Homeland Security
Science and Technology

Summary

U.S. Department of Homeland Security
SAVER
System Assessment and Validation for Emergency Responders

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions.

Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective operational tests 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?"

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Chemical, Biological, Radiological, and Nuclear (CBRN) Self-Contained Breathing Apparatus (SCBA)

(AEL reference number 01AR-01-SCBA)

In order to provide emergency responders with information on currently available SCBA technologies, capabilities, and limitations, the Center for Domestic Preparedness (CDP) conducted a comparative assessment of SCBA for the SAVER Program in January 2008. All assessed SCBA meet the new National Institute for Occupational Safety and Health (NIOSH) and National Fire Protection Association (NFPA) standards established in 2007. Detailed findings are provided in the Assessment Report on Chemical, Biological, Radiological and Nuclear Self-Contained Breathing Apparatus*, which is available by request at https://www.rkb.us/saver.*

Background

SCBA is a device worn by first responders to provide breathable air in a hostile air environment during responses to CBRN incidents or accidents. The term self-contained differentiates SCBA from other apparatus connected to a remote supply by a long hose. A SCBA typically has three main components: a high-pressure tank, a pressure regulator, and an inhalation connection (i.e., mouthpiece, mouth mask, or face mask) connected together and mounted to a carrying frame. In critical moments during which the oxygen level, atmosphere, toxicity, and radiation levels are unknown, emergency responders use CBRN SCBA as part of a Level A or Level B ensemble, as mandated by OSHA 1910.120, or as part of a Level A or Class 2 ensemble, as directed by the NFPA 1991 and NFPA 1994 standards.

Assessment

Prior to the assessment, the CDP conducted a market survey to identify commercially available SCBA. Then, a focus group of 10 emergency responders met in November 2007 to identify equipment selection criteria, determine evaluation criteria, and recommend assessment scenarios.

The focus group discussed SCBA technologies and recommended assessing SCBA that meet the NIOSH standard for CBRN SCBA, as well as the NFPA *1981 Standard on Open-Circuit Self-Contained Breathing Apparatus, 2007 Edition*, and NFPA 1982 *Standard on Personal Alert Systems, 2007 Edition*.

The four assessed SCBA included:

- Avon International Safety Instruments, Inc. (ISI) Viking Z SEVEN
- Mine Safety Appliances Co. (MSA) FireHawk® M7
- Scott Health & Safety Air-Pak® 75™
- Scott Health & Safety Air-Pak NxG7™

Nine emergency responders from various backgrounds and jurisdictions served as assessment evaluators. Each SCBA was evaluated in the same manner, and operational conditions were controlled.

Assessment Results

Evaluators rated the assessed SCBA based on the evaluation criteria established by the SCBA focus group. Each recommended criterion was assigned to one of the five SAVER categories and was then assigned a weighting factor based on a 100-point scale. Higher evaluator scores indicate better SCBA performance. Table 1 presents the respective equipment scores. To view how each SCBA scored within the specific evaluation criteria assigned to the SAVER Program categories, see Table 2 (on page 6).

The following paragraphs provide a brief summary of evaluator comments and feedback on each SCBA used during the assessment. The sections present the SCBA equipment from the highest to the lowest composite scores. The full report includes a more thorough review of evaluator comments by category and individual criterion.

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.

Air-Pak 75

The Air-Pak 75 received the highest overall composite score. The Air-Pak 75 and the Air-Pak NxG7 were similar and received comparable scores in all five categories, including capability and usability. However, the Air-Pak 75 scored higher in the affordability, deployability, and maintainability categories.

The affordability criteria included maintenance, cylinder compatibility, and certification to repair. Cylinder compatibility was an important affordability consideration because the Air-Pak 75 used the same cylinders from previous Scott models, while the Air-Pak NxG7 did not appear to have this compatibility.

Deployability criteria included the ability to quickly don, vehicle space requirements, and the ability to easily carry the SCBA. Maintainability criteria included durability, ease of cleaning, storage requirements, and a user-friendly maintenance manual. Based on evaluator comments and scoring, both the Air-Pak 75 and the Air-Pak NxG7 performed well in these two categories.

The Air-Pak 75 offered user-friendly components such as the regulator, heads up display (HUD), and large

Table 1. SCBA Assessment Results[1]

CBRN SCBA	Composite Score	Affordability (5% Weighting)	Capability (25% Weighting)	Deployability (10% Weighting)	Maintainability (20% Weighting)	Usability (40% Weighting)
Air-Pak® 75™	**77**	72	74	77	81	78
Air-Pak NxG7™	**76**	52	74	75	79	79
FireHawk® M7	**69**	60	58	74	77	71
Viking Z SEVEN	**68**	66	57	74	75	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.

