



System Assessment and Validation for Emergency Responders (SAVER)

Handheld Image Intensifiers Assessment Report

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System Assessment and Validation for Emergency Responders

Prepared by Space and Naval Warfare Systems Center Atlantic

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FOREWORD

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 commercially available equipment and systems, and develops knowledge products that provide relevant equipment information to the emergency responder community. The SAVER Program mission includes:

- Conducting impartial, practitioner-relevant, operationally oriented assessments and validations of emergency response equipment; and
- Providing information, in the form of knowledge products, that enables decision-makers and responders to better select, procure, use, and maintain emergency response equipment.

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 responder community: “What equipment is available?” and “How does it perform?” These knowledge products are shared nationally with the 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. As a SAVER Program Technical Agent, the Space and Naval Warfare Systems Center (SPAWARSYSCEN) Atlantic has been tasked to provide expertise and analysis on key subject areas, including communications, sensors, security, weapon detection, and surveillance, among others. In support of this tasking, SPAWARSYSCEN Atlantic developed this report to provide emergency responders with information obtained from an operationally oriented assessment of commercially available handheld image intensifiers, which is described by AEL reference number 03OE-02-TILA titled Optics, Thermal Imaging and/or Light Amplification and AEL reference number 04MD-01-LAMP titled Equipment, Light Amplification.

Visit the SAVER website on First Responder.gov (<http://www.firstresponder.gov/SAVER>) for more information on the SAVER Program or to view additional reports on handheld image intensifiers or other technologies.

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EXECUTIVE SUMMARY

Handheld image intensifiers increase the intensity of available light to provide imaging in poorly lit situations. They are widely used by emergency responders in nighttime surveillance, search and rescue, and covert operations. Image intensifiers may assist with navigation of terrain in darkness and recognition of objects and people that may not be seen by the unaided eye. In March 2014, the System Assessment and Validation for Emergency Responders (SAVER) Program conducted an operationally oriented assessment of handheld image intensifiers.

Six handheld image intensifiers were assessed by emergency responders. The criteria and scenarios used in this assessment were derived from the results of a focus group of emergency responders with experience using handheld image intensifiers. The assessment addressed 18 evaluation criteria in five SAVER categories: Affordability, Capability, Deployability, Maintainability, and Usability. The overall results of the assessment are highlighted in the following table.

Product	Overall Score	Overall	Usability	Capability	Maintainability	Affordability	Deployability
Tactical Night Vision Company Inc. TNV/PVS-14 Pinnacle		4.1	4.0	4.4	4.0	4.7	3.5
Summit Night Vision Group SNVG-14 (AN/PVS-14)		4.0	4.0	4.3	4.0	2.7	3.5
American Technologies Network (ATN) Corp. ATN-6015-3		3.9	3.8	4.2	4.0	3.5	4.3
N-Vision Optics LLC GT-14		3.8	3.8	4.0	4.0	2.7	4.2
Nivisys LLC MUM-14 Mini-monocular (Omni IV Grade)		3.7	3.7	3.6	4.0	2.8	4.8
Night Optics USA Inc. D-300 Monocular		3.6	3.7	3.6	3.5	3.3	3.5
	0 1 2 3 4 5 Lower Higher						

1. INTRODUCTION

Handheld image intensifiers increase the intensity of available light to provide imaging in poorly lit situations. They are widely used by emergency responders in nighttime surveillance, search and rescue, and covert operations. Image intensifiers may assist with navigation of terrain in darkness and recognition of objects and people that may not be seen by the unaided eye. In March 2014, the System Assessment and Validation for Emergency Responders (SAVER) Program conducted an operationally oriented assessment of handheld image intensifiers. The purpose of this assessment was to obtain information on handheld image intensifiers that will be useful in making operational and procurement decisions. The activities associated with this assessment were based on recommendations from a focus group of emergency responders with experience using handheld image intensifiers.

1.1 Evaluator Information

Six emergency responders from various jurisdictions and with experience using handheld image intensifiers were selected to be evaluators for the assessment. Evaluator information is listed in Table 1-1. Prior to the assessment, evaluators signed a nondisclosure agreement, conflict of interest statement, and photo release form.

Table 1-1. Evaluator Information

Evaluator	Years	State
Law Enforcement, Assistant Chief/Field Services	20+	WI
Law Enforcement, Patrol Officer/SWAT Team	16-20	AZ
Law Enforcement, Surveillance Special Agent	16-20	VA
Law Enforcement, Patrol Officer/Sniper Team Leader	16-20	WA
Law Enforcement, Patrol Sergeant	11-15	SC
Law Enforcement, Patrol Officer	6-10	WA

1.2 Assessment Products

Six products were selected and purchased for the assessment based on market research and the focus group's recommendations. Final selection was based on how well each product met the product selection criteria identified by the focus group and listed in Table 1-2.

Table 1-2. Product Selection Criteria



Product Selection Criteria	Description
Magnification	Magnification of 1x
Infrared (IR) Illuminator	Built-in IR illuminator
Tube Protection	Tube protection feature(s)
Manual Gain/Focus Adjustment	Manual gain/focus adjustment feature
Size	7 inches in length or less
Water Resistance	Water resistant
Battery Runtime	20-hour battery runtime with the IR illuminator off
Accessories	Eye cup and lens cover included
Warranty	3-year warranty

The products selected for assessment met the following product selection criteria: magnification, built-in infrared illuminator, tube protection, manual gain/focus adjustment, size, and water resistance.

Table 1-3 presents the products that were assessed.

Table 1-3. Assessed Products

Vendor	Product	Product Image
American Technologies Network (ATN) Corp.	ATN-6015-3	
Night Optics USA Inc.	D-300 Monocular	
Nivisys LLC	MUM-14 Mini-monocular (Omni IV Grade)	
N-Vision Optics LLC	GT-14	

Vendor	Product	Product Image
Summit Night Vision Group	SNVG-14™ (AN/PVS-14)	
Tactical Night Vision Company Inc.	TNV/PVS-14 Pinnacle	

2. EVALUATION CRITERIA

The SAVER Program assesses products based on criteria in five established categories:

- **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; and
- **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.

The focus group of emergency responders met in April 2013 and identified 18 evaluation criteria within five SAVER categories: Affordability, Capability, Deployability, Maintainability, and Usability. They assigned a weight for each criterion's level of importance on a scale of 1 to 5, with 1 being somewhat important and 5 being of utmost importance. The SAVER categories were assigned a percentage to represent each category's importance relative to the other categories.

