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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 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).

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, contact the SAVER Program Support Office.

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Summary

Explosive Ordnance Disposal Search Mirrors

(AEL reference number 02EX-02-TLRO)

In order to provide emergency responders with information on currently available explosive ordnance disposal (EOD) search mirror technologies, capabilities, and considerations, Science Applications International Corporation (SAIC) conducted a comparative assessment of EOD search mirrors for the System Assessment and Validation for Emergency Responders (SAVER) Program in June 2010. Detailed findings are provided in the Assessment Report on Explosive Ordnance Disposal (EOD) Search Mirrors, which is available by request at <https://www.rkb.us/saver>.

Background

EOD search mirrors are used by bomb and hazardous devices technicians to perform searches during explosive device search and investigative response tasks. These mirrors are available in a variety of configurations; possible features include wheels or casters for maneuverability, telescopic handles for increased versatility, and lighting features to provide illumination during search activities. Though there are several types of search mirrors (e.g., surgical, room surveillance, and under vehicle), the assessment focused on models used primarily to inspect the undercarriage of a vehicle.

Assessment

The SAVER Program conducted a market survey to investigate currently available EOD search mirrors. The primary objective of the market survey was to provide an overview of the EOD search mirrors available to the nation's emergency responders as well as their capabilities, features, and considerations. In addition, the market survey report provided state and local jurisdictions with user-friendly information about a sample of the many EOD search mirrors offered for search and investigative applications.

Prior to the assessment, eight emergency response personnel were chosen from various jurisdictions to participate in a focus group. Participants possessed strong backgrounds in law enforcement, EOD, firefighting, emergency medicine, and hazardous materials (HAZMAT) response. The focus group's primary assignment was to develop EOD search mirror evaluation criteria; however, they were also tasked with recommending possible uses and operational outcomes to support the assessment plan development. The group's final task was to recommend for evaluation specific EOD search mirrors considered potentially beneficial to response disciplines.

Based on focus group recommendations, market survey research, and equipment availability, the following EOD search mirrors were assessed:

- ICOR Technology Stealth M1000 Search Mirror
- Lumenyte International Corporation SLAM-V™

- Allen Vanguard VMBD/2
- Salient Manufacturing Detective Series 3000N.

Eight responders served as evaluators for this assessment. Each evaluator had completed training, received bomb or hazardous devices technician certification, and had no less than 5 years of experience using EOD tools.

Evaluators conducted various improvised explosive device (IED) inspection tasks requiring the use of EOD search mirrors. Specifically, these tasks included locating a series of devices that were planted in the reception area for a visiting dignitary, in an outdoor parking lot of a stadium, in an indoor parking garage, and aboard a public transportation vehicle. The assessment environment and activities performed were replicable should there be a future need to repeat an identical or similar assessment. The activities performed in this assessment were consistent with the operational objectives that may exist in a similar incident.

Assessment Results

Evaluators rated the EOD search mirrors based on the evaluation criteria established by the EOD search mirror focus group. Each criterion was assigned to one of the five SAVER categories, and then weighted for its level of importance. Once weighted, each of the five SAVER Program categories was assigned a percentage value representing its level of importance relative to the other categories.

SAVER Program Category Definitions

Affordability: This category groups criteria related to life-cycle costs of a piece of equipment or system.

Capability: This category 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 responder-relevant tasks.

Deployability: This category 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: This category groups criteria related to the maintenance and restoration of a piece of equipment or system to operational conditions by responders.

Usability: This category 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 displays the composite assessment scores as well as the category scores for each product. Higher scores indicate a higher rating by evaluators. For product specifications, see table 2. To view how EOD search mirrors scored against each of the evaluation criteria assigned to the SAVER Program categories, see table 3.

The following paragraphs provide a brief summary of evaluator comments and feedback on each EOD

Table 1. Explosive Ordnance Disposal Search Mirror Assessment Results¹

Model	Composite Score	Affordability (5% Weighting)	Capability (35% Weighting)	Deployability (20% Weighting)	Maintainability (15% Weighting)	Usability (25% Weighting)
ICOR Technology Stealth M1000 Search Mirror	77	71	71	82	80	81
Lumenyte International Corporation SLAM-V™	77	78	72	80	79	79
Allen Vanguard VMBD/2	65	65	65	59	70	65
Salient Manufacturing Detective Series 3000N	46	50	43	53	42	45

Note:

¹ Scores contained in the assessment report may be displayed differently. For the purposes of the SAVER Summary, all SAVER category scores are normalized using a 100-point scale and rounded to the nearest whole number.

search mirror used during the assessment. The mirrors are listed from highest to lowest composite score. The complete assessment report includes a breakdown of evaluator comments by individual criterion.

