Homeland Security
Science and Technology

Summary

Search Cameras

(AEL reference number 03SR-03-SCAM)

In order to provide emergency responders with information on currently available search camera technologies, capabilities, and considerations, Science Applications International Corporation (SAIC) conducted a comparative assessment of search cameras for the System Assessment and Validation for Emergency Responders (SAVER) Program in April 2010. Detailed findings are provided in the Assessment Report on Search Cameras, *which is available by request at* https://www.rkb.us/saver.

Background

Search cameras are critical response tools used by search and rescue teams and other responders for inspecting voids and confined spaces with limited physical access. These cameras are commonly used during search and rescue situations after a structural collapse. They are also used to search confined spaces that are considered too dangerous for emergency responders to enter.

Assessment

The SAVER Program conducted a market survey to investigate currently available search cameras. The primary objective of the market survey was to provide an overview of the search cameras 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 search cameras offered for search and rescue 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 fire service, search and rescue, hazardous materials (HAZMAT) response, and emergency medicine. The focus group's primary assignment was to develop search camera 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 specific search cameras considered potentially beneficial to the response disciplines for evaluation.

Based on focus group recommendations, market survey research, and equipment availability, the following search cameras were selected for the assessment:

- Zistos® Corporation Rescue System
- Aqua Communications Inc. SnakeEye™ III
- Con-Space Communications Ltd. SearchCam® 3000
- Tactical Electronics LPSS2 Long Pole Search System.

The LPSS2 camera head attachment broke when evaluators attempted to connect the color camera head to the handle assembly, causing the LPSS2 to

become unserviceable prior to the first rotation. As such, this camera system was not assessed.

Eight responders served as evaluators for this assessment. All evaluators had at least 7 years of experience in emergency response disciplines including firefighting, HAZMAT, emergency medical response, and/or search and rescue, with no less than 4 years of experience using search cameras in search and rescue operations.

Evaluators were tasked to set up equipment and respond to three simulated structural collapse scenarios and one confined space scenario. The assessment environment and activities performed were replicable should there be a need to repeat an identical or similar assessment in the future. The activities performed in this assessment were consistent with these scenarios and with the operational objectives that may exist in a similar incident.

Assessment Results

Evaluators rated the search cameras based on the evaluation criteria established by the search cameras focus group. Each criterion was assigned to one of the five SAVER Program categories and then assigned a weight for its level of importance. Once the criteria were weighted, the five SAVER Program categories were assigned a percentage value to represent the level of each category's importance relative to the other categories.

Table 1 displays the composite assessment scores as well as the category scores for each product. Higher scores indicate a higher rating by evaluators. To view how each search camera scored against each of the evaluation criteria assigned to the SAVER Program

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.

categories, see table 2. For product specifications, see table 3.

The following paragraphs provide a brief summary of evaluator comments and feedback on each search camera used during the assessment. The cameras are listed from highest to lowest composite score. The complete assessment report, available in the SAVER section of the Responder Knowledge Base (RKB) Web site (https://www.rkb.us/saver), includes a breakdown of evaluator comments by individual criterion.

Table 1. Search Camera Assessment Results[1]

Product	Composite Score	Affordability (15% Weighting)	Capability (25% Weighting)	Deployability (20% Weighting)	Maintainability (15% Weighting)	Usability (25% Weighting)
Rescue System	69	62	61	82	62	74
SnakeEye™ III	67	73	56	72	70	70
SearchCam® 3000	65	58	55	74	64	70

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.

Rescue System

The Rescue System received a composite score of 69. Evaluators reported that the system includes infrared and thermal imaging capabilities. They liked the functionality and durability of the gooseneck probe, as well as the chest-mounted display screen. Evaluators stated that the camera head offers 180-degree articulation and the twist grip is a nice feature. They noted the camera uses disposable alkaline batteries that are contained in a strap-mounted battery pack around the user's waist. They also reported that the system offers audio capabilities to enable the user to hear a victim during search operations; an optional two-way communication feature is also available. Evaluators stated that the camera system is capable of one- or two-person operation; it also includes a wheeled carrying case that is well organized, easy to repack, and features a compartment picture. They agreed that the Rescue System is a good value for the money.

Evaluators pointed out features that they considered disadvantages of the Rescue System. For instance, they stated that the light control and battery charge indicator are not in good locations. They reported that the sun shield does not fit securely on the display monitor, and when used, it hinders access to the control buttons. Evaluators also stated that the cable on the back of the unit interferes with operations, and they encountered problems with the cable shorting out during the assessment tasks. Although the audio system was a favored feature, evaluators stated the earphones were of poor quality.

