



**Homeland
Security**

Science and Technology

Summary

U.S. Department of Homeland Security



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 unbiased 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 established and 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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Powered Air Purifying Respirators Assessment: Fire and Rescue Applications

As a part of the System Assessment and Validation for Emergency Responders (SAVER) Program, Texas A&M Engineering, including Texas Engineering Extension Service (TEEX) and Texas Transportation Institute (TTI), conducted a comparative assessment of powered air purifying respirators (PAPRs) for fire and rescue applications. The Powered Air Purifying Respirators Assessment: Fire and Rescue Applications Report is available by request at <https://www.rkb.us/saver>.

Background

PAPRs are used to provide respiratory protection to emergency responders who are 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 (figure 1).



Figure 1. Fire and rescue SMEs use PAPRs when clearing rubble and debris in a tunnel system.

Assessment

Ten different “facepiece” PAPR systems were included in the assessment:

Bullard PA-40 – Spectrum mask and standard belt (*Bullard PA-40*)

Draeger C420 – Panorama Nova EPDM SS Frame facemask (*Draeger C420*)

MSA MM2K – Ultraelite facepiece (*MSA MM2K*)

MSA 6HC – 3100 facepiece with rubber harness (*MSA 6HC*)

SEA Model SE400 AT-2 – with standard facepiece (*SEA AT-2*)

Scott C420 – with standard facepiece (*Scott C420*)

Scott Proflo 2 – with standard facepiece (*Scott Proflo 2*)

Scott Proflo 3 – with AV2000 facepiece (*Scott Proflo 3*)

Survivair Belt-Mounted Unit – belt-mounted blower assembly and battery kit with 4000 Series facepiece with 5-point headstrap (*Survivair Belt*)

Survivair Mask-Mounted Unit – 4000 Series facepiece with 5-point headstrap, battery, and blower assembly (mask-mounted) (*Survivair Mask*).

In the tests, fire and rescue subject matter experts (SMEs) used the PAPRs in four response scenarios. Activities included simulated victim carry evacuations from a passenger train (figure 2), use of concrete saws on a rubble pile (figure 3), patient evacuation from a residential basement using stretchers,



Figure 2. Fire and rescue SMEs evaluate the task compatibility of PAPR systems in a train rescue scenario.



Figure 3. A fire and rescue SME uses a PAPR to provide dust protection when cutting concrete.

and clearing of rubble and debris in tunnels. Tasks also included cleaning and rehabilitating the PAPR systems and changing mask sizes as needed. The SMEs provided numeric ratings of the systems for capability, deployability, maintainability, and usability criteria, and also provided written feedback after they used the systems in the different scenario applications. In addition, system cost, warranty, battery charging capability, interoperability, ease of assembly, monitoring/notification devices, and maintenance/repair documentation were evaluated.

The comparative assessment was conducted in a similar manner for each PAPR. The results are relevant to the individual systems and are not intended to be generalized beyond the specific devices tested as part of this assessment. These results should not be applied to the broader selection of equipment available in the marketplace. Even though the application spectrum is limited, care has been taken to ensure that the results are presented so that they are practically significant and can be used by decision-makers in their procurement process.

Assessment Results

Table 1 lists the overall and category scores for each PAPR system on a 5-point scale (5 is best). For fire and rescue applications, the *Scott Proflo 2* and *Scott Proflo 3* PAPRs rated highest, and the *SEA AT-2* and *Survivair Belt* PAPRs rated lowest.

Scott Proflo 2

The fire and rescue SMEs indicated that the *Scott Proflo 2* was one of the best units in the test set due to its size and comfort. They had positive comments about the unit’s location on the body, its belt, and its “good mask.” The unit scored in the top half of all assessment categories except affordability. Shortcomings of the unit that were identified in the test include a hose that was too short for some users and that kinked too easily, and the lack of a hard carrying case.

Scott Proflo 3

The criteria scores for the *Scott Proflo 3* system were similar to those of the *Scott Proflo 2* (the *Proflo 2* holds two filters, and the *Proflo 3* holds three filters). The fire and rescue SMEs commented that although the unit was a little large it might be useful for extended periods given the filtration capacity.

Table 1. Composite and SAVER Category Ratings for PAPR Fire and Rescue Applications

SAVER Category	PAPR System Rating									
	Bullard PA-40	Draeger C420	MSA MM2K	MSA 6HC	SEA AT-2	Scott C420	Scott Proflo 2	Scott Proflo 3	Survivair Belt	Survivair Mask
Composite Score	2.7	3.9	3.5	2.6	2.0	3.9	4.2	4.1	2.1	2.5
Usability (40% assessment weight)	2.3	3.6	3.8	1.9	2.8	3.9	4.4	4.3	2.7	3.4
Capability (30% assessment weight)	3.2	4.7	3.2	3.4	0.4	4.7	4.8	5.0	0.4	0.4
Deployability (20% assessment weight)	2.2	3.8	3.4	2.2	2.4	2.9	3.0	2.4	2.6	3.3
Affordability (5% assessment weight)	4.5	3.3	4.7	4.0	2.3	3.9	4.0	4.1	4.2	4.4
Maintainability (5% assessment weight)	3.3	3.0	2.7	2.8	3.4	3.1	3.1	3.0	3.2	3.1

They indicated that the AV2000 mask was “excellent” and the “best facepiece” of the test set. Unit shortcomings identified in the test include its size, a hose too short for some users, the lack of a hard carrying case, and the inability to change batteries quickly.