Products were assessed against all 18 evaluation criteria. Table 2-1 presents the evaluation criteria and their associated weights as well as the percentages assigned to the SAVER categories. Refer to Appendix A for evaluation criteria definitions and Appendix B for evaluation criteria considerations.

Table 2-1. Evaluation Criteria

SAVER CATEGORIES				
Usability	Capability	Maintainability	Affordability	Deployability
Overall Weight 40%	Overall Weight 32%	Overall Weight 15%	Overall Weight 8%	Overall Weight 5%
Evaluation Criteria				
Image Quality Weight: 5	Infrared Illuminator Weight: 4	Battery Type Weight: 4	Warranty Weight: 3	User Manual Weight: 2
Image Adjustment Weight: 4	Versatility Weight: 4	Maintenance Weight: 4		
Handheld Operation Weight: 4	Battery Runtime Weight: 3	Technical Support Weight: 2		
Tube Protection Weight: 3	Field of View Weight: 3			
Durability Weight: 3				
Depth Perception Weight: 3				
Coverttness Weight: 3				
Eye Relief Weight: 3				
Indicators Weight: 2				

3. ASSESSMENT METHODOLOGY

The products were assessed over 4 days. On the first day of the assessment, a subject matter expert (SME) and facilitators presented a safety briefing and an overview of the assessment process, procedures, and schedule to the evaluators. Each product was then assessed in two phases: (1) specification assessment and (2) operational assessment.

3.1 Phase I/Specification Assessment

During the specification assessment, evaluators assessed each product based on vendor-provided information and specifications. Product information was confirmed by vendors prior to the assessment.

3.2 Phase II/Operational Assessment

During the operational assessment, evaluators assessed each product based on their hands-on experience using the product after becoming familiar with its proper use, capabilities, and features. The SME and facilitators assisted the evaluators with product familiarization, and evaluators had access to the reference material included with each product. The products were assessed in four scenarios: (1) setup, (2) search and rescue, (3) surveillance, and (4) bright light. Evaluators used the products one at a time during the scenarios and provided ratings and comments for each product before assessing the next product.

3.2.1 Setup Scenario

During the setup scenario, evaluators reviewed the user manual, installed the battery (Figure 3-1), and cleaned each device following the recommended maintenance procedures. Evaluators referenced the user manuals to determine the location of the low-battery indicator on each device. With the room lights on, evaluators observed the appearance of each device and powered them on to determine if sound was made during operation. Evaluators also inspected the image intensifiers for durability, manipulating the buttons and controls on each device. With the lights off, evaluators used each hand to manipulate controls on the devices. Next, evaluators focused on a target in the room with the IR illuminator on and observed IR illumination, image quality, and the appearance of the IR illuminator indicator. Lastly, evaluators observed a facilitator using each device to determine if light escaped from around the eyepiece, if any indicators were evident, and if any sound produced from operation was audible.



Figure 3-1. Installing Battery

3.2.2 Surveillance Scenario

During the surveillance scenario (Figure 3-2), evaluators used the devices with the IR illuminator off to monitor individuals at nighttime, first from 50 yards away and then from 25 yards. Evaluators, annotated by an 'X' in Figure 3-2, attempted to identify objects in the individuals' possession, including a decoy handgun and an umbrella, and adjusted the gain and focus as necessary.

Evaluators then moved to a designated location outside a building. Next, one at a time, evaluators followed an individual into the building, navigating hallways and opening doors. When instructed by the individual, the evaluators turned on the IR illuminator and navigated a flight of stairs.



Figure 3-2. Surveillance Scenario

3.2.3 Search and Rescue Scenario

During the search and rescue scenario, evaluators wore gloves and used the devices with the IR illuminator off to search for an individual located 50 yards away. The location of the individual was disclosed to evaluators. Evaluators moved closer to the individual and made adjustments to gain and focus as necessary, stopping at a specified location 5 yards away from the individual.

Then, to assess field of view, the evaluators walked to a predetermined location, annotated by an 'X' in Figure 3-3, where they observed a row of cones located 20 yards away and spaced 5 feet apart over a 65 foot distance (Figure 3-3).

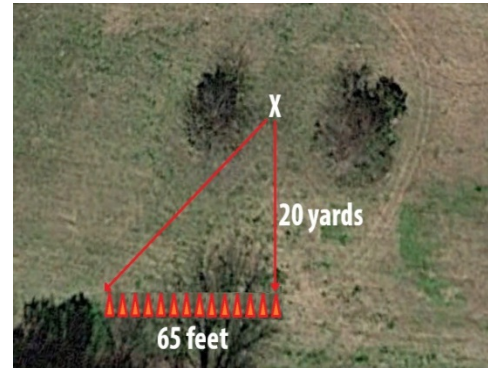


Figure 3-3. Field of View Assessment

3.2.4 Bright Light Scenario

Tube protection was assessed during the bright light scenario. Evaluators used each device to observe a darkened room in which a light was turned on momentarily. Additionally, evaluators used each device to scan from a darkened room to an area where bright light was present.

3.3 Data Gathering and Analysis

Each evaluator was issued an assessment workbook that contained vendor-provided information and specifications, assessment procedures, and worksheets for recording criteria ratings and comments. Evaluators used the following 1 to 5 scale to rate each product:

1. *Meets none* of my expectations for this criterion;
2. *Meets some* of my expectations for this criterion;
3. *Meets most* of my expectations for this criterion;
4. *Meets all* of my expectations for this criterion; and

5. *Exceeds* my expectations for this criterion.

Criteria that were rated multiple times throughout the assessment were assigned final overall ratings by the evaluators. Facilitators captured advantages and disadvantages for the assessed products as well as general comments on the handheld image intensifiers assessment and the assessment process. Once assessment activities were completed, evaluators had an opportunity to review their criteria ratings and comments for all products and make adjustments as necessary.

At the conclusion of the assessment activities, an overall assessment score, as well as category scores and criteria scores, were calculated for each product using the formulas referenced in Appendix C. In addition, evaluator comments for each product were reviewed and summarized for this assessment report.

4. ASSESSMENT RESULTS

Overall scores for the assessed products ranged from 3.6 to 4.1. Table 4-1 presents the overall assessment score and category scores for each product. Products are listed in order from highest to lowest overall assessment score throughout this section. Calculation of the overall score uses the raw scores for each category, prior to rounding.

