



Homeland Security

Science and Technology

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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. Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on commercial equipment and systems, and develops knowledge products that provide relevant equipment information to the emergency responder community.

SAVER Program knowledge products provide information on equipment that falls under the categories listed in the DHS Authorized Equipment List (AEL), focusing primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?" These knowledge products are shared nationally with the emergency responder community, providing a life- and cost-saving asset to DHS, as well as to Federal, state, and local responders.

The SAVER Program is supported by a network of Technical Agents who perform assessment and validation activities and produce SAVER knowledge products.

For more information on the program or the assessed technologies, contact the SAVER Program by e-mail or visit the SAVER website.

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Website: <http://www.firstresponder.gov/SAVER>

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Summary

Handheld Underwater Metal Detectors

(AEL reference number 03WA-01-UWMD)

Handheld underwater metal detectors assist public safety divers with locating objects underwater by providing visual, audible, and/or vibration alerts when metallic objects are detected. These detectors are typically composed of four components: coil, control box, handle, and shaft.

In order to provide responders with information on currently available handheld underwater metal detectors, the Space and Naval Warfare Systems Center (SPAWARSYSCEN) Atlantic conducted a comparative assessment for the System Assessment and Validation for Emergency Responders (SAVER) Program in August 2013. Detailed findings are provided in the *Handheld Underwater Metal Detectors Assessment Report*, which is available at <http://www.firstresponder.gov/SAVER>.

Assessment Methodology

Prior to the assessment, eight public safety divers with at least 3 years of experience using handheld underwater metal detectors were chosen from various jurisdictions to participate in a focus group. The group identified evaluation criteria and recommended product selection criteria and possible scenarios for assessment.

After identifying evaluation criteria, the focus group assigned each criterion to one of four SAVER categories; no criteria were identified for the Affordability category. The focus group then assigned a weight for each criterion's level of importance. Once the criteria were weighted, the four SAVER categories were assigned a percentage value to represent the level of each category's importance relative to the other categories.



Based on focus group recommendations and market research, the following handheld underwater metal detectors were selected for assessment:

- JW Fishers Mfg. Inc., Pulse 8X;
- Garrett Electronics Inc., Sea Hunter™ Mark II;
- Fisher® Research Labs, CZ-21 QuickSilver;
- Aquascan International Ltd., Aquapulse 1B;
- Minelab Americas Inc., Excalibur II;
- Tesoro Electronics Inc., Tiger Shark;
- White's Electronics Inc., Surf PI Dual Field; and
- Kellyco Metal Detectors, Viper Hybrid Trident.

Eight public safety divers from various jurisdictions with at least 2 years experience using handheld underwater metal detectors were selected to be evaluators for the assessment. The evaluators' experience with handheld underwater metal detectors provided meaningful results for this assessment.

During the assessment, evaluators rated the handheld underwater metal detectors based on evaluation criteria established by the focus group. The assessment was separated into two phases: the specification assessment and the operational assessment. Evaluators assessed the products based on vendor-provided information during the specification assessment. Hands-on experience during four scenarios—pre-dive, object detection, dive operation (Wando River), and object detection (Lake Moultrie)—served as the basis for the operational assessment. For the object detection scenario, an inoperable handgun, a galvanized steel pipe, and a 9mm shell casing were buried at 0.5-, 3-, 6-, and 12-inch depths.

Assessment Results

Table 1 displays the composite assessment scores as well as the category scores for each handheld underwater metal detector. Scores are based on a 5-point scale; higher scores indicate a more favorable rating by evaluators. The advantages and disadvantages of each handheld underwater metal detector, as identified by evaluators, are listed in table 2. To view how each handheld underwater metal detector scored against the evaluation criteria assigned to the SAVER categories, see table 3. For specifications, see table 4.

According to evaluators, handheld underwater metal detectors with a minimal amount of controls are preferred, and batteries, headphones, and coils should be user replaceable and rugged enough to endure public safety use. Metal detectors that can be easily reconfigured (i.e., modular) are preferred. Coil size is important, and coils with a large surface area may create drag underwater, making use difficult during a dive. Evaluators agreed that technical support should be available 24 hours a day, 7 days a week and reference material should be printed on water-resistant paper. Evaluators noted all of the assessed handheld underwater metal detectors featured coils that were easy to adjust. In addition, all of the handheld underwater metal detectors alerted on the steel pipe and handgun at all depths assessed.