	Pros	• Easy-to-attach/detach regulator • Easy-to-see and easy-to-interpret HUD • Comfortable harness • Comfortable facepiece • Large, easy-to-use PASS device buttons • Sturdy drag attachment
	Cons	• Alarming PASS device difficult to reset without hip movement
Air-Pak®75™	**Composite Assessment Score: 77**	

personal alert safety system (PASS) device buttons. The harness and facepiece were comfortable, and the drag attachment appeared sturdy enough to rescue an average-sized responder.

Evaluators noted one disadvantage related to the PASS device. The PASS device was attached to the SCBA backframe. When evaluators were not performing activities involving hip movements, the pre-alarm would activate, and evaluators had to make intentional movement in order to reset the alarm.

Air-Pak NxG7

The Air-Pak NxG7 received the second highest overall composite score, as well as the highest scores in the capability and usability categories. Capability criteria included drag attachments, upgradeability, compatibility with ancillary equipment, belt adjustment range, and bail-out devices. Usability criteria included an easy-to-use HUD, a user-friendly PASS device, easy-to-use strap/harness adjustments, a user-friendly facepiece/harness, simple cylinder change, an easy-to-use regulator, a user-friendly voice amplifier, overall comfort, a wide range of visibility, and a user-friendly low air alarm. Only slight differences between the Air-Pak NxG7 and the Air-Pak 75 were captured in evaluator scoring and comments in these two categories. The most notable difference was in the usability category, where the Air-Pak NxG7 received a higher usability score in the simple cylinder change criterion. The Snap-Change™ cylinder connector and connection port utilized by the Air-Pak NxG7 allowed for quicker and easier cylinder changes than the other assessed models.

The Air-Pak NxG7 offered a regulator that was easy to attach and detach, a HUD that was easy to see and interpret, a comfortable harness and facepiece, easy-to-use PASS device buttons, and a sturdy drag attachment for rescuing an average-sized responder.

	Pros	• Easy-to-attach/detach regulator • Easy-to-see and easy-to-interpret HUD • Comfortable harness • Comfortable facepiece • Large, easy-to-use PASS device buttons • Sturdy drag attachment • Snap-Change™ connector
	Cons	• Alarming PASS device difficult to reset without hip movement • Cannot use Scott cylinders that do not have Snap-Change connectors
Air-Pak NxG7™	**Composite Assessment Score: 76**	

Evaluators noted two disadvantages. The PASS device, which was attached to the SCBA backframe, would alarm due to a lack of hip movement, and evaluators had to make intentional movement in order to reset the alarm. There was also concern about cylinder compatibility. Evaluators were uncertain whether cylinders from previous Scott models would be compatible with the Air-Pak NxG7 due to the design of the Snap-Change connector.

FireHawk M7

The FireHawk M7 consistently scored third in all of the SAVER categories, resulting in the third overall composite score. Evaluators noted several advantages: (1) the SCBA harness and facepiece were comfortable, (2) the harness offered sufficient strap length for a wide range of body sizes, and (3) the harness buckles/clips were easy to grasp and adjust for a secure fit. In addition, the facepiece and head harness provided a strong seal and were easily tightened using the four adjustment points.

Evaluators reacted positively to the PASS device as well. The control module was located near the arm instead of at the waist, which allowed them to reset the

	Pros	• Comfortable harness • Alarming PASS device easy to reset with routine arm movement • Sturdy, easy-to-adjust buckles/clips
	Cons	• Difficult-to-attach/detach regulator • Cyclical HUD light display • Metal cylinder strap hindered cylinder change
FireHawk M7®	**Composite Assessment Score: 69**	

alarm with routine arm movement instead of intentional hip movement.

There were several disadvantages to this SCBA. Evaluators had to guide the regulator down a track to the attachment point, making it difficult to attach and detach. In addition, the HUD did not offer a constant reading and was considered to be ineffective due to its intermittent display. Finally, evaluators commented that cylinder change might be difficult due to the metal cylinder strap, which could be loosened but not completely opened for cylinder replacement.

Viking Z SEVEN

The Viking Z SEVEN received the lowest composite score; however, evaluators noted several advantages. First, they experienced a wide range of visibility, specifically good peripheral vision, while performing assessment activities. The SCBA harness offered a good comfort level. The harness straps were long enough to accommodate a variety of body sizes; excess belt length was easily secured. Finally, the HUD location did not interfere with the normal field of vision; it was easy to see and interpret.