Table 4-1. Assessment Results

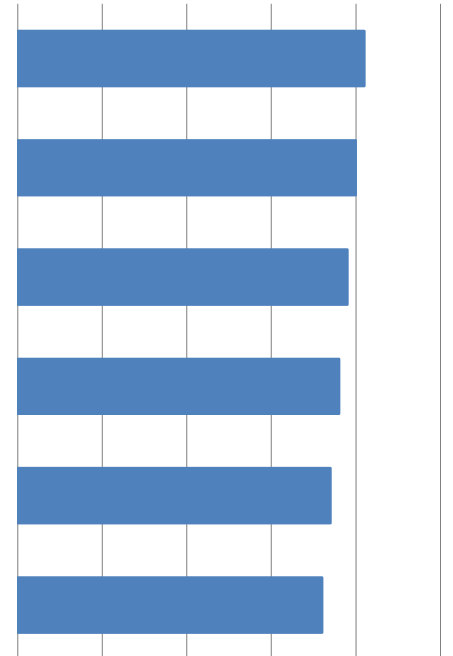





Product	Overall Score	Overall	Usability	Capability	Maintainability	Affordability	Deployability
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Summit Night Vision Group SNVG-14 (AN/PVS-14)		4.0	4.0	4.3	4.0	2.7	3.5
American Technologies Network (ATN) Corp. ATN-6015-3		3.9	3.8	4.2	4.0	3.5	4.3
N-Vision Optics LLC GT-14		3.8	3.8	4.0	4.0	2.7	4.2
Nivisys LLC MUM-14 Mini-monocular (Omni IV Grade)		3.7	3.7	3.6	4.0	2.8	4.8
Night Optics USA Inc. D-300 Monocular		3.6	3.7	3.6	3.5	3.3	3.5
	0 1 2 3 4 5 Lower Higher						

Table 4-2 presents the criteria ratings for each product. The ratings are graphically represented by colored and shaded circles. A green, fully shaded circle represents the highest rating. Refer to Appendix A for evaluation criteria definitions and Appendix B for evaluation criteria considerations. Table 4-3 presents vendor-provided key specifications for the assessed products.

All six handheld image intensifiers received a three-quarter shaded circle for depth perception, eye relief, image adjustment, indicators, and infrared illuminator. Evaluators, some of whom wore glasses, agreed that all image intensifiers had an eye relief that met expectations. Additionally, evaluators agreed that all image intensifiers minimally affected their depth perception and that all the devices had effective IR illumination as well as tube protection capabilities, recovering quickly from exposure to bright light. Lastly, evaluators determined all image intensifiers had indicators that met expectations, although they noted the IR illuminator indicator on the GT-14 was somewhat difficult to see without tilting the device to look for it in the field of view.

All of the image intensifiers assessed were Generation 3, covert in color (black), had tube protection capabilities built into the device, featured low-battery and IR illuminator indicators, were water resistant (at a minimum), and had a tube life of 10,000 hours or more. Additionally, all had a built in IR illuminator and could be used with a camera or image magnifier. Technical support is available for all devices during normal business hours, Monday through Friday. User maintenance activities specific to each image intensifier were outlined in the user manual.

Table 4-2. Criteria Ratings

<div> <div> <div>Lowest Rating</div> <div> </div> <div>Highest Rating</div> </div> <div> <div>KEY</div> <div>→</div> </div> </div>		<div> </div>					
Category	Evaluation Criteria	TNV/PVS-14 Pinnacle	SNVG-14 (AN/PVS-14)	ATN-6015-3	GT-14	MUM-14 Mini-monocular (Omni IV Grade)	D-300 Monocular
Usability	Image Quality						
	Image Adjustment						
	Handheld Operation						
	Tube Protection						
	Durability						
	Depth Perception						
	Covertness						
	Eye Relief						
	Indicators						
Capability	Infrared Illuminator						
	Versatility						
	Battery Runtime						
	Field of View						

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<div> <div> <div>Lowest Rating</div> <div> </div> <div>Highest Rating</div> </div> <div>KEY</div> </div>							
Category	Evaluation Criteria	TNV/PVS-14 Pinnacle	SNVG-14 (AN/PVS-14)	ATN-6015-3	GT-14	MUM-14 Mini-monocular (Omni IV Grade)	D-300 Monocular
Maintainability	Battery Type						
	Maintenance						
	Technical Support						
Affordability	Warranty						
Deployability	User Manual						

Table 4-3. Key Specifications

Key Specification	TNV/PVS-14 Pinnacle	SNVG-14™ (AN/PVS-14)	ATN-6015-3	GT-14	MUM-14 Mini-monocular (Omni IV Grade)	D-300 Monocular
MSRP	\$2,918	\$3,495	\$2,949	\$2,926	\$3,685	\$3,399 ¹
Warranty Duration	5 years	1 year	2 years	1 year	1 year	2 years
Typical Resolution (lp/mm)	64	64	64	57 to 64	64	64
Dimensions (inches)	4.5x2.3x2.0 ¹	4.5x2.2x2.0	4.5x2.2x2.0	4.5x2.0x2.0	4.2x2.7x2.0	5.5x2.3x1.8
Weight (ounces)	12	10	11	11	9	16
Operating Temperature Range	NP	-59° to 120°F	-40° to 122°F	-60° to 120°F	-35° to 129°F	-4° to 113°F
Storage Temperature Range	NP	-59° to 120°F	-58° to 158°F	-60° to 185°F	-60° to 160°F	NP
Waterproof	✓	✓	✓	✓	✓	
Ingress Protection (IP) Rating	NP	IP67	NP	IP67	NP	IP67
Impact Resistant	NP	✓ (6 foot drop)	NP	✓	✓	✓ (6 foot drop)
Mounting Options	Head, Helmet, Weapon	Head, Helmet, Weapon, Tripod	Head, Helmet, Weapon	Head, Helmet, Weapon, Tripod	Head, Helmet	Head, Helmet, Weapon
Sacrificial Lens Compatible	✓	✓	✓	✓	✓	

