



Preparedness Directorate
Office of Grants and Training

Summary

U.S. Department of Homeland Security



System Assessment and Validation for Emergency Responders

The U.S. Department of Homeland Security, Preparedness Directorate, Office of Grants and Training (G&T) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders in performing their duties. The mission of the SAVER Program is to:

- Provide impartial, practitioner relevant, and operationally oriented assessments and validations of emergency responder equipment.
- Provide information that enables decision-makers and responders to better select, procure, use, and maintain emergency responder equipment.
- Assess and validate the performance of products within a system, as well as systems within systems.
- Provide information and feedback to the user community through a well-maintained, Web-based database.

The SAVER Program established and is supported by a network of technical agents who perform the actual 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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The Air-Purifying Respirators Analysis Report

The objective of the air-purifying respirators (APR) assessment project was to evaluate and assess the comparative parameters of six full face-piece National Institute for Occupational Safety and Health (NIOSH) chemical, biological, radiological, or nuclear (CBRN) approved negative pressure, non-powered APR used by emergency responders at a weapons of mass destruction (WMD) or hazardous materials (hazmat) scene. Subject matter experts (SMEs) from the emergency-response community, who have hazmat operations or higher level of training and previous APR training and experience, were used to evaluate and assess the selected APR. The assessment included a scenario driven field assessment of APR to evaluate pre-operational requirements, durability, usability, and fitting issues when used by responders wearing Class 3 personal protective equipment (PPE).

The APR assessment project provides the emergency response community with comparative information on six NIOSH CBRN approved APR used by emergency responders to protect themselves from lethal chemical and biological materials designed to kill or injure persons coming into contact with these agents. Air purification involves removing particulate matter or vapors from the atmosphere.



North Safety Products 54501 CBRN

An APR accomplishes this by filtering or purifying ambient air before it is inhaled. The basic parts of an APR include the straps, face shield, and filter canister. APR may present logistical problems for storage and maintenance because of the variety of canisters and face-piece combinations. There is not a single canister available that is capable of filtering every possible contaminant. When using an APR, these safety factors will apply:

- Cannot be used in oxygen-deficient atmospheres containing less than 19.5 percent oxygen
- Should not be used in an environment where an unidentified contaminant may be present
- Should not be used in an immediately dangerous to life and health (IDLH) atmosphere
- Can be used when the concentration of the hazmat is known

The Center for Domestic Preparedness (CDP) conducted the comparative assessment of APR from March 27 through March 31, 2006, at the CDP in Aniston, Alabama. The assessment scenarios were developed using a scenario selected from the Homeland Security Council National Planning Scenarios and tasks recommended by the APR focus group. The assessment scenarios consisted of four activities: victim drag and extrication (figure 1), victim cutout (figure 2), victim decontamination (figure 3), and post decontamination monitoring (figure 4). Each scenario utilized a station rotation that required different levels of exertion. Evaluators had the opportunity to evaluate the performance of each APR using light, moderate, and heavy levels of work.

This is a summary of the contents of the APR analysis report. The report should be viewed for the full discussion



Figure 1: Victim Drag and Extrication



Figure 2: Victim Cutout



Figure 3: Victim Decontamination



Figure 4: Post Decontamination Monitoring

and recommendations. The complete report can be found on the SAVER Web site (<https://saver.fema.gov>).

provides a graphical representation of the results. The QuickLook chart for the APR assessment is available on the SAVER Web site.

The APR Systems

The APR systems that were included in the assessment were selected based on the primary criterion that they be NIOSH approved for CBRN environments. Six systems were chosen representing five manufacturers.

- 3M Full Facepiece FR-7800B
- AVON CBRN FM12
- SURVIVAIR Opti-Fit CBRN Gas Mask
- North Safety Products 54501 CBRN
- MSA Millennium CBRN Gas Mask
- MSA Ultra Elite CBRN Gas Mask

Assessment Ratings

The rating system used by the CDP in the APR assessment is based on a 100 point scale. Higher scores indicate better APR performance. In the tests that were conducted, the FR-7800B system rated highest. Overall, the APR systems rated fairly close to each other with scores ranging between 62.4 and 69.0 out of 100 overall. These results are shown in table 1. Figure 5, the SAVER QuickLook chart,

Evaluators' Comments

Evaluators compared the features of the individual APR and evaluated both common and unique components of each respirator. During the assessment, each evaluator scored all six APR and provided positive and negative observations and opinions based on the five SAVER categories: capability, usability, affordability, deployability, and maintainability. Examples of the evaluators' comments are included below.

The **FR-7800B** was not ranked as favorably in affordability as the other assessed APR primarily because the initial cost of the FR-7800B did not include a CBRN canister. This was not clearly stated in the manufacturer's literature, which states that the APR is shipped "as a complete system." The additional canister cost caused this APR to be the most expensive overall. However, the APR was comfortable, and most evaluators' breathing was unrestricted, even while performing heavy levels of work.

