



**Homeland
Security**

Science and Technology

TechNote

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 objective assessments and validations 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?"

For more information on this and other technologies, contact the SAVER Program by e-mail or visit the SAVER website.

E-mail: saver@hq.dhs.gov

Website: <http://www.firstresponder.gov/saver>

This SAVER TechNote was prepared by the National Urban Security Technology Laboratory for the SAVER Program.

NUSTL

Reference herein to any specific commercial products, processes, or services by trade name, trademark, manufacturer, or otherwise does not constitute or imply its endorsement, recommendation, or favoring by the U.S. Government. Neither the U.S. Government nor any of its employees make any warranty, expressed or implied, including but not limited to the warranties of merchantability and fitness for a particular purpose for any specific commercial product, process, or service referenced herein.

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

CBRN SCBAs are used by first responders when entering an oxygen-deficient or extremely hazardous environment, or when the threat to breathable air is unidentified, of unknown concentration, or determined to be immediately dangerous to life and health (IDLH). The SCBA supplies breathing air from a source carried by the user and typically consists of an air cylinder, pressure regulator, tubing, facepiece, and harness. Three organizations issue standards to ensure that CBRN SCBAs are safe for use by first responders: the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), and the National Fire Protection Association (NFPA). CBRN SCBAs must be used in conjunction with the appropriate level of personal protective equipment to prevent entry of contaminants through the skin.

Background

SCBAs provide respiratory protection against toxic gases and oxygen deficiency. Since the wearer has their own portable air supply, they may enter an environment where contaminants are determined to be IDLH. OSHA provides regulations and standards for respiratory protection when entering toxic environments. NIOSH provides standards, tests CBRN SCBAs, and approves equipment for use by first responders based on positive test results. For SCBAs that will be used in firefighting applications, NFPA standards related to material heat and flame resistance must also be met. The primary NFPA standards related to CBRN SCBA, which were revised in 2013, are NFPA 1981, Standard for Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services, and NFPA 1982, Standard on Personal Alert Safety Systems (PASS).

Technology Overview

An SCBA consists of a harness, a compressed air cylinder, first and second stage regulators, a hose, and a facepiece. The harness has adjustable shoulder straps and a waist belt, which pivots and adjusts to give the user more freedom of movement. Improvements in materials have made the harness more fire resistant and durable, while improvements in the mechanism for changing cylinders decreases downtime. The air cylinder can range in volume from 3.4 to 6.7 liters and in pressure from 2,216 to 5,500 pounds per square inch and deliver 30 to 75 minutes of air to the facepiece. Higher pressure cylinders are smaller and lighter for equivalent capacity. The cylinders are made of aluminum, Kevlar, or carbon composite, with carbon being the lightest. Facepieces are available in different sizes and have been improved to allow a larger field of vision, better sealing due to optimal weight distribution, and

enhanced speech quality. All SCBA facepieces must be specifically fit-tested for individual first responders in accordance with OSHA regulations. Both OSHA and the NPFA require that the SCBA facepiece be maintained at positive pressure at all times to ensure that there is no entry of hazardous substances from the environment into the facepiece.



Deltair™ SCBA

Photo courtesy of Avon Protection Systems

An SCBA approved for CBRN agents must be compliant with all NIOSH and NFPA standards and pass special tests to confirm resistance to chemical agent permeation and penetration as well as to confirm the respirator's ability to fit a wide range of facial sizes and shapes. The chemical agent tests assure that the materials used in the CBRN SCBA resist chemical warfare agent (CWA) migration through the facepiece, valves, lens, hose, etc.

Applications

SCBAs are mainly used in HAZMAT situations and in unknown, toxic, or low-oxygen environments that may be IDLH. These dangerous situations would likely involve an ongoing release of gas/vapor with the responder close to the point of release. Exposure times in these environments are likely to be short and limited by the air available from the air cylinder. If the CBRN SCBA is contaminated with any amount of liquid or vapor phase CWA it must be decontaminated and discarded. It is certified for up to 6 hours of use after initial exposure, and should not be used for a longer time to avoid the possibility of CWA permeation.

Standards

The 2013 revisions to NFPA 1981 and 1982 have led to new requirements for safety indicators, communications between firefighters, heat resistance, and audible alerts.

Personal Alert Safety System (PASS). PASS devices sound an audible alert to let others know that a firefighter is in danger. The PASS device activates if it does not detect motion for a period of time, usually between 15 and 30 seconds. It can also be activated

manually. The 2013 edition of NFPA 1982 requires a universal PASS sound.

End-of-service time indicator (EOSTI) or low-air alarm. This audible alarm indicates when the air supply in the cylinder is low. In response to requests by firefighters, current revisions to the standard require an alarm indication when the air supply reaches 33 percent of cylinder capacity, rather than the previous 25 percent. Along with the change to the alarm, heads-up display (HUD) indicators, which provide a visible indication of remaining cylinder pressure, will now be required to display signals at 75, 50, and 33 percent, as opposed to just 50 percent previously.

Facepiece. The 2013 edition of NFPA 1981 calls for increased durability of the facepiece, which must now undergo two additional tests to measure performance at high temperature and when exposed to radiant heat. In the new standard, the SCBA must be able to withstand a 500°F oven test, which helps determine whether the SCBA can withstand a catastrophic event such as a flashover.

Communications. Verbal communication while wearing an SCBA is difficult. Previously, voice intelligibility was judged by determining if five listeners could understand words being read by a speaker wearing the SCBA. New tests use a speech transmission index that gives numerical values to sound and uses a machine to measure it. This removes the subjectivity associated with human testing and makes it easier to determine if the SCBA allows effective communication.

Emergency Breathing Safety Systems (EBSS). The NFPA 1981 revisions include the minimum performance requirements for EBSS, also known as buddy breathing systems. EBSS had never been recognized or accepted by NIOSH before even though they were used by most fire departments.¹ They are considered an optional accessory but must meet the new standard if used.



MSA FireHAWK M7XT Air Mask

Photo courtesy of MSA Fire

¹ NFPA 1981: Standard for Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services. 2013 Edition.