ICOR Technology Stealth M1000 Search Mirror

The ICOR Technology Stealth M1000 Search Mirror received a composite score of 77. The Stealth M1000 is an adequate size for under-vehicle searches, offering the user a good field of view with a clear reflected image and no magnification of the objects in the mirror. The convex mirror is angled toward the user to increase its field of view, but the Stealth M1000 offers no adjustment angles or locking mechanisms to retain mirror angles. The mirror’s two lights provide sufficient lighting for indoor search operations, though two teams noted that the bright light source was blinding at times. Adding a third light would create a more even distribution of light. The telescopic pole remains sturdy when fully extended, does not bend when the unit is lifted, and reaches the width of undercarriages when conducting under-vehicle searches. The pole has locking mechanisms that are easy to use even when wearing gloves, and the mirror is comfortable to use with even weight distribution and an easily attachable/detachable handle. The three swivel caster wheels enhance the maneuverability of the mirror, which rolls easily on most ground surfaces.

	 Pros	<ul style="list-style-type: none"> • Extension capabilities • Locking mechanism on pole extension • Bright light source • Easy battery access and replacement • 15-hour battery life • Inexpensive battery requirement (i.e., 9-volt) • Angle and contour of mirror • Wheel design; wheel pattern; roller-blade style • Quality construction
	 Cons	<ul style="list-style-type: none"> • Third light source needed toward the front of the mirror • Blinding of user due to light source angle • Battery box not stationary; wiring susceptible to breakage • Mirror angle not adjustable • Cost
ICOR Technology Stealth M1000 Search Mirror		Composite Assessment Score: 77

The unit can be easily deployed to a response scene and was the only unit evaluated to come with a case. The mirror is lightweight due to its aluminum construction, and the foam hand grip enhances user comfort.

The Stealth M1000 is difficult to manipulate in confined spaces because of its size. The on/off switch, located at the tip of the pole, would be more convenient in another location. The mirror uses 9-volt batteries, which are easy to access and replace, and has a 15-hour battery life; however, the battery box is not stationary and the wiring appears susceptible to breakage and failure. Though the cost of the unit may be prohibitive for some jurisdictions, evaluators noted that the added expense was justified based on the 1-year warranty and the quality of the equipment.

Lumenyte International Corporation SLAM-V

The Lumenyte International Corporation SLAM-V received a composite score of 77. The SLAM-V works well in limited spaces; there is no distortion from the mirror’s flat surface, though a convex mirror would have provided a greater field of view. A manufacturer-specific fiber-optic light provides sufficient illumination indoors and in darkened areas, and an independent light source is provided. The SLAM-V is lightweight and sturdy, the hinged mirror plate is easily manipulated and adjusted, and the size of the SLAM-V is ideal for tight spaces. With a single-wheeled design that increases maneuverability,

	 Pros	<ul style="list-style-type: none"> • Independent light source • Common batteries • No mirror distortion • Versatility (i.e., can be used for multiple applications) • Durability • Cost • Lightweight; portable; easy to maneuver • Works well in confined spaces • 2-year warranty
	 Cons	<ul style="list-style-type: none"> • No positive lock adjusting mechanism • Manufacturer-specific fiber-optic light source • No pole adjustment/extension • No forearm padding
Lumenyte International Corporation SLAM-V™		Composite Assessment Score: 77

the mirror moves in all directions on various ground surfaces except gravel. The SLAM-V operates using two disposable CR123A lithium batteries, and the mirror is versatile enough to use for multiple applications and seems capable of withstanding various environmental conditions.

The mirror is not equipped with a locking mechanism, and there are no telescoping options. The vinyl hand grip and arm cradle adjustment capabilities enhance user comfort, though there is no forearm padding. The SLAM-V appears durable, but the pivot hinge at the base of the pole seems susceptible to wear after extensive use. The cost of the unit is reasonable; however, the optional wheel assembly does not come standard with the unit. The SLAM-V comes with a 2-year warranty.

