



**Homeland
Security**

Science and Technology

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, express 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.

TechNote

CBRN Air-Purifying Escape Respirators

Air-Purifying Escape Respirators (APERs) are worn for protection from breathing harmful gases during an emergency evacuation to fresh air. Chemical, biological, radiological and nuclear (CBRN) APERs are a special class of APER designed to block chemical and biological agents and radioactive dust particles. CBRN APERs do not use an internal fresh air supply; instead, they filter contaminants from the ambient air. They are designed for a single, emergency use, to be quickly donned and worn for a short time, typically 15 minutes to 1 hour. CBRN APERs could be prepositioned in high-risk locations for self-rescue during emergency situations, issued in workplaces for emergency preparedness, or used in high-rise or safe-haven rescues where shelter-in-place is not an option. As their name implies, CBRN APERs are used to escape from, not to enter, a dangerous atmosphere.

Technology Overview

Respirators generally work by either cleaning the ambient air before inhalation or by supplying fresh air; they offer varying levels of protection. The simplest version is a particulate respirator, such as a mask worn in hospitals to mechanically block infectious particles. However, because it cannot remove gaseous contaminants, a particulate respirator does not protect against hazardous gases. In contrast, a gas-mask respirator contains a special filter that chemically reacts with specific gaseous hazards, and it seals onto the face or head so that inhaled air does not bypass the filter. A gas mask is effective only for the specific hazard(s) for which the filter is designed. Respirators that offer the greatest level of protection are known as self-contained breathing apparatuses (SCBAs), which include an air tank to supply clean air and do not need a filter. SCBAs can weigh more than 30 pounds and require special training to use safely.

The CBRN APER is a type of gas mask. CBRN APERs consist of a hood that fits over the entire head and seals around the base of the neck, as well as an attached filter that captures airborne contaminants. The hood may be made from synthetic rubber and protects the head and eyes. The filter is designed to block particles, such as dust or infectious spores, and includes materials that chemically react with specific gaseous chemicals or aerosolized toxic liquids to neutralize the hazard in order to provide purified air for breathing. The filter is typically housed in a cylindrical canister (also called a cartridge). Cartridges are color coded, either by an attached label or the color of the cartridge itself, to indicate the specific hazard for which the filter is designed. CBRN protection is indicated by an olive color.

CBRN APERs are available in two different types. Negative pressure models require the wearer to draw in filtered air through a cup that fits over the mouth and nose or through a mouth bit with a nose clip to prevent nasal breathing. Positive pressure APERs have an integrated fan that draws air through the filter and fills the hood. The wearer breathes the air circulating around his or her head. Positive pressure devices may be easier to use and have the advantage that small breaches in the neck seal would not allow contaminated air to enter the hood. However, they require batteries for operation. Negative pressure APERs do not require batteries and usually cost less, but breathing may be more difficult, especially for someone with a respiratory illness.



Examples of negative and positive pressure CBRN APERs
Photos courtesy of Honeywell Safety Products USA Inc., and ILC Dover Inc., respectively

Limitations of CBRN APERs

The following performance limitations are important to consider before purchase or use of CBRN APERs.

- CBRN APERs are not for use in an oxygen deficient environment; the wearer could suffocate.
- Unless specified for dual use, CBRN APERs are not for use in escaping a fire. The filters are not effective for carbon monoxide and could become clogged by smoke particles. Also, the hood may not be heat resistant.
- Filters may become overloaded in high CBRN contaminant concentrations. Their capacity depends on the contaminant concentration and how hard the wearer is breathing.
- CBRN APERs must be stored in the manufacturer-specified minimum packaging configuration, which typically includes an airtight filter package that must remain intact until needed for use. Even if sealed, the filters have a finite shelf life, typically 5 years.
- Performance can vary among users. Small or large necks may be hard to fit. Hoods can be difficult to don and wear with glasses and may become fogged due to perspiration or condensation. Vision and speech may be restricted.

- Improper use of CBRN APERs could result in injury or death from the respirator itself. Safe use requires training and practice.
- CBRN APERs are intended for escape only and not for responder operational use involving entry into dangerous atmospheres.

Standards and Certification Testing

The U.S. Centers for Disease Control and Prevention (CDC), National Institute for Occupational Safety and Health (NIOSH) has published a performance test standard for CBRN APERs. The standard includes tests for 10 chemical contaminants, such as organic vapors, acid gases, ammonia, sarin, sulfur mustard, and a range of particulates. Air-purifying escape respirators submitted for certification for carbon monoxide protection are also subject to flammability and heat resistance tests. Environmental and durability tests evaluate the product's storage package. Other tests cover field of view, fogging, and donning time. In a category called practical performance, trained users evaluate human interface components, such as the use of mouth bits and nose clips, the hood seal around the neck, and the strength required to don.

APERs submitted voluntarily by manufacturers are tested by the NIOSH National Personal Protective Technology Laboratory (NPPTL). Products that meet the standard requirements receive a Testing and Certification (TC) approval number and a capacity level of protection rating of 15, 30, 45, or 60 minutes. A list of certified CBRN APER equipment is posted at the NPPTL Certified Equipment List (CEL) website. <http://www.cdc.gov/niosh/npptl/topics/respirators/CEL/default.html>

References

What's special about Chemical, Biological, Radiological, and Nuclear (CBRN) air-purifying respirators (APR¹)?

<http://www.cdc.gov/niosh/topics/respirators/>

What You Should Know in Deciding Whether to Buy Escape Hoods, Gas Masks, or other Respirators for Preparedness at Home and Work

<http://www.cdc.gov/niosh/topics/respirators/>

General Respiratory Protection Guidance for Employers and Workers

<https://www.osha.gov/SLTC/respiratoryprotection/guidance.html>

¹ APERs are a subcategory of APRs, intended for use during escape only.