and automobiles can be surveyed and documented as part of recovery operations. For example, in 2007, the Hennepin County, Minnesota, Sheriff's Department used side-scan sonar to locate submerged vehicles following the collapse of the I-35W Mississippi River Bridge. In 1999, the National Oceanic and Atmospheric Administration (NOAA) used side-scan sonar to locate the wreckage of the downed aircraft piloted by John F. Kennedy, Jr. The submerged airplane was discovered off the coast of Martha's Vineyard in 120 feet of water.

Performance Considerations

Basic operating principles for side-scan sonar should be reviewed when considering these systems for various applications. For example, maneuvering the towfish in restricted spaces can be challenging. The towfish is not designed to operate or maneuver independently and will only follow where the towing vessel travels.

Another consideration is the environmental conditions in which the side-scan sonar towfish will be used. Strong river currents or rough waves can cause the boat to lurch forward and sway from side to side, which can have an adverse affect on the stability of the towfish. Operating in such conditions can result in poor quality images. Optimal conditions for obtaining the best images require the towfish to be traveling in a straight line and at a constant depth and speed. To assist with this effort, the towfish can be equipped with tailfins or wings to provide greater stability and directional control.

It is possible that during standard operations, the towfish may become entangled or strike an underwater obstruction. Many towfish are equipped with safety mechanisms, such as a weak link or safety line, that will prevent the towfish from being lost or severely damaged if underwater debris is encountered.

Side-scan sonar has proven to be a reliable and effective tool that has been used in a variety of search and recovery efforts. The equipment has become and will continue to be a valuable asset in the day-to-day and emergency operations of law enforcement and search and rescue personnel.