Self-contained breathing apparatus

Toronto firefighter wearing an SCBA

A **self contained breathing apparatus**, or **SCBA**, sometimes referred to as a **Compressed Air Breathing Apparatus (CABA)**, **air pack**, or simply **Breathing Apparatus (BA)** is a device worn by rescue workers, firefighters, and others to provide breathable air in an **IDLH** (Immediate Danger to Life and Health) Atmosphere. When not used underwater, they are sometimes called **industrial breathing sets**. The term "self-contained" means that the breathing set is not dependent on a remote supply (*e.g.*, through a long hose). If designed for use under water, it is called SCUBA (self-contained *underwater* breathing apparatus).

An SCBA typically has three main components: a high-pressure tank (*e.g.*, 2200 psi to 4500 psi), a pressure regulator, and an inhalation connection (mouthpiece, mouth mask or face mask), connected together and mounted to a carrying frame.

There are two kinds of SCBA: open circuit and closed circuit.

Closed-circuit SCBAs

Siebe Gorman Savox in a coalmining museum

The closed-circuit type filters, supplements, and recirculates exhaled gas: see rebreather for more information. It is used when a longer-duration supply of breathing gas is needed, such as in mine rescue and in long tunnels, and going through passages too narrow for a big open-circuit air cylinder. Before open-circuit SCBA's were developed, most industrial breathing sets were rebreathers, such as the Siebe Gorman Proto, Siebe Gorman Savox, or Siebe Gorman Salvus. An example of modern rebreather SCBAs would be the SEFA. Rebreathers used underwater have the advantage of not releasing tell-tale bubbles, making it more difficult to detect divers involved in covert operations (see frogman).

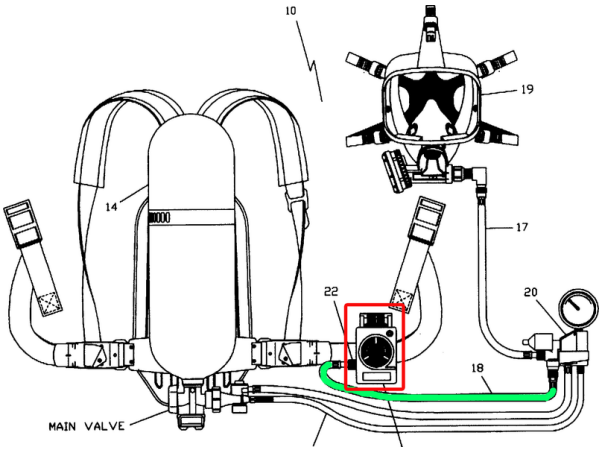
Open-circuit

A person wearing an MSA Brand breathing mask with a Nomex hood on. This face piece attaches with a regulator to form a full SCBA.

SCBA packs carried on a rack in a firetruck

Open-circuit industrial breathing sets are filled with filtered, compressed air, rather than pure oxygen. Typical open-circuit systems have two regulators; a first stage to reduce the pressure of air to allow it to be carried to the mask, and a second stage regulator to reduce it even further to a level just above standard atmospheric pressure. This air is then fed to the mask via either a demand valve (activating only on inhalation) or a continuous positive pressure valve (providing constant airflow to the mask).

An open-circuit rescue or firefighter SCBA has a fullface mask, regulator, air cylinder, cylinder pressure gauge, and a harness with adjustable shoulder straps and waist belt which lets it be worn on the back. The air cylinder usually comes in one of three standard sizes: 4 liter, 6 liter, or 6.8 liter. The duration of the cylinder can be calculated to Size of cylinder X Pressure / by 40 and then less 10 minutes because of a safety margin. so a 6 liter cylinder, of 300bar, is 6 X 300 / 40 - 10 = 35minutes working duration The relative fitness, and especially the level of exertion of the wearer, often results in variations of the actual usable time that the SCBA can provide air, often reducing the working time by 25% to 50%.