Key Specification	TNV/PVS-14 Pinnacle	SNVG-14™ (AN/PVS-14)	ATN-6015-3	GT-14	MUM-14 Mini-monocular (Omni IV Grade)	D-300 Monocular
Battery Type ²	AA	AA	AA	AA or CR123 ³	AA or CR123	CR123
Battery Runtime (hours)	50	40	60	40 ⁴	20 to 40 ⁵	40
Technical Support Duration	Lifetime	Lifetime	Lifetime	NP	NP	Lifetime
Technical Support Hours	Eastern Time 8:00 a.m. to 4:30 p.m. Monday through Friday	Central Time 8:00 a.m. to 5:00 p.m. Monday through Friday	Pacific Time 8:00 a.m. to 5:00 p.m. Monday through Friday	Eastern Time 8:00 a.m. to 5:00 p.m. Monday through Friday	Mountain Standard Time 6:00 a.m. to 3:30 p.m. Monday through Friday	Pacific Time 8:00 a.m. to 5:00 p.m. Monday through Friday
Notes: ¹ The information was not confirmed by the vendor ² All units require one battery of the type specified ³ Battery type must be specified at time of purchase. The AA model was assessed. ⁴ Battery runtime listed is based on AA battery; CR123 battery life was not provided by vendor ⁵ Dependent on battery chemistry, Alkaline or Lithium ✓—image intensifier is equipped with corresponding feature Blank cell—image intensifier is not equipped with corresponding feature NP—information not provided by vendor lp/mm—line pairs per millimeter						

4.1 Tactical Night Vision Company Inc. TNV/PVS-14 Pinnacle

The TNV/PVS-14 Pinnacle (Figure 4-1) received an overall assessment score of 4.1 and costs \$2,918 as assessed. An eyecup, an objective lens cover, a head/helmet adapter, a demist shield, a sacrificial window, a lanyard, two size AA batteries, a soft carrying case, optical tissue, a user manual, and a 5-year warranty were included with purchase.

The following sections, broken out by SAVER category, summarize the assessment results.

Usability

The TNV/PVS-14 Pinnacle received a Usability score of 4.0. The following information is based on evaluator comments:

- Overall, the image intensifier provided a clear image across the field of view. The image was sharper and improved with the IR illuminator on. It featured a manual gain control so an automatic adjustment for different lighting conditions was less important. During the surveillance scenario, it was evident from 50 yards the individuals were holding objects; from 25 yards, the handgun and umbrella were clearly identifiable;
- Adjusting the gain and focus controls improved the image quality. Once set, adjustments to the controls were not required to maintain image quality;
- The controls were familiar due to the commonly used PVS-14 body style. They were easily reached and manipulated with either hand, although two hands were required when adjusting controls (i.e., one hand to hold the device and the other to adjust controls). It was somewhat difficult to turn the power/IR illuminator control while wearing gloves due to the pull-and-twist design;
- The housing was waterproof and felt durable; however, the power/IR illuminator control projected from the body slightly and appeared susceptible to breakage if dropped (Figure 4-2). The pull-and-twist design of the plastic power/IR illuminator control may also make it prone to damage. Additionally, the ingress protection (IP) rating and impact resistance of the device are important considerations for durability and were not provided by the vendor; and
- The image intensifier operated quietly and the eyecup prevented light from escaping around the eyepiece.



Figure 4-1. TNV/PVS-14 Pinnacle



Figure 4-2. Power/IR Illuminator Control

Capability

The TNV/PVS-14 Pinnacle received a Capability score of 4.4. The following information is based on evaluator comments:

- The image intensifier provided for a variety of mounting options; however, an additional option to mount on a tripod would be beneficial;
- The 50-hour battery runtime (according to vendor specification) exceeded expectations and should be more than adequate for a week's worth of use; and
- The image intensifier provided a field of view approximately 40 feet wide from 20 yards away; however, the extreme edges were slightly blurred.

Maintainability

The TNV/PVS-14 Pinnacle received a Maintainability score of 4.0. The following information is based on evaluator comments:

- The size AA battery required to power the device is common and easily acquired at most retail stores;
- The image intensifier was easy to clean with simple instructions provided in the user manual and the optical tissue included with purchase. Battery access was slightly difficult due to the proximity of the battery compartment to the gain control; and
- The lifetime technical support duration met expectations.

Affordability

The TNV/PVS-14 Pinnacle received an Affordability score of 4.7. The following information is based on evaluator comments:

- The duration of the warranty was exceptional (5 years), and the warranty terms appeared standard, covering defects in workmanship and materials, as expected.

Deployability

The TNV/PVS-14 Pinnacle received a Deployability score of 3.5. The following information is based on evaluator comments:

- The user manual was very detailed and included several diagrams and a comprehensive parts list; however, contact information for the vendor was not provided. Additionally, a quick-start reference guide was not included.

4.2 Summit Night Vision Group SNVG-14™ (AN/PVS-14)

The SNVG-14 (AN/PVS-14) (Figure 4-3) received an overall assessment score of 4.0 and costs \$3,495. An eyecup, an objective lens cover, a head/helmet adapter (J-arm attachment), a head mount assembly with brow pads, a daylight training filter, a demist shield, a sacrificial lens, a lanyard, one size AA battery, a soft carrying case,



Figure 4-3. SNVG-14 (AN/PVS-14)

optical tissue, a user manual, and a 1-year warranty were included with purchase.

The following sections, broken out by SAVER category, summarize the assessment results.

Usability

The SNVG-14 (AN/PVS-14) received a Usability score of 4.0. The following information is based on evaluator comments:

- The image intensifier provided a clear image across the field of view with no noticeable defects or distortion. The image was sharper and improved with the IR illuminator on. The image intensifier featured a manual gain control so an automatic adjustment for different lighting conditions was less important. During the surveillance scenario, it was evident from 50 yards the individuals were holding objects; from 25 yards, the handgun and umbrella were clearly identifiable;
- Adjusting the gain and focus controls improved the image quality. Once set, adjustments to the controls were not required to maintain image quality;
- The controls were familiar due to the commonly used PVS-14 body style. The device was easy to hold and the controls were easily reached and manipulated with either hand, although two hands were required when adjusting controls (i.e., one hand to hold the device and the other to adjust controls). It was somewhat difficult to turn the power/IR illuminator control while wearing gloves due to the pull-and-twist design;
- The housing was waterproof with a good IP rating and felt durable. Additionally, the impact resistance (drop-tested to 6 feet) was very good; however, the pull-and-twist design of the plastic power/IR illuminator control may make it prone to breakage; and
- The image intensifier operated quietly and the eyecup prevented light from escaping around the eyepiece.