Allen Vanguard VMBD/2

The Allen Vanguard VMBD/2 received a composite score of 65. The mirror offers true reflection with no magnification. The VMBD/2 light source includes two 6-watt fluorescent lamps with a handle-mounted switch that can be unclipped from the trolley and used as a search lamp. It is easy to maneuver across smooth surfaces, but not across coarse surfaces such as grass or gravel. Though the VMBD/2 fogs when moving from indoor to outdoor areas with humidity, the fog dissipates quickly. The search mirror is easily stowed for transport; however, the unit would be more compact if the handle or pole were collapsible.

Because the VMBD/2 is larger than the other assessed mirrors, it provided a larger surface area; however, the flat surface limited its field of view, with the size and orientation of the mirror restricting access to confined spaces. The pole mounting bracket also restricts field of view. The light rotates during use due to vibration caused when rolling the unit, and the cord does not wrap securely around the light, blocking the field of view. The mirror is heavy with unequal weight distribution, does not include a pole extension capability, and lacks adjustment angles and locking features to allow users to retain a preferred angle during a search. The aluminum unit does not offer a forearm rest, and the short pole may cause discomfort for taller users. By the third rotation of the assessment, the screw receptacle used for battery access became cross-threaded. The unit, which requires 10 disposable D-cell batteries for operation, maintained a continuous charge throughout the assessment tasks. The cost and 1-year warranty for the VMBD/2 are reasonable, though the operational

	 Pros	<ul style="list-style-type: none"> • Bright light source • Light switch position • Good mirror size • Warranty • Cost
	 Cons	<ul style="list-style-type: none"> • Requires 10 D-cell batteries • Cost of consumables • View of mirror blocked by light cord not wrapping tightly • Heavy • No extension capabilities • Not long enough • Problematic wheel design; collects gravel when used outdoors • Screw receptacle susceptible to wear
Allen Vanguard VMBD/2		Composite Assessment Score: 65

costs may be a bit more than other units due to the number of batteries required.

Salient Manufacturing Detective Series 3000N

The Salient Manufacturing Detective Series 3000N received a composite score of 46. The 3000N has a good field of view, but the curvature of the mirror surface magnifies and distorts reflections. The 3000N uses either eight rechargeable nickel metal hydride (NiMH) AA batteries or disposable AA alkaline batteries; a 110/120-volt universal charger is supplied with the unit. The batteries retained their charge throughout the evaluation, but the small set screws for the battery box could be easily lost. The 3000N is easy to carry due to the lightweight fiberglass construction, and the mirror has a telescopic pole extension capability; however, the locking mechanism is not secure so the pole cannot effectively support the weight of the mirror.

The halogen lamp is inadequate for indoor operations because the direct beam is not broad enough and the light is located on the pole axis rather than on the mirror. The loose tension of the hinge at the base of the pole does not retain the user's preferred mirror angle, and adjustments to the angle are somewhat difficult. The wheels allow the 3000N to be moved in all directions, but the support bar minimizes ground clearance and limits maneuverability. In addition, the wheel assembly is not large enough to protect the support pole from abrasion, and the weight distribution of the mirror is not equal. The wiring

	 Pros <ul style="list-style-type: none"> • Lightweight, fiberglass construction • Extension capabilities • Easy-to-replace mirror
	 Cons <ul style="list-style-type: none"> • Wearing/grinding down of mirror support pole due to wheel size • Loose tension at hinge at the end of the extension pole • Poor lighting source (i.e., brightness and location) • Light source position • Small set screws for battery box; easily lost • Limited warranty too exclusive • Continual releases of pole extension locking mechanism • Poorly constructed; poor quality materials • Cost versus quality • Pinching caused by rivets • Wiring harness exposed; light shorted out during use • Easily scratched
Salient Manufacturing Detective Series 3000N	Composite Assessment Score: 46

harness at the base of the pole had multiple holes by the end of the assessment, possibly causing the light to short out during the rotations. The mirror acquired multiple scratches during the assessment, and while the mirror can be easily replaced, the search mirror could require ongoing repairs and restoration. The ergonomic features of the 3000N cause user discomfort, and the rivets cause pinching and pulling of arm hair. Though the 3000N collapses for storage, the convex shape of the mirror prevents it from laying flat; the pole makes contact with the mirror surface while in the folded position, allowing it to bump against the mirror during transport. While the cost of the unit is reasonable for most jurisdictions, evaluators indicated the quality of the unit does not justify the expense. The 1-year warranty covers the battery, charger, and light source; with the exception of the light, the most damage-prone components are not covered.