SCBA apparatus with PASS device (ADSU).

Air cylinders are made of aluminium, steel, or of a composite construction (usually carbon-fiber wrapped.) The composite cylinders are the lightest in weight and are therefore preferred by fire departments (UK: fire brigades), but they also have the shortest lifespan and must be taken out of service after 15 years. Air cylinders must be hydrostatically tested every 3 years for composite cylinders, and every 5 years for metal cylinders. During extended operations, empty air cylinders can be quickly replaced with fresh ones and then refilled from larger tanks in a cascade storage system or from an air compressor brought to the scene.

Fullface masks

The fullface masks of breathing apparatus designed for use out of water are sometimes designed in a way that makes them unsuitable for scuba diving, although some may allow emergency very shallow submersion:

- The seal at the edge of the mask is a wide tube with thin very flexible walls running all round the edge of the mask, full of air at atmospheric pressure. On the surface it squashes against the wearer's face's edges, causing a good seal despite small variations in head shape. At more than a few feet depth pressure (underwater or in a caisson) this tube collapses, destroying the seal and making the mask leak massively.
- Curved window which underwater would severely distort the image by refraction.

The mask may have a big fullface window, or small eye windows.

The mask may have a small mouth-and-nose (ori-nasal breathing mask inside, reducing breathing deadspace.

- Link to image and description of a negative-pressure fullface mask [1]

The mask may incorporate a two-way radio communicator.

- See also Full face diving mask

Some old industrial rebreathers (e.g. the Siebe Gorman Proto) had a mouthpiece and attached noseclip instead.

Positive pressure (preventing inward leaking)

Open circuit SCBAs utilize either "positive pressure" or "negative pressure" operation.

- A "negative pressure" SCBA may be used with a type of fullface mask which could be used as a gasmask (with a filter canister on the facepiece's air inlet) or with an open-circuit breathing set connected to the air inlet. Air is delivered to the wearer when he breathes in, or in other words, reduces the pressure in the mask to less than outside pressure, hence the name "negative pressure". The limitations of this are obvious, as any leaks in the device or the interface between the mask and the face of the wearer (caused for example by small face skin wrinkles) would reduce the protection offered.
- "Positive pressure" SCBA addresses this limitation. By careful design, the device is set to maintain a small pressure inside the facepiece. Although the pressure drops when the wearer breathes in, the device always maintains a higher pressure inside the mask than outside of the mask. Thus, even if the mask leaks slightly, there is a flow of clean air out of the device, automatically preventing inward leakage under most circumstances. Although the performance of both types of SCBA may be similar under optimum conditions, this "fail safe" behaviour makes a "Positive pressure" SCBA preferable for most applications. As there is usually no air usage penalty in providing positive pressure, the older "Negative pressure" type is, in most cases, an obsolete configuration and is only seen with older equipment.

Types of use

There are two major application areas for SCBA, fire fighting, and industrial use.

For fire fighting, the design emphasis is on heat and flame resistance above cost. SCBA designed for fire fighting tend to be expensive because of the exotic materials used to provide the flame resistance and to a lesser extent, to reduce the weight penalty on the fire fighter. In addition, modern firefighting SCBAs incorporate a PASS device (Personal Alert Safety System) or an ADSU (Automatic Distress Signal Unit) into their design. These units emit distinctive high pitched alarm tones to help locate firefighters in distress by automatically activating if movement is not sensed for a certain length of time (typically between 15 and 30 seconds), also allowing for manual activation should the need arise. In firefighting use, the layout of his breathing set should not interfere with ability to carry a rescued person over his shoulders.

The other major application is for industrial users of various types. Historically, mining was an important area, and in Europe this is still reflected by limitations on use in the construction of SCBAs of metals that can cause sparks.

Other important users are petrochemical, chemical, and nuclear industries. The design emphasis for industrial users depends on the precise application and extends from the bottom end which is cost critical, to the most severe environments where the SCBA is one part of an integrated protective environment which includes gas tight suits for whole body protection and ease of decontamination. Industrial users will often be supplied with air via an air line, and only carry compressed air for escape or decontamination purposes.