Capability

The SNVG-14 (AN/PVS-14) received a Capability score of 4.3. The following information is based on evaluator comments:

- The image intensifier provided for all possible mounting options, some of which were included with purchase;
- The 40-hour battery runtime met expectations and should be sufficient for completion of most missions without requiring battery replacement in the field; and
- The image intensifier provided a clear field of view approximately 40 feet wide from 20 yards away.

Maintainability

The SNVG-14 (AN/PVS-14) received a Maintainability score of 4.0. The following information is based on evaluator comments:

- The size AA battery required to power the device is common and easily acquired at most retail stores;

- The maintenance instructions were thorough, including information on warranty and lubrication points. However, the battery cap was difficult to turn due to its proximity to the gain control, especially when wearing gloves;
- The image intensifier was easy to clean with simple instructions provided on the package of optical tissue included with purchase. Accessing the battery for replacement was somewhat difficult because the screw cap was difficult to turn because of the seal; and
- The lifetime technical support duration met expectations.

Affordability

The SNVG-14 (AN/PVS-14) received an Affordability score of 2.7. The following information is based on evaluator comments:

- The 1-year warranty duration was less than expected for this technology. The warranty terms appeared standard, covering defects in workmanship and materials, as expected.

Deployability

The SNVG-14 (AN/PVS-14) received a Deployability score of 3.5. The following information is based on evaluator comments:

- The user manual was comprehensive and included several diagrams; however, the parts list did not indicate what was included in purchase vice optional accessories, and contact information for the vendor was not included. Additionally, a quick-start reference guide was not included.

4.3 American Technologies Network (ATN) Corp. ATN-6015-3

The ATN-6015-3 (Figure 4-4) received an overall assessment score of 3.9 and costs \$2,949. An eyecup, an objective lens cover, a head/helmet adapter, a head mount assembly with brow pads, a demist shield, a sacrificial lens, a lanyard, two size AA batteries, a soft carrying case, a lens cloth, a user manual, and a 2-year warranty were included with purchase.



Figure 4-4. ATN-6015-3

The following sections, broken out by SAVER category, summarize the assessment results.

Usability

The ATN-6015-3 received a Usability score of 3.8. The following information is based on evaluator comments:

- In general, the image intensifier provided a clear, sharp image with few noticeable blemishes. The image was brighter and improved with the IR illuminator on. The gain automatically adjusted and assisted in providing consistent image brightness in different lighting conditions. During the surveillance scenario, it was evident from

50 yards the individuals were holding objects; from 25 yards, the handgun and umbrella were identifiable;

- Adjusting the focus control improved the image quality. Once set, no additional adjustments to the focus were required to maintain image quality. There was no manual gain control;
- The controls were familiar due to the commonly used PVS-14 body style. They were easily reached and manipulated with either hand, although two hands were required when adjusting controls (i.e., one hand to hold the device and the other to make adjustments). It was somewhat difficult to turn the power/IR illuminator control while wearing gloves due to the pull-and-twist design;
- The housing was waterproof and felt durable; however, the power/IR illuminator control projected from the body slightly and appeared susceptible to breakage if dropped. The pull-and-twist design of the plastic power/IR illuminator control may also make it prone to damage. Additionally, the ingress protection (IP) rating and impact resistance of the device are important considerations for durability and were not provided by the vendor; and
- The image intensifier operated quietly and the eyecup prevented light from escaping around the eyepiece.

Capability

The ATN-6015-3 received a Capability score of 4.2. The following information is based on evaluator comments:

- The image intensifier provided for a variety of mounting options, some of which were included with purchase; however, an additional option to mount on a tripod would be beneficial;
- The 60-hour battery runtime (according to vendor specification) exceeded expectations and should be more than adequate for a week's worth of use; and
- The image intensifier provided a field of view approximately 40 feet wide from 20 yards away; however, the extreme edges were slightly blurred.

Maintainability

The ATN-6015-3 received a Maintainability score of 4.0. The following information is based on evaluator comments:

- The size AA battery required to power the device is common and easily acquired at most retail stores;
- The maintenance and troubleshooting instructions are thorough;
- The image intensifier was easy to clean with the supplied lens cloth by following instructions in the user manual; however, optical tissue was preferred since the cloth could become dirty over time and potentially scratch the lens. The battery was easily replaced; and
- The lifetime technical support duration met expectations.

Affordability

The ATN-6015-3 received an Affordability score of 3.5. The following information is based on evaluator comments:

- The 2-year warranty duration met expectations. The warranty terms appeared standard, covering defects in workmanship and materials, as expected.

Deployability

The ATN-6015-3 received a Deployability score of 4.3. The following information is based on evaluator comments:

- The user manual was comprehensive with detailed diagrams and a parts list. A quick-start reference guide was not included.

4.4 N-Vision Optics LLC GT-14

The GT-14 (Figure 4-5) received an overall assessment score of 3.8 and costs \$2,926.

An eyecup, an objective lens cover, a head/helmet adapter, a head mount assembly with brow pads, a demist shield, a sacrificial lens, a lanyard, two size AA batteries, a soft carrying case, optical tissue, a user manual, and a 1-year warranty were included with purchase.



Figure 4-5. GT-14

The following sections, broken out by SAVER category, summarize the assessment results.

Usability

The GT-14 received a Usability score of 3.8. The following information is based on evaluator comments:

- The image was somewhat grainy and streaks were noticeable across the image, affecting the clarity. Image quality was somewhat improved with use of the IR illuminator. The automatic gain feature was inconsistent. During the surveillance scenario, it was difficult to see that the individuals were holding objects from 50 yards away; however, from 25 yards, the handgun and umbrella were identifiable;
- Adjusting the focus did not consistently improve the image. There was no manual gain control;
- The power/IR illuminator control was a single button easily manipulated with the thumb, permitting one-handed, ambidextrous operation, with or without gloves. The diopter and focus were easily adjusted using the other hand;
- The compact housing is waterproof with a good IP rating and felt durable. It is impact resistant, which was preferred, but the vendor should have provided drop-test information. Additionally, the rubber coating on the single push-button control appeared prone to wear;

- The image intensifier operated quietly, with only a slight humming noise that was barely audible. The eyecup prevented light from escaping around the eyepiece; and
- The IR illuminator indicator in the field of view was difficult to see without tilting the device to look for it.

Capability

The GT-14 received a Capability score of 4.0. The following information is based on evaluator comments:

- The image intensifier provided for all possible mounting options;
- The 40-hour battery runtime (with the AA battery option) met expectations and should be sufficient for completion of most missions without requiring battery replacement in the field; and
- The image intensifier provided a field of view approximately 35 feet wide from 20 yards away; however, the image became blurry near the edges.

