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 mission includes:

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

Information provided by the SAVER Program will be shared nationally with the responder community, providing a life-saving 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. 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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Air-Purifying Respirators (APRs)

In order to provide emergency responders with reference information on currently available APR capabilities, limitations, and usability, the U.S. Department of Homeland Security's Center for Domestic Preparedness (CDP) conducted a comparative assessment of APRs for the SAVER Program in June 2007, and provided findings in the Assessment Report on Air-Purifying Respirators*, which is available by request at https://www.rkb.us/saver.*

Background

APRs are used to provide respiratory protection to emergency responders operating in atmospheric environments that are not oxygen deficient, but still require respiratory protection. Examples include conditions with heavy or hazardous air particulates or where there are low and known levels of certain chemical or biological agents. An APR uses an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

Assessment

In March 2006, the CDP conducted a comparative assessment of six APRs. At that time, there were seven National Institute for Occupational Safety and Health (NIOSH)–approved APRs, but one of the seven manufacturers was unable to provide their APR in time for the assessment. Since the time of the first assessment, four additional APR have been approved by NIOSH, and the SAVER Program elected to conduct an additional comparative assessment in June 2007 to include the available additional NIOSH-approved APR, as well as the one APR that was not previously assessed (the 3M™ FR-M40B). The Avon Protection C50 was scheduled for the assessment, but the distributor/manufacturer could not meet the required delivery date.

The 3M FR-7800 was the highest scoring APR in the March 2006 assessment and was also included in this assessment for comparative purposes. Altogether, the following five APR models were assessed in June 2007:

- 3M FR-M40B Series Full Facepiece (FR-M40B)
- 3M FR-7800B Series Full Facepiece (FR-7800B)
- Draeger CDR 4500 (CDR 4500)
- Scott M110 Full Facepiece Respirator (M110)
- Scott M120 Full Facepiece Respirator (M120).

Eight emergency responders were selected to serve as evaluators. Each APR was evaluated in the same manner, and operational conditions were controlled to make the evaluation of each system as similar as possible. Although only simulants were used throughout the June 2007 assessment, each evaluator underwent quantitative fit testing on the first day using the TSI PORTACOUNT® machine with each APR to be in accordance with Occupational Safety and Health Administration (OSHA) mandates for fit

testing. The fit testing session allowed responders to also comment on their first impressions of each APR.

Assessment Results

Evaluators rated APR equipment based on the evaluation criteria established by the APR focus group and prioritized within the five SAVER categories. The scoring system utilized the evaluation criteria weighting factors established by the focus group. Higher scores indicate better APR equipment performance (table 1).

The following paragraphs provide a brief summary of the evaluator comments and feedback on each APR during the assessment. Information in the pros and cons charts was provided during final evaluator discussions following the assessment. The APR equipment is listed by composite score (highest to lowest). The full report includes a more thorough review of evaluator comments on each APR by category.

Draeger CDR 4500

Although the overall scores of all five APRs were close, the CDR 4500 was favored by most evaluators in the usability and deployability categories and received the highest overall score. The CDR 4500 was comfortable, lightweight, and maintained the facial seal. The filter canister was durable and tamper resistant. Evaluators could easily breathe through the filter canister and the central port did not hinder movement while wearing this APR.

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 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.

The user manual was easy to read and to find information; however, there was confusion on how to order CDR 4500 facepiece sizes. One piece of literature stated that "one size fits all" while another stated this APR can be ordered in small, medium, and large.

3M FR-7800B

The overall score of the FR-7800B was only slightly lower than the CDR 4500. Evaluators' assessment

Table 1. APR Assessment Results[1]

APR	Composite Score	Affordability	Capability	Deployability	Maintainability	Usability
Draeger CDR 4500	**70.8**	67	66	76	69	73
3M™ FR-7800B	**70.3**	66	70	73	71	71
3M FR-M40B	**70.1**	68	74	71	71	65
Scott M120	**69.3**	66	68	72	71	70
Scott M110	**68.6**	66	70	70	67	70

Notes:

[1] Scores contained in the complete assessment report may be listed in a different numerical scale. For the purposes of the SAVER Summary, SAVER category scores are normalized and rounded to the nearest whole number.

APR = air-purifying respirator

	Pros	• Easy to breathe • Lightweight • Pliable, soft mask material • Fit well with helmet • Easy rifle sighting • Excellent field of vision • Mask seal confidence after long use and perspiration • Clearly written user manual • Variety of carry cases • Single filter canister port makes attachment simple • Tamper/usage indicator • Long filter canister shelf life
	Cons	• Facepiece size discrepancy • Routine maintenance must be performed by an authorized technician • No information about use with toxic industrial chemical (TIC)/toxic industrial material (TIM) besides standard NIOSH insert • No information about filter canisters besides standard NIOSH insert • Canister placement limits accessory use
Draeger CDR 4500	**Composite Assessment Score: 70.8**	

	Pros	• Color coded for sizing options • User-friendly design • Wide field of vision • Complete, easy-to-read documentation • Variety of available filter canisters, clearly listed in package insert • Easy, coin screw, filter canister port cover
	Cons	• No key to color coding system on mask • Difficult to breathe • Helmet use may compromise mask seal • Mask shape hinders long gun sighting • No available hydration system
3M™ FR-7800B	**Composite Assessment Score: 70.3**	

7800B APR with filter canister and PPE overhood

activities caused them to report more labored breathing while wearing this APR. The facepiece lens was wide and offered a good field of vision, but the wide-shaped faceplate and frame caused some distortion when sighting long guns. A simple tool (i.e., quarter, flathead screwdriver) was used by evaluators who wanted to test the ease of changing the filter canister from one side of the APR to the other side, and this was done without difficulty. Although mask sizes were indicated with a color-coded button, it is necessary to look in the user manual to identify what size each color indicates. The user manual was easy to navigate and was preferred by the evaluators.