Draeger C420

The fire and rescue SMEs commented that the *Draeger C420* was “a good unit with minor flaws.” They found that the air volume was consistent, the unit was lightweight, and they liked the system’s carrying case and storage ability. Problems mentioned about the unit include the facepiece that was not as comfortable as other systems, the belt that needed improvement, and the hose that could be a bit longer.

Scott C420

The *Scott C420*, equipped with an identical blower assembly unit as the *Draeger C420*, had the same overall scores. As with the Draeger PAPR, the fire and rescue SMEs found the air volume to be consistent. They found the mask to fit better than the Draeger’s, but the unit lacked a hard carrying case. Compared with the Draeger, problems mentioned about the unit included that the belt could use improvement and the hose could be a bit longer. One user also indicated a problem with hose kinking as with another Scott unit.

MSA MM2K

The *MSA MM2K* was the highest rated mask-mounted blower assembly unit in the test set, and rated in the middle overall. The fire and rescue SMEs found the unit to be lightweight and portable, and “great in [a] tight situation.” The users had mixed comments about the fan motor noise—some found it noisy, but overall they found the mask to be comfortable although some difficulty in

adjusting it was noted. Limitations noted about the unit were its single filter that reduces the duration of operation. Several users cautioned that the battery power wire should be tucked inside clothing, which is made easier since the battery “easily fits in any pocket.”

Bullard PA-40

The *Bullard PA-40* was one of the highest rated systems for affordability and maintainability, but among the lowest for usability and deployability, which comprised 60 percent of the test weight. The fire and rescue SMEs experienced “unacceptable” problems with the unit’s mask and they noted that the airflow seemed insufficient, causing the mask to fog up. They also commented that the hose length was too short, but the belt was “the best of the group.”

MSA 6HC

Although the *MSA 6HC* had one of the higher air flow rates of the units in the test set, it received the lowest overall ratings from the fire and rescue SMEs for deployability and usability in field applications. They noted particular difficulties with adjusting and maintaining unit position with the belt, and indicated that the hose was too short.

Survivair Mask

The *Survivair Mask* PAPR was easy for the fire and rescue SMEs to assemble, and it was in the middle of the test set for four of the five SAVER categories (usability, deployability, affordability, and maintainability). SMEs commented, however, that the unit was compact and a “decent system” but the mask-mounted fan motor was noisy and did not provide enough air flow under working conditions. They also indicated that the unit’s belt was of low quality, and the inability to trickle-charge the unit hurt its capability rating.

As with the *MSA MM2K*, users cautioned about preventing the battery power wire from snagging.

Survivair Belt

The *Survivair Belt* system was also easy to assemble for fire and rescue SMEs, but users indicated mixed comments about the system's belt—it created problems for some SMEs but not others. Several users also indicated that the mask was very uncomfortable, and comments were also made about the unit's poor suitability for the train rescue and tunnel crawl scenario. Overall the SMEs rated the unit toward the lower end of the test set for compatibility with firefighter equipment and tasks after using the PAPR in simulated field activities.

SEA AT-2

The *SEA AT-2* PAPR carried the highest price tag of the test set, but fire and rescue SMEs rated it in the lower third of the group for usability, capability, and deployability. They found the unit to be large and bulky, less compatible for fire and rescue tasks than other systems, and the mask uncomfortable. The unit did have monitoring notification for low battery and filter quality, but the SMEs indicated the unit was too complicated. They also had difficulty locating the power switch. Usability of the microphone system drew mixed comments—one user indicated it to be a nice feature while another commented that it was “unclear.”

Conclusion

The PAPR fire and rescue composite rating is the combined result of the system scores and weights. For fire and rescue applications, the *Scott Proflo 2* and *Scott Proflo 3* PAPRs rated highest, and the *SEA AT-2* and *Survivair Belt* PAPRs rated lowest.

Systems by Scott and Draeger were consistently among the higher performers in the test set. The mask-mounted unit by MSA was also among the higher rated, but MSA's belt-mounted unit was rated lowest by fire and rescue SMEs in field applications. The test set PAPR from Bullard also received low field application scores, although that unit was among the more affordable and maintainable. Both the belt and mask-mounted systems by *Survivair* were in the lower third of the test set overall ratings, especially impacted by a lack of trickle charge capability with standard equipment provided. Finally, the PAPR from SEA was among the most expensive but rated in the lowest third in four of the five assessment criteria.

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