Maintainability

The GT-14 received a Maintainability score of 4.0. The following information is based on evaluator comments:

- The image intensifier can be purchased to use either commonly available size AA or CR123 battery types. Evaluators viewed the option to choose battery type as beneficial;
- The image intensifier was easy to clean following the simple instructions provided in the user manual and the optical tissue included with purchase. Battery replacement was easy; and
- The duration of technical support should have been provided by the vendor.

Affordability

The GT-14 received an Affordability score of 2.7. The following information is based on evaluator comments:

- The 1-year warranty duration was less than expected for this technology. The warranty terms appeared standard, covering defects in workmanship and materials, as expected.

Deployability

The GT-14 received a Deployability score of 4.2. The following information is based on evaluator comments:

- The user manual was very detailed and included several pictures and diagrams. Additionally, part numbers and contact information for the vendor were provided. A quick-start reference guide was not included.

4.5 Nivisys LLC MUM-14 Mini-monocular (Omni IV Grade)

The MUM-14 Mini-monocular (Omni IV Grade) (Figure 4-6) received an overall assessment score of 3.7 and costs \$3,685 as assessed. An eyecup, an objective lens cover, a head/helmet adapter, a head mount assembly with brow pads, a weapon mount, a demist shield, a sacrificial lens, a lanyard, a battery adapter (to allow for AA sized battery use), one size AA battery, one size CR123 battery, a soft carrying case, optical tissue, a user manual, a quick-start reference guide, and a 1-year warranty were included with purchase.



Figure 4-6. MUM-14 Mini-monocular

The following sections, broken out by SAVER category, summarize the assessment results.

Usability

The MUM-14 Mini-monocular (Omni IV Grade) received a Usability score of 3.7. The following information is based on evaluator comments:

- Overall, the image intensifier provided a clear image with minimal defects. Use of the IR illuminator improved image quality. The gain automatically adjusted and assisted in providing consistent image brightness in different lighting conditions. During the surveillance scenario, it was difficult to see that the individuals were holding objects from 50 yards away; however, from 25 yards, the handgun and umbrella were identifiable;
- Adjusting the focus control improved the image quality. Once set, no additional adjustments to the focus were required to maintain image quality. There was no manual gain control;
- The image intensifier could be used ambidextrously, although hand position was critical due to the position of the power/IR illuminator control. In addition, the power/IR illuminator control had a push-and-turn design with positive clicks, making it difficult to power on and activate the IR illuminator with only one hand and while wearing gloves. The focus and diopter were easily adjusted using the other hand. To activate the IR illuminator switch, the unit had to be momentarily switched to the off position, which was not preferred;
- The housing was waterproof and felt durable; however, an IP rating was not provided by the vendor. It is impact resistant, which was preferred, but the vendor should have also provided drop-test information; and
- Overall, the image intensifier operated quietly, with a slight humming noise that was barely audible; however, switching between on, off, and the IR illuminator made an audible clicking noise. The eyecup minimized the amount of light escaping around the eyepiece.

Capability

The MUM-14 Mini-monocular (Omni IV Grade) received a Capability score of 3.6. The following information is based on evaluator comments:

- The image intensifier has a bright IR illuminator;
- The lack of mounting options greatly impacts the image intensifier's versatility; weapon mounting is a primary use in some applications;
- The 40-hour battery runtime with a lithium battery met expectations; however, the 20-hour runtime with an alkaline battery may not be sufficient for typical use; and
- The image intensifier provided a clear field of view approximately 40 feet wide from 20 yards away.

Maintainability

The MUM-14 Mini-monocular (Omni IV Grade) received a Maintainability score of 4.0. The following information is based on evaluator comments:

- The option to use either size AA or CR123 battery types through the use of an adapter is beneficial;
- The image intensifier was easy to clean following the simple instructions provided in the user manual and the optical tissue included with purchase. Battery replacement was easy; and
- The duration of technical support should have been provided by the vendor.

Affordability

The MUM-14 Mini-monocular (Omni IV Grade) received an Affordability score of 2.8. The following information is based on evaluator comments:

- The 1-year warranty duration was less than expected for this technology. However, in addition to covering defects in workmanship and materials, the warranty terms specifically refer to warranty-related inspections taking place at the factory or by "authorized field personnel", which may be convenient if located nearby.

Deployability

The MUM-14 Mini-monocular (Omni IV Grade) received a Deployability score of 4.8. The following information is based on evaluator comments:

- The user manual was thorough and contained multiple diagrams, a spare parts list, and a color quick-start reference guide. In addition, vendor contact information was prominently displayed in the manual.

4.6 Night Optics USA Inc. D-300 Monocular

The D-300 Monocular (Figure 4-7) received an overall assessment score of 3.6 and costs \$3,399 as assessed. An eyecup, an objective lens cover, one size CR123 battery, a Pelican® 1050 Micro Case (Figure 4-8), a lens cloth, a user manual, and a 2-year warranty were included with purchase.

The following sections, broken out by SAVER category, summarize the assessment results.

Usability

The D-300 Monocular received a Usability score of 3.7. The following information is based on evaluator comments:

- The image intensifier provided a clear image except for a noticeable blurry ring at the outer edges of the field of view. Use of the IR illuminator improved the clarity of the image. The gain automatically adjusted and there were no issues with the brightness of the image in different lighting conditions. During the surveillance scenario, it was evident from 50 yards the individuals were holding objects; from 25 yards, the handgun and umbrella were clearly identifiable;
- Adjusting the focus control improved the image quality. Once set, no additional adjustments to the focus were required to maintain image quality. There was no manual gain control;
- The power and IR illuminator controls were easily reached and manipulated one-handed, using either hand, and with or without gloves. However, the image intensifier is heavy. The diopter and focus were easily adjusted and turned smoothly; however, both hands were required;
- The all-metal housing felt durable and had good drop-test and IP ratings. However, the O-ring remains exposed to the elements when the battery cap is in place and the battery cap is not tethered to the device. In addition, the IP rating and waterproof information provided by the vendor were in conflict; and
- The image intensifier operated quietly, with only a slight humming noise that was barely audible. Although the eyecup prevented light from escaping around the eyepiece, the IR illuminator was easily seen with the unaided eye, which could potentially compromise the user's location in covert operations.