The **FM12** arrived with the canister connection port on the left side, and the user manual stated that the APR must be

APR/Category	Overall	Affordability	Capability	Deployability	Maintainability	Usability
FR-7800B	69.0	15.0	18.2	14.7	3.4	17.7
FM-12	68.8	17.0	16.7	15.1	3.2	16.8
Opti-Fit	67.8	16.7	17.4	14.0	3.5	16.2
54501 CBRN	66.4	15.3	16.7	14.1	2.7	17.6
Millennium	65.8	15.2	16.8	14.1	3.4	16.3
Ultra Elite	62.4	14.5	16.1	13.4	3.3	15.1

Table 1: Overall weighted category scores.

ordered with port side preference at the time of the order. The canister position affected head turning ability, and it touched some of the evaluators' chests while looking down, causing the APR to shift positions. There was no ridge or fastener to hold the PPE hoods in place; therefore, the hoods often exposed skin or slipped into the evaluator's field of vision.

One SME evaluating the **Opti-Fit** found breathing to be easy from light to heavy exertion levels of work; the other evaluators commented that more effort was required to breathe while performing the heavy work assessment tasks. While no fit problems were encountered, evaluators with a square jaw or wide face experienced some discomfort from tightness on the forehead and chin cup pressure. Also, a riot helmet did not fit well with this APR and donning the helmet broke most of the evaluators' mask seals.

The **54501 CBRN** canister port changes were simple, taking less than one minute to complete. The facepiece design allowed maximum peripheral vision, and no fogging occurred while performing assessment activities. However, this APR did not maintain its seal when evaluators tried to wear a riot helmet, so they were concerned that this APR could not be worn with other helmets during response activities.

The **Millennium** filter canister can be mounted in either a left or right side port, and a special tool was required to remove and replace the canister port plug. Changing canister ports on the Millennium took evaluators up to ten minutes to complete. The canisters were heavy and could cause neck muscle stress if worn for longer periods of time. A riot helmet fit well with this APR and evaluators were able to sight weapons easily, except in the prone position. Evaluators said the fit and seal were effective for response activities.

The **Ultra Elite** front canister port was the only canister location. The weight of the canister in this location caused the APR to slide down the evaluators' faces during assessment tasks. This weight also caused the nosecup to slide down from their noses, creating more labored breathing. The canister, also, hindered weapons sighting in the prone position because the canister would touch the

ground, and the Ultra Elite was the second most expensive of the assessed APRs.

Overall Assessment Results

Overall comments indicated that all six of the evaluated APR would provide emergency responders with adequate protection when responding to a WMD or hazmat incident. The "best" system for the job will be determined according to responder discipline, personal preferences, jurisdictional budgets, and assignment tasks.

During the post assessment debriefing, evaluators reiterated that different face shapes create APR comfort and fit issues. They noted that some APR may suit particular face types more than others. Size considerations were also important. APR nose cup sizes were not necessarily consistent with APR sizes. Some evaluators' APR fit, but the nose cups did not. In addition, after performing heavy levels of work, some evaluators experienced discomfort wearing an APR that had passed fit testing procedures.













Evaluators repeatedly said that different APR may not work well with helmets or other equipment necessary for particular disciplines. For example, SWAT teams may not be able to use some APR because of the additional gear they must wear.

Equipment procurement specialists in various jurisdictions may want to consider different styles, models, and manufacturers of APR to ensure responders are equipped with APR that fit correctly and are best suited for their particular need. By doing so, they will better aid their local jurisdictions' responders in effectively and confidently responding to a WMD or hazmat incident.

For Further Information

For complete APR assessment recommendations, visit the SAVER Web site. All of the CDP's reports pertaining to the APR assessment can be found on the Web site, along with reports on other technology assessed as part of the SAVER Program.

Figure 5: SAVER QuickLook chart. The QuickLook chart offers responders a mechanism to select equipment items based on characteristics that are of most importance to their department. Using the QuickLook chart, responders can emphasize and de-emphasize the five SAVER categories to fully refine their search for equipment items.

Product	COMPOSITE	AFFORDABILITY	CAPABILITY	DEPLOYABILITY	MAINTAINABILITY	USABILITY
  SURVIVAIR Opti-Fit CBRN Gas Mask	★	★	★	★	★	★
  3M Full Facepiece FR-7800B	★	★	★	★	★	★
  AVON CBRN FM12	★	★	★	★	★	★
  North Safety Products 54501 CBRN	★	★	★	★	★	★
  MSA Millennium CBRN Gas Mask	★	★	★	★	★	★
  MSA Ultar-Elite CBRN Gas Mask	★	★	★	★	★	★



3M Full Facepiece FR-7800B

SAVER is sponsored by the U.S. Department of Homeland Security, Preparedness Directorate, Office of Grants and Training.

For more information on the air-purifying respirators project please see the SAVER Web site or contact the SAVER Program Support Office.

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