Homeland Security
Science and Technology

Summary

Portable X-Ray Systems for Suspicious Package Screening

(AEL reference number 02EX-01-XRAP)

In order to provide emergency responders with information on currently available portable X-ray systems, the Space and Naval Warfare Systems Center (SPAWARSYSCEN) Atlantic conducted a comparative assessment of portable X-ray systems for the System Assessment and Validation for Emergency Responders (SAVER) Program in August 2010. Detailed findings are provided in the Portable X-ray Systems for Suspicious Package Screening Assessment Report*, which is available by request at* https://www.rkb.us/saver.

Background

Portable X-ray systems are used by hazardous devices technicians to screen objects for explosives, weapons, drugs, and other contraband. These systems are deployed to the site of their intended use so that objects such as unattended baggage, suspicious packages, and unexploded ordnance can be X-rayed without being moved, protecting the lives of emergency responders and civilians in the vicinity of suspect objects.

Assessment Methodology

Prior to the assessment, eight emergency responders were chosen from different jurisdictions to participate in a focus group. Participants had experience working as bomb technicians, bomb squad commanders, and arson investigators. The group's primary objectives were to recommend evaluation criteria, product selection criteria, products, and assessment scenarios.

Based on focus group recommendations, market research, product selection criteria, and equipment availability, the following systems were assessed:

- FoXrayIIe/VCU-10, Vidisco Ltd;
- RTR-4L® 10 Portable Digital X-ray System, Science Applications International Corporation (SAIC); and
- Scanwedge, Scanna MSC Inc.

Only flat panel direct-radiography systems that are packaged in a single container and can be hand-carried by one or two people to the site of deployment were considered for the assessment.

Six certified hazardous devices technicians were selected to serve as assessment evaluators. All evaluators had at least 6 years of experience.

Evaluators assessed the portable X-ray systems in two phases. During the specification phase, evaluators assessed equipment against vendor-provided specifications. Hands-on experience with the systems during two scenarios served as the basis for assessment during the operational phase. In the first scenario, evaluators obtained X-ray images of a suitcase through the side of a vehicle. The second scenario was separated into two segments. In the first segment, evaluators obtained X-ray images of an unattended suitcase left in the

middle of a room; in the second, evaluators obtained X-ray images of a shipping box placed against a wall.

Assessment Results

Evaluators rated the portable X-ray systems based on the evaluation criteria established by the focus group. The focus group assigned each criterion to one of the five SAVER categories, and then assigned a weight for its level of importance. Once the criteria were weighted, the five SAVER 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 portable X-ray system scored against each of the evaluation criteria assigned to the SAVER categories, see table 2. For equipment specifications, see table 3.

The following paragraphs provide a brief summary of evaluator comments and feedback for each portable X-ray system used during the assessment. The systems are listed from highest to lowest composite score. The complete assessment report includes a breakdown of evaluator comments by SAVER category.

FoXraylle/VCU-10

The foXrayIIe/VCU-10 received a composite score of 70. The initial purchase price is $31,394, which includes the following major components: a Golden Engineering XRS-3 X-ray generator, laptop, imaging plate, and proprietary Xfox software. The system, which can be purchased without the X-ray generator for $24,598, is compatible with most Golden Engineering and continuous wave X-ray generators.

The power options were rated favorably, particularly the rechargeable lithium-ion battery, which powers the imaging plate (VCU-10) and only uses power when the system is actively taking X-ray images. Color-coded cables allowed for quick and easy setup. The system's case is durable and has wheels, allowing the system to be easily transported, and the imaging plate features a handle for transport downrange. The system is capable of saving images in standard formats that permit image enhancement, and evaluators were pleased with the range of available file format options. Image sharing options, particularly the e-mail feature, were rated favorably. System software includes helpful features such as the capability to adjust the pulse count from the laptop, making it easy to use. The imaging plate's 2-week battery life is practical, and having battery status indicators on both the

Table 1. Portable X-ray System Assessment Results[1]

Product	Composite Score	Affordability (13% Weighting)	Capability (20% Weighting)	Deployability (33% Weighting)	Maintainability (7% Weighting)	Usability (27% Weighting)
FoXraylle/VCU-10	**70**	72	74	64	78	68
RTR-4L 10	**60**	54	72	62	48	54
Scanwedge	**60**	54	58	54	70	68

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.