SnakeEye III

The SnakeEye III received a composite score of 67. Evaluators agreed that the SnakeEye III offers added versatility due to its multiple camera options including infrared capability, finger attachment, gooseneck

	↑ Pros	• Versatile heads: waterproof, thermal imaging, infrared • Gooseneck probe: good design, functional, durable • Chest-mounted display • Waist strap-mounted battery • 180-degree image rotation • Multiple power sources: charger or battery pack using disposable/rechargeable alkaline batteries • One- or two-man operation • Good value for money • Good articulation; twist grip was nice feature • Very sensitive audio • Optional two-way communication • Carrying case: wheels, well-organized, easy to repack, compartment picture included
	↓ Cons	• Location of light control and battery charge indicator • Unsecured fit of sun shield on display • Hindrance to control buttons when using sun shield • Cable loop at back of unit: interference with operations and problems shorting out • No accessory price parts information available • Poor quality earphones
Rescue System	**Composite Assessment Score: 69**	

	↑ Pros	• Reasonable cost, value of system • Versatility with available options: infrared, finger attachment, gooseneck wand, mini camera • Lightweight • Display screen size and picture clarity • Intuitive to use • Voice notes (narration) capability • Ease of transporting entire system • Multiple power sources: alternating current (AC) or direct current (DC) batteries, or 10-hour rechargeable battery pack • Positive locking (push button) on pole extension
	↓ Cons	• Ergonomics of control buttons (separation of buttons on two sides of display) • No audio capability for communicating with victims • Hard to connect video cables with gloved hands • Two battery covers (not attached and could be lost) • Poor quality hand strap • Wand construction • Battery life: 30-minute rechargeable internal battery • Possible stress points caused by method of articulation, potential awkwardness for users in some situations • Case unable to contain all of the necessary components; no case provided for pole
SnakeEye™ III	**Composite Assessment Score: 67**	

wand, and miniature camera. They determined that the lightweight system is easy to transport, the controls are intuitive to use, and the display screen provides clear images. They also stated that the audio capability allows the user to capture narration, the pole extension includes positive locks, and the system offers a 10-hour external battery pack. Evaluators agreed the SnakeEye III is available at a reasonable cost and is a good value.

There were noted disadvantages with this particular camera system as well. Evaluators commented that they did not like the ergonomics of the control buttons; they are located on both sides of the display rather than together. Evaluators stated that the set screw fell out when unpacking the camera, the wand is poorly constructed, and the hand strap broke during the first rotation. They reported that the video cables are hard to connect while wearing gloves and the method of articulating the camera head can create a possible stress point on the system. Evaluators commented that the battery provides only 30 minutes of use and that both battery covers could be lost since they are not attached to the system. They indicated that it is a disadvantage that the camera system does not provide audio capabilities for the user to hear victims during search operations. Evaluators also stated that the carrying case is not large enough to contain all of the system's components, but it does appear durable enough for long-term use.

SearchCam 3000

The SearchCam 3000 received a composite score of 65. Evaluators reported that the SearchCam 3000 provides excellent video and versatile camera head options (e.g., boom extension, rope drop head). They agreed that the camera provides a wide field of view, the control buttons on the pistol grip provide convenient access, and the two-way communication feature includes a quality headset. They also liked the location of the battery indicator and the well-organized, wheeled carrying case.

Disadvantages included the heavy weight of the system, poorly designed carrying strap, and multiple power buttons. Evaluators stated that there is inadequate spacing between controls and knobs when using the pistol grip with a gloved hand. They also reported that the monitor mount/display yoke creates an obstruction for the articulation button. Evaluators determined that the cable is not long enough for the pole when extended, creating added stress and time required for assembly. They also stated that the

		Pros	• Excellent video quality and clarity • Versatile options: submersible, boom extension, rope drop head • Wide field of view • Piston grip provides convenient access to control buttons • Two-way communication • Quality headset • Carrying case: wheels, well-organized • Location of battery indicator
		Cons	• Heavy • Expensive • Reboot required for whole system when articulating head would "freeze up" • Reboot required before use of audio system • Reboot required if contrast and brightness controls are engaged in the wrong sequence • Lengthy boot and shutdown time • Multiple power buttons • Inadequate spacing between controls and adjustment knob when using pistol grip with a gloved hand • Poorly designed monitor mount/display yoke, obstruction of articulation button • Cables not long enough for the pole when extended • Carrying strap: not heavy-duty, not padded, too narrow, did not balance camera well • Powered by lithium ion batteries only (no AC or DC power source capabilities)
SearchCam® 3000		Composite Assessment Score: 65	

system freezes up when articulating the camera head, reboot is required before using the audio system, and reset is required if the contrast and brightness controls are engaged in the wrong sequence. In addition, evaluators agreed that the cost of the SearchCam 3000 is high.