3M FR-M40B

The FR-M40B scored slightly higher than the other APR in the capability, affordability, and maintainability categories. Breathing was unlabored with the FR-M40B, even while performing moderate assessment activities. This APR, however, was heavier with the filter canister in place, causing the mask to pull downward on evaluators' faces during assessment activities. The dual style lenses did not

	Pros	• Available in S-M-L • Easy to breathe • Tight face seal • Can be repaired by user • Thorough maintenance and repair instructions included • Easy-to-read documentation • Overhood available • Replaceable lens covers, available in colors • Comes well packaged, including a plastic face form retainer for storage
	Cons	• Heavy • Shape of mask hinders weapon sighting • Poor field of vision • "Second skin" could allow contamination in between mask layers • Indistinguishable grips/pull tabs on straps • Manual font is too small • Map-style folded instruction manual is difficult to handle
3M™ FR-M40B	**Composite Assessment Score: 70.1**	

offer a clear field of vision, and there was some distortion in the lower portions of the lenses. The FR-M40B is equipped with a drinking tube positioned under the nosecup area, but it did not hinder APR donning. Some evaluators tested their ability to use their tongue to reach for and use the drinking tube, but found that it was difficult to dislodge from its position.

Evaluators commented positively on the mask retainer that was included in the packaging to help maintain the APR shape. The user manual was large and printed in three languages, but once the evaluators found instructions in English, it was easy to navigate. Clear, concise instructions were printed along with accompanying photographs.

Scott M120 Technologies

The M120 scored third highest in the usability and maintainability categories. This APR is designed with a large lens piece, but there was some difficulty in downrange weapons sighting because the lens frame of the APR facepiece was wide. The mask is designed with a minimal amount of rubber material under the chin area, causing the evaluators to lack confidence in the APR's skin protection. The filter canister was noticeably large and heavy, but breathing was unrestricted when evaluators performed assessment activities. The harness strap pull tabs were large enough for the evaluators to grasp while wearing personal protective equipment (PPE) gloves. The straps were made of an elastic material that did not pull hair, and they also did not interfere with the generic riot helmet worn for the weapons sighting rotation. The user manual was well designed in booklet form, easy to navigate, and was printed in English only.

	**Pros**	• Easy to breathe • Overall comfortable fit • Comfortable silicone nosecup • Secure placement on head • User-friendly design • Wide field of vision • Easy to use strap pull tabs • One year warranty listed • Easy-to-read instructions
	Cons	• Uncomfortable chin area • Large filter canister obstructs movement • Wide face piece hinders long gun sighting • Visible face seal seam • Poor compatibility with neck area of PPE hood • Repair and maintenance must be performed by an authorized technician • No information on use with TIC/TIM besides standard NIOSH insert
Scott M120	**Composite Assessment Score: 69.3**	

Scott M110

M110 with filter canister

The M110 scored lower overall in the capability, deployability, and maintainability categories. Breathing was unrestricted. The overall weight of the APR was light, but the filter canister was notably large and heavy once it was installed on the side of the APR. Evaluators commented that there was not enough ridge material around the edge of the mask to obtain a good seal to a PPE hood. The lens pieces were a dual lens design that did not cause distorted vision, but did cause a limited field of vision and obscured weapons sighting capabilities.

	**Pros**	• Easy to breathe • Lightweight • Comfortable • Easy weapon sighting • Good field of vision • Easily adjustable straps • One year warranty listed • Easy-to-read instructions • Available instruction video • Silicone nosecup option
	Cons	• Plastic felt stiff • Frequent adjustment needed • Large filter canister obstructs movement • One half of field of vision is blocked when sighting weapons with dominant eye • Poor compatibility with PPE hood • Repairs must be performed by an authorized technician • Difficult-to-use drinking tube • Proprietary drinking bottle attachment • No cap or use indicator on filter canister
Scott M110	**Composite Assessment Score: 68.6**	

Conclusion

The assessment goal of evaluating the effectiveness of APR that can be used by emergency responders in weapons of mass destruction (WMD) or other hazardous materials incidents was achieved by utilizing and evaluating the APR in scenario-driven exercises. Analysis of the evaluators' scoring and comments revealed these general conclusions:

- Evaluators observed that their jurisdictions would first and foremost be concerned with whether APR and filter canisters would protect them in a hazardous environment (e.g., respiratory protection).
- Evaluators preferred APR filter canisters that did not restrict breathing.
- Evaluators preferred lightweight APRs that did not slip downward on their faces.
- Evaluators preferred APRs that allowed for freedom of movement in all directions. Filter canister positioning was important for freedom of movement and also for the ability to keep the filter canister intake free from PPE material while performing activities.
- Evaluators liked easy-to-read and -navigate product literature with clear and concise TIC and TIM information. Warranty information that included manufacturer contact information and a product registration card was also important.

During the final discussions following the assessment, the evaluators identified what they considered to be the most important factors of the assessed APRs. All evaluators agreed that their departments' first and foremost concern would be to purchase APR and filter canisters that would offer the best protection. Once responder safety is established, evaluators listed their preferred qualities in APR: unrestricted breathing; comfort; and clear, undistorted vision.

QuickLook Snapshot[2]

Note:

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.

All reports in the series, as well as reports on other technologies, are available on the SAVER Web site (https://www.rkb.us/saver).