	Pros	• Color-coded cables enable quick system setup • Handle on the imaging plate and wheeled, durable carrying case • X-ray images can be saved in a variety of standard formats • Imaging plate only consumes power when the system is actively taking X-ray images
	Cons	• X-raying large object is limited due to short length of cable between imaging plate and X-ray generator • Standard cable length between imaging plate and display may not meet distance safety standards • No image stitching capability
FoXraylle/VCU-10	**Composite Assessment Score: 70**	

	Pros	• Imaging area begins 0.06 inches from the bottom of the imaging plate • Sizeable touch screen display
	Cons	• Standard cable length between imaging plate and display may not meet distance safety standards • No image stitching capability
RTR-4L 10	**Composite Assessment Score: 60**	

imaging plate and laptop is favorable. The software controls permit satisfactory manipulation of X-ray images, enabling the user to improve image quality. The purchase price includes a 1-year warranty and evaluators commented that the initial system cost is comparable to other systems on the market. A service contract is included with the standard warranty and provides advanced replacement options if a component needs to be repaired or replaced. Technical support is also included with system purchase and is available 24/7 via phone; the response time for e-mail inquiries is 1 hour.

Some evaluators felt that the imaging plate connectors appeared susceptible to damage if exposed to harsh conditions, and that the imaging plate's plastic case may break if dropped. The system does not support image stitching, and some evaluators noted that the number of system settings requiring configuration may be an issue for users. Images must be manually saved prior to making enhancements, and evaluators would prefer that the software automatically save the original image. Finally, the standard cable length between the imaging plate and X-ray generator is 10 feet, resulting in limited capabilities when X-raying large objects such as vehicles.

RTR-4L 10

The RTR-4L 10 received a composite score of 60. The initial purchase price is $23,043, which includes the following major components: a Golden Engineering XR200 X-ray generator, Toughbook® notebook computer, and RTR-4iMa X-ray imaging

plate. The system, which can be purchased without the X-ray generator for $20,307, is compatible with most Golden Engineering X-ray generators.

The power options—both the AC/DC power inputs and internal battery power—were found to be favorable. The system met evaluators' requirements for operation in extreme conditions such as storage or use in a hot vehicle. Setup time was rated favorably with evaluators noting the ease of configuring alternate imaging plates for use with the system and the limited number of passwords required to log in. The system is capable of capturing an X-ray image near ground level since the imaging area begins 0.06 inches from the bottom of the imaging plate. Evaluators commented positively on the screen size, touch screen capability, and displayed X-ray image. The system is user-friendly. Pulse count settings were easy to configure using the system's software and the software is easy to navigate. It was noted that the 60-pulse setting used to penetrate both sides of a vehicle was excellent. Image speed was rated favorably; the image appeared quickly with little or no delay. The 40 minutes required to recharge the battery met expectations. The system's package size was rated favorably. The laptop's standard 2-year warranty was viewed as excellent as these warranties are often limited to 1 year. Maintenance costs were found to be favorable, and most of the necessary parts are standard and available through multiple vendors. The system can be decontaminated through a simple process without being damaged.

It was noted that cable upgrades may be needed to withstand storage and operation in freezing temperatures. Evaluators noted that the amount of cable included with the purchase of the standard system did not meet their agency's minimum 300-foot safety standard. It was noted that the display was washed out in the sun, making it difficult to see the details of the X-ray image at times. The system does

not permit image stitching, and saving and downloading images files for image sharing was time consuming. A service contract was not included with system purchase; evaluators felt it should have been. Technical support did not answer a call from evaluators during the assessment.

Scanwedge

The Scanwedge received a composite score of 60. The initial purchase price is $28,912, which includes the following major components: a Golden Engineering XRS-3 X-ray generator, laptop, and Scanwedge Model 2520 imaging plate. The system is compatible with most Golden Engineering X-ray generators. The assessed system also included a wireless option upgrade, which is available for an additional $3,555.

The system's operating temperature range (32° to 104°F) was rated favorably. The system features image stitching, and there did not appear to be any limitations on file formats for saving and sharing. The system's software can send images via e-mail and mobile text messages. The Windows® 7 operating system met expectations. Evaluators found the imaging speed impressive. The battery life, which is rated at 4 hours, was found to be favorable. The system's image enhancement software was rated favorably; evaluators could quickly manipulate the image by zooming in or adding color. The system's overall ease of use was also noted. Purchase of the system includes a 1-year warranty that covers parts, labor, software, and manufacturer defects. The X-ray generator is covered by a manufacturer warranty. Evaluators were impressed with the decontamination requirements of the system and commented on the ease with which the imaging plate can be decontaminated without damaging the system.

The system's storage temperature range (32° to 122°F) should be higher as portable X-ray systems are often stored in vehicles. Variations in the thickness of the imaging plate from one end to the other made placement of the device difficult. Robot compatibility was rated less favorably due to issues of cable placement on the imaging plate. Evaluators indicated that a low battery indicator on the imaging plate would be helpful. Image clarity could be better; details were not clear, particularly in X-rays obtained during the vehicle scenario. Some system components will require special attention when decontaminating the system.

