

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) program to inform emergency responder equipment selection and procurement decisions.

Located within the Science and Technology Directorate, the National Urban Security Technology Laboratory (NUSTL) manages the SAVER program and works with emergency responders to conduct objective operational assessments of commercially available equipment.

SAVER 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?”

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OPEN-CIRCUIT SELF-CONTAINED BREATHING APPARATUS

Firefighters and emergency responders whose missions require entering environments that are immediately dangerous to life and health require an independent source of breathable air to protect against particulate and gas hazards they may encounter when responding to fires or other incidents. As such, a self-contained breathing apparatus (SCBA) is an essential component of personal protective equipment for firefighters and some other emergency responders. This equipment falls under the Authorized Equipment List (AEL) reference number 01AR-01-SAR titled “[Respirator, Supplied Air](#),” 01AR-01-SCBA titled “[SCBA, CBRN](#)” and 01AR-01-SCBT titled “[SCBA, CBRN, Tactical](#).”

Overview

An SCBA supplies breathing air from a source that is independent of the ambient air and is carried by the wearer. This allows the wearer to enter oxygen-deficient environments. SCBAs may weigh more than 30 pounds and require special training to use safely. SCBAs are categorized as “closed-circuit” or “open-circuit.” Closed-circuit SCBAs, also known as rebreathers, operate by filtering and recirculating the wearer’s exhaled breath and supplementing it with pure oxygen from a storage a cylinder. Open-circuit SCBAs carry filtered, compressed air rather than pure oxygen and exhaled breath is vented to the atmosphere. [1] The scope of this TechNote is limited to open-circuit SCBAs.

While SCBAs come in many different configurations and form factors, all open-circuit SCBAs share the same four main components:

- a breathing air cylinder
- a pressure regulator
- a facepiece
- a carrying frame

In the United States, SCBAs used by firefighters often include a heads-up display (HUD), a pressure gauge, and a personal alert safety system (PASS).

These same elements are also required for an SCBA to be certified by the National Fire Protection Agency (NFPA). The HUD and pressure gauge inform the wearer of how much breathable air is left in their cylinder. A PASS is integrated into the SCBA to continually monitor the SCBA wearer’s movement and remaining breathable air. The PASS automatically activates audio and visual alarms if the wearer’s movement ceases or their remaining breathable air is low; the alarms can also be manually activated. This device alerts other emergency responders in the area of a downed or distressed SCBA wearer who needs assistance. Some SCBA’s have a radio frequency PASS option that also wirelessly transmits the alarm to incident command.



Figure 1. Overview image of the four main SCBA components
Image credit: 3M Scott

Accessories and Options

Organizations can equip SCBAs with a variety of accessories that provide additional communications, situational awareness, and safety capabilities. Vendor options or accessories include (but are not limited to) electronic voice communication systems, wireless telemetry modules, thermal imaging cameras and self-rescue systems.

Electronic Voice Communication Systems

Optional electronic voice communication systems can be integrated into SCBAs to transmit and receive audio from other remote transceivers. Electronic voice communications can also be direct from one SCBA to another or relayed through third-party portable radios.

Wireless Telemetry Modules

Wireless telemetry modules can be integrated into SCBAs to transmit and receive data from the incident commander coordinating the emergency response. Data being transmitted to an incident commander is captured by sensors on the SCBAs that collect information on the operating environment (e.g., temperature and video), the SCBA (e.g., remaining air, PASS alarm status), or the SCBA wearer (e.g., location and physiological status).

Thermal Imaging Cameras

Thermal imaging cameras can be integrated into the SCBA or used as stand-alone devices. They provide the SCBA wearer with a visualization of the temperature differences radiating off of objects within the camera's view, a boost to situational awareness that allows a firefighter to better navigate and respond in a hazardous environment.

Self-rescue Escape System

A self-rescue escape system is sometimes integrated into the harness of the SCBA or may be a separate device worn around the waist, affixed to the SCBA harness. Such a system contains the necessary equipment for the wearer to rappel to safety should they become trapped in the upper levels of a structure.



Figure 2. A HUD built into a facepiece (left) uses color-coded LED indicators, while the pressure gauge (shown right) uses both analog pressure displays and digital graphical displays of numeric cylinder pressure, battery status, alarms, and remaining service time.

Image credit: MSA (left) and 3M Scott (right)

Relevant Standards/Regulations

The Code of Federal regulations, specifically [42 CFR § 84.7 \[1\]](#), requires SCBAs to have multiple and redundant safety features including hand-operated valves, a facepiece, and respirable breathing gas container with pressure demand (positive pressure). They must also have a minimum use time of 30 minutes and an end of service time indicator.

Additionally, SCBAs used by firefighting organizations in the U.S. often comply with the [NFPA 1981 Standard on Open-Circuit SCBAs \[2\]](#) and [NFPA 1982 Standard on PASS \[3\]](#), both of which impose additional design specifications and testing requirements.

References

- [1] *Public Health, Approval of Respiratory Protective Devices (42 C.F.R. Section 84.70)*, Code of Federal Regulations, 2004.
- [2] National Fire Protection Association (NFPA), "NFPA 1981 Standard on Open-Circuit Self-Contained Breathing Apparatus for Emergency Services," [Online]. Available: <https://catalog.nfpa.org/NFPA-1981-Standard-on-Open-Circuit-Self-Contained-Breathing-Apparatus-SCBA-for-Emergency-Services-P1483.aspx>.
- [3] National Fire Protection Agency (NFPA), "NFPA1982 Standard on Personal Alert Safety Systems," [Online]. Available: <https://catalog.nfpa.org/NFPA-1982-Standard-on-Personal-Alert-Safety-Systems-PASS-P1484.aspx>.