Figure 4-7. D-300 Monocular



Figure 4-8. Pelican® 1050 Micro Case

Capability

The D-300 Monocular received a Capability score of 3.6. The following information is based on evaluator comments:

- The IR illuminator has two brightness settings;
- The image intensifier provided for all possible mounting options; however, the lack of a sacrificial lens option could make the image intensifier more susceptible to damage;
- The 40-hour battery runtime met expectations and should be sufficient for completion of most missions without requiring battery replacement in the field; and
- The image intensifier provided a field of view approximately 35 feet wide from 20 yards away; however, the image became blurry near the edges.

Maintainability

The D-300 Monocular received a Maintainability score of 3.5. The following information is based on evaluator comments:

- Although commonly available, the CR123 battery type is typically more expensive than size AA batteries;
- Battery replacement was easy, although the cap was not tethered. Maintenance, troubleshooting, and cleaning instructions were limited in the user manual. Although it was easy to clean with the supplied lens cloth, optical tissue was preferred since the cloth could become dirty over time and potentially scratch the lens; and
- The duration of technical support was for the life of the device.

Affordability

The D-300 Monocular received an Affordability score of 3.3. The following information is based on evaluator comments:

- Although the 2-year warranty duration met expectations, coverage for defects in material and workmanship was limited to the original purchaser only.

Deployability







The D-300 Monocular received a Deployability score of 3.5. The following information is based on evaluator comments:

- The user manual included multiple diagrams and adequate instructions on battery orientation; however, there were no part numbers listed and a quick-start reference guide was not included.

5. SUMMARY

According to evaluators, image intensifiers that can easily be configured with head/helmet/weapon/tripod mounting options are preferred. Additionally, they favored image intensifiers that were equipped with a manual gain control, featured a long battery life, and were covert during operation. Evaluators agreed that monocular night vision devices assist in maintaining depth perception since only one eye is viewing the image while the other eye remains open. Additionally, they noted it is important to keep in mind that the IR illuminators on these devices are limited to close-quarter applications due to their limited illumination range. The evaluators also agreed that all of the assessed image intensifiers had good eye reliefs and would assist emergency responders in conducting operations in poorly-lit conditions. The advantages and disadvantages for the assessed products are highlighted in Table 5-1 on the next page.

Table 5-1. Product Advantages and Disadvantages

Vendor/Products		Advantages	Disadvantages
	Tactical Night Vision Company Inc. TNV/PVS-14 Pinnacle MSRP: \$2,918 Overall Score: 4.1	<ul style="list-style-type: none"> • Commonly used PVS-14 controls • Manual gain control • Warranty duration (5 years) • Long battery runtime (according to vendor specification) 	<ul style="list-style-type: none"> • Battery cap difficult to turn while wearing gloves due to proximity to gain control
	Summit Night Vision Group SNVG-14 (PVS-14) MSRP: \$3,495 Overall Score: 4.0	<ul style="list-style-type: none"> • Commonly used PVS-14 controls • Manual gain control • Included a variety of mounting options • Housing easy to hold 	<ul style="list-style-type: none"> • Battery cap difficult to turn while wearing gloves due to proximity to gain control
	American Technologies Network (ATN) Corp. ATN-6015-3 MSRP: \$2,949 Overall Score: 3.9	<ul style="list-style-type: none"> • Commonly used PVS-14 controls • Included a variety of mounting options • Long battery runtime (according to vendor specification) 	<ul style="list-style-type: none"> • No manual gain control
	N-Vision Optics LLC GT-14 MSRP: \$2,926 Overall Score: 3.8	<ul style="list-style-type: none"> • One-handed operation • Can specify AA battery or CR123 battery at time of purchase 	<ul style="list-style-type: none"> • No manual gain control • Streaked image quality • IR illuminator indicator location in the field of view is difficult to see
	Nivisys LLC MUM-14 Mini-monocular (Omni IV Grade) MSRP: \$3,685 Overall Score: 3.7	<ul style="list-style-type: none"> • Bright IR illuminator • Color quick-start reference guide • Accepts AA battery or CR123 battery with adapter 	<ul style="list-style-type: none"> • No manual gain control • Must turn device off before activating IR illuminator • Noisy switches
	Night Optics USA Inc. D-300 Monocular MSRP: \$3,399 Overall Score: 3.6	<ul style="list-style-type: none"> • Bright IR illuminator • One-handed operation • All metal housing • Diopter and focus adjustment turn smoothly 	<ul style="list-style-type: none"> • No manual gain control • IR illuminator visible to unaided eye • Heavy • Untethered battery cap with exposed O-ring • Blurry edges around image perimeter

Emergency responder agencies that consider purchasing handheld image intensifiers should carefully research each product's overall capabilities and limitations in relation to their agency's operational needs.

APPENDIX A. EVALUATION CRITERIA DEFINITIONS

The focus group identified 18 evaluation criteria, which are defined as follows:

USABILITY

Image quality refers to the device providing a clear, sharp image with minimal defects and distortion such as blooming, shadowing, and haloing as well as automatically adjusting for different lighting conditions. The focus group noted that image quality impacts the user's ability to detect and recognize objects of interest.

Image adjustment refers to how well image quality can be improved by manually adjusting gain and focus.

Handheld operation refers to how easily the device can be held and carried (i.e., inclusion of a lanyard or hand strap attachment point). Handheld operation also refers to the ease of activation and adjusting controls such as focus, gain, diopter, and/or infrared (IR) illuminator with or without gloves. The focus group noted that controls should be readily accessible and the device should be useable ambidextrously.

Tube protection refers to the ability to remain operational or recover quickly when compensating for lighting conditions to protect the tube(s). The focus group noted that when a bright light is present, some tubes shut off while others may flicker or dim.

Durability refers to the overall ruggedness of the device, including the sturdiness of its buttons/controls. Durability also includes the device's water resistance, Ingress Protection (IP) rating, and shock resistance.

Depth perception refers to the image characteristics that enable the user to estimate distances and three-dimensional (3-D) relationships between objects and subjects in the field of view.

Covertiness refers to factors that contribute to the user's ability to use the device without being detected. The focus group noted that the device should have a black or camouflage casing, operate quietly, and restrict light escaping from the eyepiece.

Eye relief refers to the optimal distance between the eye and the eyepiece of the device to ensure maximum view of the exit pupil. The focus group noted that a longer eye relief is preferred.