Conclusion

Evaluators were able to successfully complete the assessment tasks using the assessed cameras. Evaluators observed advantages and disadvantages of the systems, but noted that their results are limited to the search camera tasks used for this assessment. Additionally, the results indicate that the scores were very close for many criteria and there were aspects of

each camera system 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 search cameras:

- Evaluators expressed a strong preference for search cameras that can be easily assembled and are intuitive to use. They explained that the components and cables should be easy to connect and secure, even when wearing responder gloves, and the system should have ergonomic controls to allow the user convenient access to the control buttons.
- Evaluators preferred search cameras with versatile heads (e.g., waterproof, thermal imaging, infrared). They stated that multiple camera options enhance search operations and equip users with search capabilities for various applications. For example, thermal imagers allow individuals to be located by detecting body temperatures, and infrared cameras provide responders with search capabilities in nighttime or low-light conditions.
- Evaluators placed a high value on search cameras with audio capabilities. Although one-way communication allows the user to detect and hear the victim while response tasks are being conducted, evaluators explained that two-way communication permits the user to communicate with the victim during rescue operations. Evaluators also commented that some search camera systems offer voice notes or narration capabilities to enable the user to record his or her comments while recording a search area. They further noted their preference for audio capabilities with clear output and quality headsets.
- Evaluators preferred search cameras capable of operating from multiple power sources. They agreed that the capability to be powered by different sources increases flexibility and enhances response times by providing a backup source of power. Examples discussed include disposable alkaline and lithium batteries, rechargeable batteries, and battery packs. Evaluators also discussed their preference for batteries that have an extended or lengthy battery life.

- Evaluators expressed a strong preference for search cameras with good articulation capabilities. Areas of importance included various degrees of articulation, the ease of controlling the articulation, and the durability of the camera to be repetitively articulated during search operations.
- Evaluators placed a high value on search cameras that include display screens that can be easily read in various light conditions. They explained the importance of displays offering crisp, clear images that can be easily viewed in both bright sunlight and low-light conditions. Evaluators preferred displays that offer image rotation capabilities to ensure proper orientation of the subject being viewed. They considered characteristics such as screen size, picture clarity, video quality, and adjustment capabilities. In addition, evaluators discussed the advantages of using sun shields that securely fit onto the displays without interfering with the controls.
- Evaluators expressed a strong preference for search cameras that are durable and well-built. They stressed the importance of all components (i.e., camera, display, poles, connections, cables, straps) being rugged and able to withstand repetitive use; they agreed that the quality of the search cameras should align with the cost of each system.
- Evaluators preferred search cameras with durable carrying cases for ease of transport and storage, as well as protection. They agreed that the case should be lightweight, include wheels, and provide comfortable handles for extended deployment times. Evaluators explained that the case should allow components to be easily repackaged and it should keep the components well organized for accountability and access purposes. They also agreed that the carrying case should be durable enough to withstand long-term use.

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. Search Cameras Criteria Ratings[1]

KEY — Least Favorable ➡ Most Favorable (○ ◔ ◐ ◕ ●)	Rescue System	SnakeEye™ III	SearchCam® 3000
Assessment Criteria			
Affordability			
Kit price	◕	◕	◐
Accessory costs	◐	◕	◐
Service contracts	◕	◕	◐
Replacement part costs	◐	●	◐
Maintenance costs	●	●	◕
Technical support	●	●	●
Training costs	◕	◕	●
Capability			
Multiple power sources	◕	◕	◐
Environmental factors	◐	◐	◐
Field of view	◐	◐	◐
Picture clarity	●	●	◕
Scratch resistance	◐	◐	◐
Field repairable	◐	◐	◐
Audio capability	◐	◔	●
Multiple modes	◕	◐	◐
Warning indicators	◐	◐	◕
Wireless transmission	◐	◔	◔
Deployability			
Easy to carry	●	◕	◕
Carrying case	●	◕	◕
Easy to disassemble	●	●	●
Vehicle storage	◕	◕	◕
Maintainability			
Battery maintenance	◕	◕	◐
Serviceable parts	◐	◕	◐
Easy to clean	◕	●	◕
Self diagnostics	◕	◕	◕
Service requirements	◐	◕	◕

Table 2. Search Cameras Criteria Ratings[1] (Continued)

KEY		Rescue System	SnakeEye™ III	SearchCam® 3000
Least Favorable → Most Favorable (○ ◔ ◑ ◕ ●)				
Assessment Criteria				
Usability				
Easy setup		◕	◕	◕
Ruggedness		●	◕	◕
Simple operation		◕	◕	◕
Lighting		◑	◕	◕
Pole articulation		◕	◕	◕
Screen visibility		◕	◕	◕
Accessibility		●	●	◕
Interoperability		◑	◑	◑
Versatility		●	●	●

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.

Table 3. Search Camera Specifications

Product	Specifications
Rescue System	- Low-light color camera 90-degree articulation 5-inch display 9-foot telescoping pole - Talkback audio module and headphones - Two rechargeable battery packs, vehicle adaptor - Custom carrying case - Universal chest harness - Sun shield
SnakeEye™ III	- Low-light color camera 90-degree articulation 5-inch display - Telescoping pole (optional accessory: four different lengths available) - Voice note capability for making narration notes while recording - Rechargeable battery pack, vehicle adaptor, alternating current (AC) adaptor - Custom carrying case 18-inch wand, finger adaptor, gooseneck adaptor - Sun shield (optional accessory)
SearchCam® 3000	- Low-light color camera 240-degree articulation 5-inch display 92-inch telescoping pole - Two-way communication and headphones - Lithium ion batteries - Custom carrying case - Rope with carabineer, rope coupler - Sun shield