Conclusion

Evaluators were able to successfully complete the assessment tasks with all four of the assessed EOD search mirrors. Evaluators observed advantages and disadvantages of the assessed mirrors. The results indicate that the scores were very close for many

criteria and there were aspects of each tool that evaluators liked and disliked, as they related to personal experience and preference. An analysis of the evaluator comments and scores revealed several common observations of the assessed EOD search mirrors:

- Evaluators favored EOD search mirrors that are lightweight, comfortable, and easy to maneuver. They explained that some response situations require extensive search operations; therefore, units that are lighter and evenly balanced allow the operator to comfortably use the mirror for extended periods of time. They also explained that it is imperative that the wheel assembly enable the unit to be easily maneuvered to and from the response scene and from one vehicle to the next.
- Evaluators placed a high value on EOD search mirrors that feature pole extension capabilities and locking mechanisms to secure the preferred length of the pole. They stated that pole extensions increase the versatility of the unit by allowing it to be used for different sized vehicles; they also enhance user comfort by preventing the user from having to bend or stoop during search operations.
- Evaluators expressed a strong preference for mirrors that are adequately sized, adjustable, and scratch resistant. They explained that an adequately sized mirror augments the field of view by allowing the unit to be used in open as well as confined spaces. Evaluators discussed the importance of being able to adjust the mirror to different angles for increased visibility. They also stressed their preference for mirror surfaces that are scratch-resistant so that reflections are clear and operations are not hindered. Evaluators were also partial to mirrors that provide 1:1 ratios, meaning that objects are not magnified or distorted in any way.
- Evaluators preferred EOD search mirrors that require commonly used batteries. They liked both disposable and rechargeable batteries and emphasized that the main concerns are battery life and easy battery replacement.
- Evaluators favored EOD search mirrors made with quality materials and sturdy components. They agreed that durable construction is the key to ensuring the unit can withstand repetitive use.

- Evaluators place a high value on EOD search mirrors with light sources that provide sufficient illumination for both indoor and outdoor search operations. They preferred mirrors with light sources that provide evenly distributed illumination and on/off switches that are conveniently located and easy to manipulate.
- Evaluators expressed a strong preference for EOD search mirrors that are reasonably priced, covered by a warranty, and capable of being serviced or repaired by the user. They agreed that search mirrors are available in a wide range of prices and higher priced units can be

cost prohibitive for small departments and jurisdictions.

All reports in this series, as well as reports on other technologies, are available in the SAVER section of the Responder Knowledge Base (RKB) Web site at <https://www.rkb.us/saver>.

Table 2. Explosive Ordnance Disposal Search Mirror Specifications

Product	Specifications
ICOR Technology Stealth M1000 Search Mirror	<ul style="list-style-type: none"> • Light source: Four light-emitting diodes (LEDs) • Mirror: 12-inch, round, convex • Batteries: Two 9-volt • Casters: Three swivel
Lumenyte International Corporation SLAM-V™	<ul style="list-style-type: none"> • Light source: Self-illuminating, continuous optical fiber • Mirror: Large, flat, trapezoidal • Batteries: Two CR123A lithium • Casters: Optional wheel/caster assembly
Allen Vanguard VMBD/2	<ul style="list-style-type: none"> • Light source: Two 6-watt fluorescent lamps • Mirror: 12-inch, square, convex • Batteries: 10 D-cell or rechargeable nickel-cadmium (Ni-Cad) • Casters: Four swivel
Salient Manufacturing Detective Series 3000N	<ul style="list-style-type: none"> • Light source: 20-watt halogen lamp • Mirror: 12-inch, round, convex • Batteries: Eight AA alkaline or AA nickel metal hydride (NiMH) • Casters: Four swivel

Table 3. Explosive Ordnance Disposal Search Mirror Criteria Ratings¹

KEY					
Least Favorable		Most Favorable			
					
		ICOR Technology Stealth M1000 Search Mirror	Lumenyte International Corporation SLAM-V™	Allen Vanguard VMBD/2	Salient Manufacturing Detective Series 3000N
Assessment Criteria					
Affordability					
Initial cost					
Operational costs					
Accessories and upgrades					
Capability					
Field of view					
Optics					
Illumination					
Mirror manipulation					
Pole versatility					
Deployability					
Weather resistance					
Portability					
Construction material(s)					
Maintainability					
Durability					
Battery sources					
Parts replacement					
Storage requirements					
Usability					
Ease of use					
Maneuverability					
Mirror surface properties					

Note:

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