Several disadvantages were noted. No drag attachment was included with this SCBA and evaluators experienced difficulties when changing the cylinder because the cylinder band did not completely detach from the backframe. The cylinder change instructions were unclear (i.e., instructions did not specify to rotate the cylinder through the u-shaped cylinder band). Head harness discomfort was experienced because the two adjustment points located at the back of the head were difficult to adjust for a secure fit. In addition, the SCBA harness buckles/clips were small and difficult to grasp. While the PASS device batteries were easily replaced, a large number of batteries would need to be kept on hand for replacement.

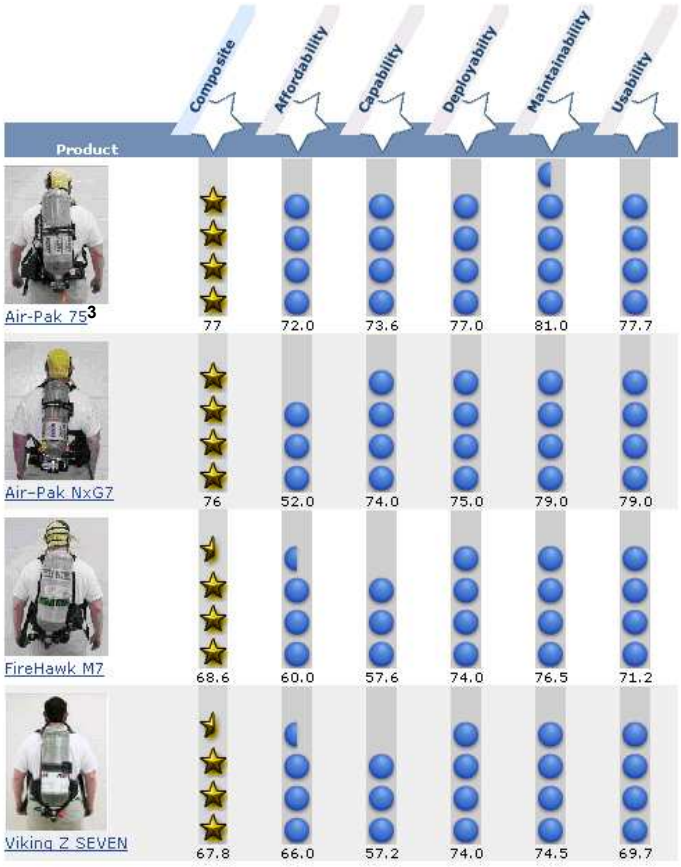
	**Pros**	• Facepiece allowed for good peripheral vision • Comfortable harness • HUD placement allowed for sufficient field of vision
	Cons	• No drag attachment • Complicated cylinder change • Uncomfortable and difficult-to-adjust head harness • Small buckles/clips that are difficult to grasp • Large number of PASS device batteries
Viking Z SEVEN	**Composite Assessment Score: 68**	

Conclusion

This assessment helped achieve the overall goal of evaluating the effectiveness of SCBA that meet the newly established standard and are used by responders in HAZMAT incidents or other related all-hazards situations. The assessment goal was achieved by utilizing and evaluating the selected SCBA in scenario-driven exercises. Evaluators reacted positively to SCBA with the following characteristics:

- Good overall comfort (e.g., sufficient harness padding, facepiece and nosecup sizing, strap adjustability)
- Adequate range of vision with minimal obstructions from the HUD, regulator, fogging, or glare from bright lighting
- Effective PASS device that provides an adequate warning prior to progressing into full alarm and is easily reset if an emergency situation is not present.

QuickLook Snapshot[2]



Notes:

[2] The SAVER QuickLook, available on the SAVER Web site, allows users to select the SAVER categories that are most important to their department and view results according to their specific needs.

[3] Scores contained in the assessment report may be displayed differently. For purposes of QuickLook, all SAVER category scores are normalized using a 100-point scale.

All reports in this series as well as reports on other technologies are available by request at https://www.rkb.us/saver.

Table 2. SAVER Category and Criteria Scores

KEY Least Favorable → Most Favorable				
	Air-Pak 75	Air-Pak NxG7	FireHawk M7	Viking Z SEVEN
Assessment Criteria				
Affordability				
Maintenance				
Cylinder compatibility				
Certification to repair				
Capability				
Drag attachments				
Upgradeable				
Compatible with ancillary equipment				
Belt adjustment range				
Bail-out device				
Deployability				
Quickly donnable				
Vehicle space requirements				
Easy to carry				
Maintainability				
Durability				
Easy to clean				
Storage requirements				
Maintenance manual				
Usability				
Easy-to-use HUD				
User-friendly PASS device				
Easy-to-use strap/harness adjustments				
User-friendly facepiece/harness				
Simple cylinder change				
Easy-to-use regulator				
User-friendly voice amplifier				
Overall comfort				
Range of visibility				
User-friendly low air alarm				