Homeland Security
Science and Technology

Summary

SAVER

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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Night Vision Devices

(AEL reference number 04MD-01-LAMP)

In order to provide emergency responders with information on currently available night vision devices (NVDs), the Space and Naval Warfare Systems Center (SPAWARSYSCEN) Atlantic conducted a comparative assessment of NVDs for the System Assessment and Validation for Emergency Responders (SAVER) Program in June 2010. Detailed findings are provided in the Night Vision Devices Assessment Report*, which is available by request at https://www.rkb.us/saver.*

Background

NVDs use image intensification technology to provide imaging in poorly lit situations, permitting navigation of terrain and recognition of objects and people that would normally be unrecognizable to the unaided human eye. These devices are widely used by emergency responders during nighttime surveillance, search and rescue, and covert operations. A key component of an NVD is the image intensifier tube, which may use a green or white phosphorous output screen. A green phosphorous output screen produces images in shades of green (green and black), while a white phosphorous output screen produces grayscale (black and white) images.

Assessment Methodology

Prior to the assessment, six emergency responders were chosen from various jurisdictions to participate in a focus group. Participants possessed strong law enforcement backgrounds, including patrol, Special Weapons and Tactics, search and rescue, marine patrol, and surveillance. The group's primary objectives were to recommend evaluation criteria and possible scenarios for the assessment.

Based on market research and equipment availability, the PVS-14 NVD was assessed with the following intensifier tubes:

- Photonis XR5™ Onyx white phosphorous intensifier tube; and
- ITT Night Vision & Imaging Pinnacle® Series 9815G green phosphorous intensifier tube.

Both intensifier tubes featured comparable resolution, luminous gain, signal-to-noise ratio, and operational life expectancy, as shown in table 3. For the assessment, both intensifier tubes were housed in the PVS-14 NVD, which is commonly used in the emergency response community. Proper use of the NVD involves placing the device in front of one eye while the eye continues to view the environment. NVD specifications are listed in table 4.

Eight emergency response practitioners, each with at least 10 years of law enforcement experience, were selected to serve as assessment evaluators. The assessment was conducted at night, in starlight conditions, with no moon present. Evaluators were permitted to use the integrated infrared illuminator and to adjust the gain and focus controls on the NVD throughout the

assessment to ensure they were viewing an optimal image at all times.

During the assessment, evaluators participated in four assessment scenarios—tactical, surveillance, patrol, and search and rescue—using NVDs equipped with white and green phosphorous intensifier tubes. The surveillance and search and rescue scenarios each had two segments; surveillance operations were conducted in urban and rural settings, while search and rescue operations were conducted in land-based and marine-based environments. In each scenario, people were strategically placed in areas to simulate suspects. These individuals dressed in different colors and carried different objects. Evaluators were required to locate suspects, describe physical characteristics (e.g., gender, height, etc.), and identify the objects that were carried.

Assessment Results

The SAVER Program typically assesses products based on five established SAVER categories; however, the focus group for this project identified, grouped, and prioritized criteria in three subcategories within the usability category: image clarity, eye fatigue, and perception; these subcategories are defined as follows:

- Image Clarity — This category groups criteria relating to the quality of the responders' experience with obtaining a clear, usable image of objects within the field of view;
- Eye Fatigue — This category groups criteria relating to the responders' level of comfort with continued operation of the NVD, often limited by eyestrain and weariness; and
- Perception — This category groups criteria relating to the responders' satisfaction with the dimensional aspects and realness of the image, resulting in a viewing experience that is familiar to the end user.

SAVER 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 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.

The focus group then assigned a weight for each criterion's level of importance. Once the criteria were weighted, the three usability subcategories were assigned a percentage value to represent each subcategory's importance relative to the other subcategories.

Table 1 displays the composite scores as well as the usability subcategory scores for each product. Higher scores indicate a higher rating by evaluators. To view how each intensifier tube scored against each of the evaluation criteria assigned to the usability subcategories, see table 2.

The following paragraphs provide a brief summary of evaluator comments and feedback on each intensifier tube used during the assessment. The complete assessment report includes a breakdown of evaluator comments by usability subcategory.

Table 1. Assessment Results[1]

Product	Composite Score	Image Clarity (75% Weighting)	Eye Fatigue (15% Weighting)	Perception (10% Weighting)
Photonis XR5™ Onyx	**82**	82	80	80
ITT Night Vision & Imaging Pinnacle® Series 9815G	**78**	78	78	74

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.

Photonis XR5 Onyx White Phosphorous Intensifier Tube

The PVS-14 NVD equipped with the Photonis XR5 Onyx white phosphorous intensifier tube costs $3,095. Evaluators agreed that the PVS-14 NVD equipped with the Photonis XR5 Onyx white phosphorous intensifier tube meets the needs for emergency response operations, particularly in marine environments and in the presence of ambient light similar to urban environments. The white phosphorous intensifier tube created a clear image of the scenery, resulting in good recognition, sharpness, contrast, and brightness capabilities, especially during operations conducted on the water; it was also noted that objects in and around the water were easy to recognize, clear, and sharp when increased amounts of ambient and reflective light were present. The sharp image produced helped in the identification of objects and people. The color of the image did not impact the contrast or brightness of the image and had very little impact on depth perception. Images appeared natural and realistic. Evaluators found that the color of the image had very little impact on washout, which was minimal throughout the assessment. Evaluators also indicated that the amount of time required for eye recovery was minimal, particularly in the marine environment.