Responder agencies that may be considering the purchase of a handheld underwater metal detector should review the detailed findings in the *Handheld Underwater Metal Detectors Assessment Report* and carefully consider each product's overall capabilities and limitations in relation to their jurisdiction's operational needs. All reports in this series, as well as reports on other technologies, are available in the SAVER section of the FirstResponder.gov website, <http://www.firstresponder.gov/SAVER>.

SAVER Category Definitions
Affordability groups criteria related to life-cycle costs of a piece of equipment or system.
Capability groups criteria related to the power, capacity, or features available for a piece of equipment or system to perform or assist the responder in performing one or more relevant tasks.
Deployability groups criteria related to the movement, installation, or implementation of a piece of equipment or system by responders at the site of its intended use.
Maintainability groups criteria related to the maintenance and restoration of a piece of equipment or system to operational condition by responders.
Usability groups criteria related to the quality of the responders' experience with the operational employment of a piece of equipment or system. This includes the relative ease of use, efficiency, and overall satisfaction of the responders with the equipment or system.

Table 1. Handheld Underwater Metal Detector Assessment Results

Product	Composite Score	Capability (40% Weighting)	Deployability (10% Weighting)	Maintainability (5% Weighting)	Usability (45% Weighting)
Pulse 8X	4.3	4.3	4.3	4.4	4.3
Sea Hunter™ Mark II	3.9	4.1	3.3	4.0	3.8
CZ-21 QuickSilver	3.9	3.9	4.1	3.6	3.9
Aquapulse 1B	3.7	3.5	3.8	3.5	3.9
Excalibur II	3.6	3.7	3.3	3.6	3.7
Tiger Shark	3.3	3.7	2.9	3.3	3.1
Surf PI Dual Field	3.3	3.5	2.9	3.7	3.2
Viper Hybrid Trident	3.1	3.1	3.1	3.4	3.1

Table 2. Handheld Underwater Metal Detector Advantages and Disadvantages




Product	Advantages	Disadvantages
 <p>Pulse 8X Composite Score: 4.3</p>	<ul style="list-style-type: none"> Only two controls Visual indicator displays signal strength Easily changed into modular configuration Includes user-replaceable land-use headphone and submersible earphone Very rugged Many accessories available Includes both AC and DC battery chargers DC battery charger features alligator clips 24/7 technical support 	<ul style="list-style-type: none"> O-ring battery compartment is difficult to set in place Heavy for land use
 <p>Sea Hunter™ Mark II Composite Score: 3.9</p>	<ul style="list-style-type: none"> Includes user-replaceable submersible headphones Low minimum operating temperature Short dive shaft 	<ul style="list-style-type: none"> Many small parts make removal of the control module difficult
 <p>CZ-21 QuickSilver Composite Score: 3.9</p>	<ul style="list-style-type: none"> Control module and controls are easy to reach and adjust High contrast lettering on control labels with clearly marked default settings Provides different tones for different metals Easily changed into modular configuration Ports on headphones for equalizing pressure and draining water Pinpoint feature Long battery runtime 	<ul style="list-style-type: none"> Too many controls Headphones are not user replaceable Thin wiring on headphones could break Heavy for land use

Table 2. Handheld Underwater Metal Detector Advantages and Disadvantages Continued






Product	Advantages	Disadvantages
 <p>Aquapulse 1B Composite Score: 3.7</p>	<ul style="list-style-type: none"> • Only two controls • Includes user-replaceable, submersible earphone • Very rugged • Many accessories available • Comes standard in a modular configuration • 24/7 technical support 	<ul style="list-style-type: none"> • No included accessories to mount control module to shaft • Free flowing cables may be entanglement hazard • Control module not attached to shaft makes it prone to unintentional adjustments • Battery is not user replaceable • Coil and earphone ports easy to confuse • Heavy for land use
 <p>Excalibur II Composite Score: 3.6</p>	<ul style="list-style-type: none"> • Bright green color easy to see underwater • Easily replaced rechargeable battery pack • Optional battery pack that accepts eight size AA batteries 	<ul style="list-style-type: none"> • Too many controls • Headphones are not user replaceable
 <p>Tiger Shark Composite Score: 3.3</p>	<ul style="list-style-type: none"> • Warning on control module and headphones noting headphones are not removable 	<ul style="list-style-type: none"> • Control module is located under the arm and controls are too close together • Headphones are not user replaceable • Battery compartment is shared with other electronics • Large surface area of coil causes drag in the current • Control labels are difficult to read due to small font • Difficult to adjust shaft length
 <p>Surf PI Dual Field Composite Score: 3.3</p>	<ul style="list-style-type: none"> • Large, bright coil is easily seen underwater • Lightweight on land • Control module setup and maintenance is basic 	<ul style="list-style-type: none"> • Control module on shaft is upside down and backwards • Control settings are too easy to change and controls are too close together • Headphones are not user replaceable • Coil floats
 <p>Viper Hybrid Trident Composite Score: 3.1</p>	<ul style="list-style-type: none"> • Only two controls • Visual indicator (LED) signals detection • Powered by a single 9-volt battery • Battery compartment is easily accessible 	<ul style="list-style-type: none"> • No accessory included that allows for hands-free (modular) use • Controls are difficult to turn • Headphones are too flexible and fit loose during the dive • Difficulty detecting small objects at deeper depths

