SCBA Information – Quick Tips

A self-contained breathing apparatus (SCBA) is a type of respirator that contains breathable compressed air. They are used by firefighters and by others who may be working in areas filled with smoke, toxic gas or other contaminants that are immediately dangerous to life and health (IDLH). There are a number of types of SCBAs. This document will focus, primarily, on open circuit, positive pressure-demand SCBAs. This is the type worn by firefighters and the most commonly used SCBA.

With a purchase price generally well above a thousand dollars, a positive pressure-demand SCBA respirator represents a substantial financial investment. Before purchasing a respirator of any type, decisions must be made to ensure that the selected respirator is appropriate for the intended use. The type of application, the duration of the application and the anticipated frequency of use are all variables that must be evaluated before purchasing an SCBA.

In the hierarchy of respiratory protection, SCBAs provide the highest level of protection available. They afford protection for environments that are oxygen deficient and/or contain levels of containments that meet or exceed IDLH concentrations. The wearer is independent of the surrounding atmosphere because he or she is breathing with a system that is portable and admits no potentially contaminated, outside air.

Type of Application

When it comes to choosing an SCBA, the intended application for the product must first be considered. If the SCBA will be used for firefighting purposes, then a National Fire Protection Association (NFPA) 1981 compliant unit is necessary. If firefighting is not the application, then a National Institute for Occupational Safety and Health (NIOSH) compliant industrial SCBA may be most appropriate.

Industrial SCBAs

For applications other than firefighting, non-NFPA compliant industrial SCBAs are a more economical alternative. A NIOSH compliant industrial SCBA is appropriate for confined space applications, applications where the levels of contaminants exceed the IDLH concentrations, situations where the contaminant(s) and/or the contaminants' concentration are unknown and oxygen deficient (oxygen concentrations below 19.5%) environments.

NFPA 1981

NFPA 1981: Standard On Open-Circuit Self-Contained Breathing Apparatus (SCBA) For

Emergency Services defines the design and performance requirements for SCBAs intended for firefighters. The standard has been updated roughly every five years since it was originally published back in 1981. It contains testing and material component requirements for SCBAs to ensure the units will withstand the environments in which firefighters may be required to perform. All NFPA compliant SCBAs also meet the NIOSH requirements for basic industrial SCBA protection.

An update to the NFPA 1981 standard occurred in 2013. The most notable changes in this update included:

- Increased lens durability and integrity high temperature testing
- New voice intelligibility requirements
- Changes to end-of-service time indicator
- Established minimum performance and approval requirements for emergency breathing support systems
- Update to the intrinsic safety requirements

Other changes in the 1997 and 2002 revisions of the NFPA standard include requirements for redundant low pressure warning devices, heads up display (HUD) or a visual signal signifying the amount of an air cylinder’s rated capacity present and the RIC Universal Air Coupling. In the 2007 revision, the focus turned to electronics. Stricter testing methods were passed to improve the performance and sustainability of electronic components of the SCBA. Another significant change in that edition was a requirement that mandated all SCBAs for emergency services personnel also be certified by NIOSH as chemical, biological, radiological and nuclear (CBRN) approved. The tragic events of 9/11 spurred NIOSH to establish testing and performance criteria for SCBAs intended for emergency personnel responding to CBRN agents.

Length of Application

Another important point to take into consideration when selecting a SCBA is the amount of time the SCBA-required task will take. NIOSH approved SCBAs are available with supply tanks capable of providing 30, 45, 60 or 75-minutes of breathing air. Unless there is a need for a 45, 60 or 75-minute supply of breathing air, the 30-minute systems offer the advantages of cost and comfort. Because the air supply tanks are generally smaller, they’re typically less expensive and pack fewer pounds than the longer duration units. Even two pounds of extra weight can make a dramatic difference in comfort when it comes to strapping on an SCBA to complete a task.

A NIOSH approved SCBA should not be confused with NIOSH approved egress or escape units. While both systems incorporate tanks of breathable air, egress units provide air for a shorter duration, typically either five or 10 minutes and are intended strictly for escaping from a toxic or oxygen deficient environment. Unlike egress units, SCBAs are approved for **entering** toxic or oxygen deficient environments.

Frequency of the Application

Comfort also comes into play when considering how often the SCBA-required task occurs. If the SCBA is only used in an emergency situation, such as shutting down a leaking valve or performing unexpected maintenance in a confined space, then comfort would not be as crucial as it would be in situations where the SCBA is used on a regular basis. If a SCBA is used regularly, wearer comfort becomes a top priority. With SCBAs, greater comfort generally equates to less weight.

Two methods are used to reduce the weight of SCBAs. Both involve the SCBA cylinders. Manufacturers either reduce the weight of the cylinders by making them out of lighter

materials or by packing more air into smaller cylinders; sometimes they combine both techniques.