	**Pros**	• Provides a natural and realistic image • Provides clear images in conditions with moderate amounts of ambient lighting present
	Cons	• Limited in extreme low-light conditions
Photonis XR5™ Onyx	**Composite Assessment Score: 82**	

ITT Night Vision & Imaging Pinnacle Series 9815G Green Phosphorous Intensifier Tube

The PVS-14 NVD equipped with the ITT Night Vision & Imaging Pinnacle Series 9815G green phosphorous intensifier tube costs $3,595. Evaluators agreed that the PVS-14 NVD equipped with the ITT Night Vision & Imaging Pinnacle Series 9815G green phosphorous intensifier tube produced clear images and that objects and people were recognizable, particularly in rural environments with very little ambient light. Some evaluators rated the dynamic range (i.e., the difference of shades in the image) of the green phosphorous intensifier tube favorably, noting that it seemed to produce a broad range of shades. Other evaluators indicated that the dynamic range displayed by both green and white phosphorous intensifier tubes were very similar and that the color of the image seemed to have little, if any, impact on the dynamic ranges produced by either tube. The effects of washout were minimal throughout the assessment. The amount of eye fatigue experienced increased with the amount of time the device was used; some evaluators felt that eye recovery occurred quickly, while others disagreed. Evaluators felt that the naturalness of the image met their expectations.

	**Pros**	• Provides clear images in areas with very low levels of ambient light and over long distance ranges
	Cons	• The intensity of surrounding lights may impair the clarity of the image
ITT Night Vision & Imaging Pinnacle® Series 9815G	**Composite Assessment Score: 78**	

Conclusion

Evaluators indicated that both the white and green phosphorous intensifier tubes produced images during the assessment scenarios that would assist them with conducting tactical, surveillance, patrol, and search and rescue operations. An analysis of evaluator comments and scores revealed the following common observations concerning the assessed intensifier tubes:

- Both tubes produced images that provided evaluators with a clear outline, detailing the physical characteristics of the people and objects in view, thereby improving recognition capabilities in low-light conditions.
- In areas of almost complete darkness, such as a basement, evaluators agreed that an infrared illuminator was required for both tubes to obtain a viewable image.
- Some evaluators noted that use of an NVD equipped with either a white or green phosphorous tube within an enclosed space

required them to refocus and make additional adjustments to achieve an acceptable image.
- Both white and green phosphorous tubes received similar image clarity ratings in all scenarios except for search and rescue operations. The image produced by the white phosphorous tube was better than that of the green phosphorous tube when an increased amount of ambient lighting was present, particularly in the marine environment with increased amounts of reflective and ambient light.
- The color of the images seemed to have little, if any, impact on the dynamic range of the images produced by either tube.
- Evaluators agreed that objects appeared closer with the use of either NVD, and some emphasized that depth perception improves with long-term use, regardless of image color.
- Evaluators expressed a preference for the image produced by the white phosphorous tube in a marine environment; however, the green phosphorous tube produced better images during long-range detection/surveillance and in poorly lit environments.
- Some evaluators recommended using multiple NVDs equipped with both white and green phosphorous intensifier tubes, as lighting conditions may vary depending on the operation.

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

Table 2. Night Vision Device Ratings Chart[1]

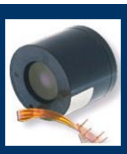
KEY: Least Favorable → Most Favorable	Scenario 1: Tactical Operations		Scenario 2: Surveillance Operations				Scenario 3: Patrol Operations		Scenario 4: Search and Rescue Operations			
			Urban Hospital		Rural Road				Land		Marine	
	W	G	W	G	W	G	W	G	W	G	W	G
Image Clarity												
Recognition	●	◕	●	◕	◕	◕	◕	◕	◕	◕	●	◕
Sharpness	●	◕	◕	◕	◕	◕	◕	◕	◕	◕	●	◕
Contrast	◕	◕	◕	◕	◕	◕	◕	◕	◕	◕	●	◕
Brightness	◕	◕	◕	◕	◕	◕	◕	◕	◕	◕	●	◕
Washout	◕	◕	◕	◕	◕	◕	◕	◕	◕	◕	◕	◕
Dynamic Range	◑	◑	◑	◕	◑	◕	◑	◕	◕	◕	◕	◕
Eye Fatigue												
Eye Recovery	◕	◕	◕	◕	◕	◕	◕	◕	◕	◕	●	◕
Tiredness	◕	◕	◕	◕	◕	◕	◕	◕	◕	◕	◕	◕
Perception												
Naturalness	●	◑	◕	◕	◕	◕	◕	◕	◕	◕	●	◕
Depth Perception	◕	◑	◕	◕	◕	◕	◕	◕	◕	◕	◕	◑

Notes:

[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.

W = Photonis XR5™ Onyx white phosphorous intensifier tube.
G = ITT Night Vision & Imaging Pinnacle® Series 9815G green phosphorous intensifier tube.

Table 3. Image Intensifier Tube Specifications

Specifications	 Photonis XR5™ Onyx	 ITT Night Vision & Imaging Pinnacle® Series 9815G
Generation	Gen 2	Gen 3
Image Color	White	Green
Resolution Minimum	64 lp/mm	64 lp/mm
Luminance Gain at 2.10^{-6} Lux	26,700 fL/fc	40,000 fL/fc
Signal-to-Noise Ratio	23	25
Halo	0.8 mm	1.0 mm
Gated/Non-Gated	Gated	Gated
Tube Life	10,000 hours	10,000 hours

Notes:

fc = foot-candle
fL = foot-lambert
lp = line pair
mm = millimeter

Table 4. PVS-14 NVD Specifications

Specifications	 PVS-14 NVD
Field of View	40 degrees
Magnification	1X
Diopter Adjustment	-6 to +2 diopters
Gain Control	Yes
Battery Type	AA
Length x Width x Height	4.5 inches x 2.3 inches x 2.0 inches
Weight	0.86 pounds