Indicators refers to the location and appearance of a low battery indicator and/or an IR illuminator "on/off" indicator. The focus group noted the importance of indicators not interfering with the field of view or covertness of the device.

CAPABILITY

Infrared illuminator refers to how well the device's IR light illuminates a target, as well as the ability to adjust the beam width.

Versatility refers to the device mounting options (e.g., head, helmet, weapon, tripod). Versatility also includes the ability to use a camera, sacrificial lenses, and magnified lenses with the device.

Battery runtime refers to the length of time the device can operate before the batteries require replacement.

Field of view refers to the area that is viewed through the device at a given distance.

MAINTAINABILITY

Battery type refers to the size and type of batteries required to power the device, including if they are readily available.

Maintenance refers to whether required maintenance and/or repairs can be performed by the user or if the device must be sent to the vendor for service. Maintenance also includes the ease of cleaning the device and its lenses as well as replacing batteries.

Technical support refers to the duration of technical support included with purchase and the availability, responsiveness, and technical knowledge of technical support.

AFFORDABILITY

Warranty refers to the duration and coverage of the warranty included with purchase.

DEPLOYABILITY

User manual refers to the included user manual having instructions and diagrams that are easy to understand. The focus group noted that the manual should include a parts list, contact information, care and maintenance instructions, indicator translations, and a quick-start reference guide.

APPENDIX B. EVALUATION CRITERIA CONSIDERATIONS

Criterion	Specification Assessment	Setup Scenario	Surveillance Scenario	Search and Rescue Scenario	Bright Light Scenario	Consideration
Usability						
Image Quality		✓	✓	✓		Does the image intensifier provide a clear, sharp image with minimal defects and distortion?
			✓			Does the image automatically adjust for different lighting conditions?
Image Adjustment			✓	✓		Does the improvement of the image quality by adjusting gain and focus meet expectations?
Handheld Operation		✓				Does the image intensifier allow for ambidextrous use?
		✓		✓		How easily can the device be held and carried? How easily can the device be powered on? How easily can the IR illuminator be activated? How easily can the diopter, gain, and focus be adjusted? Does the accessibility of controls meet expectations?
Tube Protection					✓	Does the image intensifier remain operational or recover quickly when compensating for lighting conditions to protect the tube and does this meet expectations? Does the way the image intensifier protects the tube (e.g., shuts off, flickers) meet expectations?
Durability	✓					Does the image intensifier's water resistance meet expectations? Does the image intensifier's ingress protection (IP) rating meet expectations? Does the image intensifier's resistance to impact meet expectations?
		✓				Does the overall ruggedness, including the sturdiness of buttons and controls, meet expectations?
Depth Perception			✓	✓		Can depth perception be maintained while using the image intensifier and does this meet expectations?

Criterion	Specification Assessment	Setup Scenario	Surveillance Scenario	Search and Rescue Scenario	Bright Light Scenario	Consideration
Coverttness		✓				Is the color of the image intensifier satisfactory for covert operation? Does the image intensifier operate quietly? How easily can the image intensifier be detected while in use? Are the image intensifier's indicators covert in nature?
Eye Relief			✓			Does the eye relief meet expectations?
Indicators		✓				Do the locations and appearance of the low-battery and IR illuminator indicators meet expectations? Do the indicators interfere with the field of view?
Capability						
Infrared Illuminator		✓	✓			How well does the infrared illuminator illuminate the target?
		✓				Does the adjustability of the infrared illuminator's beam width meet expectations?
Versatility	✓					Do the mounting options meet expectations? Does the image intensifier include the ability to use a camera, sacrificial lenses, and/or magnified lenses?
Battery Runtime	✓					Does the length of time the image intensifier can operate before replacing the batteries meet expectations?
Field of View				✓		Does the field of view meet expectations?
Maintainability						
Battery Type	✓					Are the type of batteries required to power the image intensifier commonly available and do they meet expectations
Maintenance	✓					Can the maintenance and/or repairs of the image intensifier be performed by the user or must the device be sent to the vendor for service?
		✓				Does the ease with which the user-replaceable battery can be changed meet expectations? Does the ease of cleaning the device, including its lenses, meet expectations?

Criterion	Specification Assessment	Setup Scenario	Surveillance Scenario	Search and Rescue Scenario	Bright Light Scenario	Consideration
Technical Support	✓					Does the duration of technical support included with purchase meet expectations? Does the availability of technical support meet expectations?
Affordability						
Warranty	✓					Do the duration and coverage of the warranty included with purchase meet expectations?
Deployability						
User Manual		✓				Are the manual's instructions and diagrams easy to understand? Does the manual include a parts list, contact information, care and maintenance instructions, indicator translations, and a quick-start reference guide?

APPENDIX C. ASSESSMENT SCORING FORMULAS

The overall score for each product was calculated using the product's averaged criterion ratings and category scores. An average rating for each criterion was calculated by summing the evaluators' ratings and dividing the sum by the number of responses. Category scores for each product were calculated by multiplying the average criterion rating by the weight assigned to the criterion by the focus group, resulting in a weighted criterion score. The sum of the weighted criterion scores was then divided by the sum of the weights for each criterion in the category as seen in the formula and example below.

Category Score Formula

$$\frac{\sum (\text{Average Criterion Rating} \times \text{Criterion Weight})}{\sum (\text{Criterion Weights})} = \frac{\text{Category}}{\text{Score}}$$

Category Score Example¹

$$\frac{(4.3 \times 4) + (5 \times 4) + (4 \times 3) + (4.5 \times 3) + (4.5 \times 3)}{4 + 4 + 3 + 3 + 3} = 4.5$$

To determine the overall assessment score for each product, each category score was multiplied by the percentage assigned to the category by the focus group. The resulting weighted category scores were summed to determine an overall assessment score as seen in the formula and example below.

Overall Score Formula

$$\sum (\text{Category Score} \times \text{Category Percentage}) = \frac{\text{Overall Assessment}}{\text{Score}}$$

Overall Score Example¹

<u>Capability</u>	<u>Usability</u>	<u>Affordability</u>	<u>Maintainability</u>	<u>Deployability</u>	
$(4.0 \times 33\%)$	$+ (4.2 \times 27\%)$	$+ (4.2 \times 20\%)$	$+ (3.8 \times 10\%)$	$+ (4.5 \times 10\%)$	$= 4.1$

¹Examples are for illustration purposes only. Formulas will vary depending on the number of criteria and categories assessed and the criteria and category weights.