Cylinder Materials

Originally SCBA cylinders were manufactured from steel. To reduce cylinder weight, aluminum became the material of choice for cylinders. Eventually manufacturers began to combine synthetic materials with aluminum to reduce the weight even further. These cylinders are generally referred to as composite cylinders. Within the composite category, there are hoop-wrapped and fully wrapped cylinders. In more recent times, Kevlar® and carbon fiber cylinders have been developed. Carbon fiber cylinders are the latest and lightest in the evolution of SCBA cylinders. As the weight of the cylinder decreases, the cost of the SCBA generally increases.

The lighter weight cylinders also have a shorter service life and require more frequent hydrostatic testing than their aluminum counterparts. All SCBA cylinders require periodic testing. The frequency of the maintenance depends upon the cylinder material. For more information regarding hydrostatic testing and service life of SCBA cylinders see Quick Tips #307: SCBA Cylinder Hydrostatic Testing. Many fire departments and some self-contained underwater breathing apparatus (SCUBA) dive shops have the equipment and trained personnel to perform the hydrostatic testing on SCBA cylinders. The SCBA manufacturer, or the distributor it was purchased through, should be able to direct you to a test facility in your area.

High Pressure versus Low Pressure

The other method of making SCBAs lighter is to pack a larger volume of air into a smaller cylinder. There are three pressure options available: high-pressure SCBA cylinders that are pressurized to either 4,500 or 5,500 pounds per square inch (PSI), medium-pressure cylinders that are pressurized to 3,000 PSI and low-pressure cylinders that are pressurized to 2,216 PSI. Of the three classes, high-pressure and low-pressure are the most common options for SCBAs. Medium-pressure cylinders are most commonly used for scuba diving.

The 45, 60 and 75-minute SCBAs use high-pressure cylinders exclusively. The high-pressure is required in order to provide 45 plus minutes of breathing air in a tank that can be worn with relative comfort. 30-minute SCBAs are available in either high or low-pressure. The advantage of a high-pressure 30-minute SCBA is that it’s smaller and lighter, than a 30-minute low-pressure SCBA. The disadvantage of the high-pressure 30-minute system is that it’s more expensive than its low-pressure counterpart.

Refilling is another drawback to high-pressure systems. It’s a bit more difficult to locate a facility capable of refilling the high-pressure tanks. Local fire departments are the best bet when it comes to the high-pressure tanks; low-pressure tanks can typically be refilled at dive shops or your local fire department.

Other Types of SCBAs: A Brief Overview

This document has focused on positive pressure-demand SCBAs because they’re the most commonly used. In its Guide to Industrial Respiratory Protection, NIOSH identifies three other basic types of SCBA: demand SCBAs, oxygen-cylinder rebreathers and self-generating type SCBAs.

Like positive pressure-demand SCBAs, **demand SCBAs** are open circuit systems. Demand SCBAs do not incorporate constantly pressurized facepieces like positive pressure-demand SCBAs. Because of this, demand SCBAs can potentially experience an inward

leakage of contaminants into the facepiece. This leakage can compromise the safety of the wearer.

Oxygen-cylinder rebreathers are closed circuit SCBAs. Closed circuit systems essentially recycle the wearer's exhaled breathing air to help generate additional breathing air capacity for the wearer. Oxygen-cylinder rebreathers use a relatively small cylinder of compressed oxygen, reducing and regulating valves, a breathing bag, facepiece and chemical container to remove carbon dioxide from the exhaled breath of the wearer. Oxygen-cylinder rebreathers are approved by NIOSH for 45 minutes, one-hour, two-hours, three-hours or four-hours of protection.

Another closed circuit system, self-generating type SCBAs are similar to oxygen rebreathers except they do not include an oxygen cylinder. The supply of oxygen for the wearers breathing air comes solely from the chemical container in the system. The container takes the exhaled breath and moisture and separates out the oxygen, which goes into the breathing bag and then the facepiece.

Commonly Asked Questions

Q: Do positive pressure-demand SCBAs require annual fit testing?

A: Yes. The Occupational Safety and Health Administration's (OSHA's) Respiratory Protection Standard (29 Code of Federal Regulations 1910.134) states that employers shall ensure that an employee using a tight-fitting facepiece respirator is fit tested prior to the initial use of the respirator, whenever a different respirator facepiece (size, style, model or make) is used, and at least annually thereafter. OSHA requires this for both negative and positive pressure tight-fitting facepieces. For more information on fit testing see Quick Tips #140, Respirator Fit Testing Requirements and Procedures.

Sources

NIOSH Respiratory Protection Resource Page

NIOSH Guide To Industrial Respiratory Protection

NFPA 1981: Standard On Open-Circuit Self-Contained Breathing Apparatus (SCBA) For Emergency Services