Conclusion

Evaluators were able to successfully complete the assessment tasks with all of the portable X-ray systems. Analysis of evaluator comments and scores revealed the following common observations concerning the assessed systems:

- Once an X-ray was taken with each of the portable X-ray systems assessed, the image appeared on the display quickly;
- Direct-radiography X-ray systems typically feature thick imaging plates that could make placement of the imaging plate difficult when packages are near other objects or obstructions;
- The standard cable length between the imaging plate and display may not meet distance safety standards. Longer cables as well as wireless options are available for an additional cost for all three assessed systems; and
- The availability of training and support is important and training should be included with the system purchase price.

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.

	Pros	• Software enables users to stitch multiple X-ray images together • The amount of time required to take an X-ray and obtain a viewable image is minimal
	Cons	• Clarity of X-ray image • No accessories provided to make integration with robot easier • Standard cable length between imaging plate and display may not meet distance safety standards
Scanwedge	**Composite Assessment Score: 60**	

Table 2. Portable X-Ray System Ratings Chart[1]

KEY: Least Favorable → Most Favorable (○ = least, ◔ red, ◐ half, ◕ green, ● = most)	FoXraylle/VCU-10	RTR-4L 10	Scanwedge
Assessment Criteria			
Affordability			
Initial Cost	◐	◔	◔
Warranty	●	◕	◐
Maintenance Costs	◐	◐	◐
Service Contract	◕	◔	◐
Capability			
Image Quality	◕	◕	◔
Image Enhancement	◕	◕	◐
Image Speed	◕	◕	◕
Status Indicators	◕	◐	◐
Battery Life	●	◕	◐
Package Size	◔	◕	◐
Authentication	◕	◐	◕
Deployability			
Setup Time	◕	◕	◐
Imaging Plate Size	◐	◐	◔
Imaging Plate Thickness	◔	○	◔
Portability	◕	◐	◐
Ruggedness	◕	◐	◐
Power Options	●	◕	◐
Robot Compatibility	◐	◐	◔
Temperature	◕	◕	◐
Cable Length	◔	◐	◐
Water Resistance	◐	◐	◕
Maintainability			
Technical Support	●	◔	◐
Decontamination	◐	◐	◕
Usability			
User-Friendly	◕	◕	◐
X-ray Image Stitching	○	○	◕
Screen Characteristics	◐	◕	◐
Training	◐	◔	◐
Software Compatibility	◕	◐	◕
File Format	●	◐	◕
Image Sharing	●	◔	◕
Non-Proprietary Hardware	◕	◕	◐

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. Portable X-Ray System Specifications[1]

Key Specifications	FoXraylle/VCU-10	RTR-4L 10	Scanwedge
Initial Cost	$31,394	$23,043	$28,912
Training Costs	Vendor-provided session $950 per day	Includes a training video and workbook Starts at $650	Vendor-provided session $800 per day
Imaging Plate Dimensions (L x W x D, inches)	13 x 11 x 5	14 x 12 x 6	22 x 11 x 4 (Imaging area is 1 inch thick)
Imaging Plate Weight (pounds)	12	13	11
Carrying Case Dimensions (L x W x H, inches)	33 x 20 x 11	19 x 32 x 11	34 x 22 x 13
Total System Weight (pounds)	63	76	78
Imaging Plate to Display/Laptop Cable Length	164 feet included with purchase. A wireless option is available for an additional $7,850 and features a wireless range of 800 feet.	164 feet included with purchase. Cable length extendable up to 492 feet in 164-foot increments. A wireless option is available for an additional $3,945 and features a wireless range of 721 feet.	164 feet included with purchase. A wireless option is available for an additional $3,555 and features a wireless range of 330 feet. An extender is available to extend the wireless range to 656 feet.
X-Ray Generator to Imaging Plate Cable Length	10-foot cable included with system purchase; alternate cable lengths are available for an additional cost; cables are not required if wireless option is purchased.	10-foot and 20-foot cables are included with system purchase; cables are not required if wireless option is purchased.	20-foot cable included with system purchase; cable is not required if wireless option is purchased.
Software Compatibility (Operating Systems Requirements)	Microsoft® Windows® 97, XP, Vista®, and Windows 7 operating systems	Microsoft Windows XP operating system	Microsoft Windows 7 operating system
Temperature	Operating: 32° to 113°F Storage: -4° to 122°F	Operating: -4° to 130°F Storage: -20° to 140°F	Operating: 32° to 104°F Storage: 32° to 122°F
Battery Life	Imaging Plate: 2 weeks Laptop: 3 to 5 hours	System: 4 to 5 hours	System: 4 hours
Warranty	1 year	Laptop: 2-year manufacturer warranty Other system components: 1 year	1 year (excludes the X-ray generator, which is covered by the manufacturer warranty)

Notes:

[1]   Information listed in table 3 was provided by manufacturers and has not been independently verified by the SAVER Program.

D   =   depth
°F   =   degrees Fahrenheit
L   =   length
W   =   width