Table 3. Handheld Underwater Metal Detector Criteria Ratings¹

[illegible]

Note:

¹ Averaged criteria ratings for each assessed product are graphically represented by colored and shaded circles. Highest ratings are represented by full green circles.

Table 4. Handheld Underwater Metal Detector Specifications¹

Specifications	Pulse 8X	Sea Hunter™ Mark II	CZ 21 QuickSilver	Aquapulse 1B	Excalibur II	Tiger Shark	Surf PI Dual Field	Viper Hybrid Trident
MSRP	\$2,495	\$880	\$1,349	\$1,955	\$1,949	\$779	\$895	\$1,000
Warranty duration	2 years	1 year	2 years	2 years	1 year	Lifetime	2 years	5 years
Search technology	PI	PI	VLF	PI	BBS	VLF	PI	VLF
Visual alert	✓							✓
Weight	6.2 pounds	5.1 pounds	6.1 pounds	9.0 pounds	4.6 pounds	4.5 pounds	4.6 pounds	4.2 pounds
Coil size ²	7.5 and 10.0 ³	8.0 and 10.0x14.0 ⁴	10.5 inches	10.0 inches	10.0 inches	10.5 inches	12.0 inches	10.0 inches
Interchangeable coil	✓	✓		✓				
Detachable headphone	✓	✓		✓				
Depth rating	200 feet	200 feet	250 feet	328 feet	200 feet	200 feet	100 feet	132 feet
Operating temperature	32°F to 120°F	-4°F to 140°F	32°F to 110°F	32°F to 120°F	32°F to 113°F	30°F to 100°F	32°F to 158°F	32°F to 120°F
Storage temperature	20°F to 150°F	-40°F to 158°F	32°F to 110°F	32°F to 120°F	-4°F to 140°F	30°F to 100°F	0°F to 158°F	32°F to 120°F
Low-battery indicator	Needle-style indicator	Single audible alert at startup	Faint audible alert when battery check is performed	None	Continuous audible alert	Single audible alert when battery check is performed	Faint audible alert when battery check is performed	Continuous audible alert
Battery	Proprietary battery pack ⁵	AA (8)	9 volt (4)	Proprietary battery pack	Proprietary battery pack ⁵	AA (8)	AA (8)	9 volt (1)
Battery runtime	10 to 12 hours	18 to 22 hours	35 to 55 hours	10 to 12 hours	14 to 19 hours	10 to 20 hours	25 to 35 hours	6 to 10 hours
Training	Not provided by vendor	Instructional DVD and online videos	Not provided by vendor	Not provided by vendor	Not provided by vendor	Not provided by vendor	Online videos	Not provided by vendor
Technical support availability	24/7	Central time 8:00 a.m. to 4:30 p.m. Mon. through Fri.	Mountain time 8:00 a.m. to 5:00 p.m. Mon. through Fri.	24/7	Eastern time 8:00 a.m. to 5:00 p.m. Mon. through Fri.	Mountain time 10:00 a.m. to 4:00 p.m. Mon. through Fri.	Pacific time 8:00 a.m. to 4:30 p.m. Mon. through Fri.	Eastern time 8:00 a.m. to 5:00 p.m. Mon. through Fri.

Notes:

¹ Information was provided by manufacturers and has not been independently verified by the SAVER Program.

² The diameter is provided for round coils; the length and width are provided for oval coils.

³ The 10-inch coil was used in the assessment.

⁴ The 10x14-inch coil was used in the assessment.

⁵ The proprietary battery pack is user replaceable with purchase of a second battery pack.

✓ Detector is equipped with corresponding feature. If the cell is blank, the detector is not equipped with the corresponding feature.

BBS = Broadband Spectrum

F = Fahrenheit

MSRP = manufacturer's suggested retail price

PI = Pulse Induction

VLF = Very Low Frequency