Safety specifications

In the United States and Canada, SCBAs used in firefighting must meet guidelines established by the National Fire Protection Association, NFPA Standard 1981. If an SCBA is labeled as "1981 NFPA compliant", it is designed for firefighting. The current version of the standard was published in 2007. These standards are revised every five years. Similarly, the National Institute for Occupational Safety and Health (NIOSH) has a certification program for SCBA that are intended to be used in chemical, biological, radiological, and nuclear (CBRN) environments. See NIOSH Approved SCBAs [2].

Any SCBA supplied for use in Europe must comply with the requirements of the Personal Protective Equipment Directive (89/686/EEC). In practice this usually means that the SCBA must comply with the requirements of the European Standard EN 137 : 2006. This includes detailed requirements for the performance of the SCBA, the marking required, and the information to be provided to the user. Two classes of SCBA are recognised, Type 1 for industrial use and Type 2 for fire fighting. Any SCBA conforming to this standard will have been verified to reliably operate and protect the user from -30°C to +60°C under a wide range of severe simulated operational conditions.

The Royal Australian Navy uses the **Open Circuit Compressed Air Breathing Apparatus (OCCABA)**, a backpack-style, positive pressure breathing apparatus, for fire-fighting roles.

Types

Among the leading manufacturers of SCBA for the USA fire service are:

- Avon-ISI [3]
- MSA Fire [4]
- Draeger
- Survivair [5]
- Interspiro [6]
- Scott Health and Safety [7]
- ISI (International Safety Instruments [8]).

Among the leading manufacturers of SCBA for the European fire service and industrial safety:

- Spasciani [9]
- Interspiro [6]
- MSA [10]
- Draeger

Siebe Gorman produced these makes of open-circuit SCBA units:

- Airmaster MK 1 (blue back plate)
- Airmaster MK 2 (chrome plated back plate)
- Firefighter
- Specials for the armed forces

Also known as

In Australia different firefighting agencies refer to SCBA by different acronyms in general terms. For example:

- The New South Wales Rural Fire Service calls it CABA, Compressed Air Breathing Apparatus.
- The New South Wales Fire Brigades and Queensland Fire and Rescue Service call it BA, Breathing Apparatus.

All these initials mean the same type of open-circuit equipment.

An SCBA unit may also be referred to as a "Scott Pack", deriving the name of the Scott company that manufactures many SCBAs.

In New Zealand, SCBA is generally referred to by New Zealand Fire Service personnel as BA, Breathing Apparatus.

Volunteer fire fighter exiting live burn structure wearing NIOSH-certified SCBA, NFPA compliant turn-out gear, and holding pike

See also

- Glossary of firefighting terms
- PASS device (= Personal Alert Safety System), also known as ADSU (Automatic Distress Signal Unit) - which is often integrated into an SCBA system
- Oxygen mask
- STAS - *short-term air supply* for self-rescue
- SCUBA - Self-Contained Underwater Breathing Apparatus

External links

- BioPak 240R Revolution [11] - make a 4-hour-duration rebreather (commercial site)
- These references are related to NIOSH-certified SCBA with chemical, biological, radiological, and nuclear (CBRN) protection (SC/PD/CBRN):
  - CBRN SCBA interim user guide and list of approved CBRN SCBA [2]
  - CBRN SCBA standard development and publication leading to the first NIOSH-Certified SCBA with CBRN protection offered by the US DHHS/CDC/NIOSH/NPPTL on June 3, 2002 [12]
  - Image of 2-cylinder open-circuit SCBA [13]

References

[1] http://www.arle.nl/fm53.php
[2] http://www.cdc.gov/niosh/npptl/topics/respirators/cbrnapproved/scba/
[3] http://www.Avon-Fire.com
[4] http://www.msafire.com/catalog/catalog518.html
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