The ideal breathing technique for firefighters on the fireground

When it comes to breathing in firefighting it is not easy to obtain the correct information. You can find general indications with ease but they fail to be specific for rescue activities. That's because breathing with a BA is not the same. There are a few significant differences that modify physical responses of the users, who therefore have to absolutely change their behaviour, i.e. the way they breathe.

Here are some of the main differences:

- **Limited air supply**. Cylinders provide us with a specific amount of air that is going to be finished and thus must be exploited and not wasted.
- **Increase of about 33% in energy expenditure**. By analysing the combined effects of the BA and the PPE EN 469, Sykes[1] observed an increase of about 33% in energy expenditure.
- **Increase in oxygen uptake, heart rate and air consumption.** Borghols et al.[2] analysed how carrying heavy weights on the back influences the cardiorespiratory function. This study measured O_2 uptake, heart rate and pulmonary ventilation. The authors reported they observed minimal variations when at rest and still. The results are very different in case of walking or climbing a ladder. It was found that each kilogram carried weight increases:
    - O_2 uptake by 0.03 l/min;
    - HR by 1.1 bpm;
    - PV by 0.6 l/min.

Now consider that the PEEs and the BA together can reach a weight of up to 25 kg…

These three points alone make us understand how important it is to learn the correct breathing technique to employ when we use the BA so that we exploit every single litre of air that is contained in the cylinder and we don't simply let it "come through" the exhalation valve.

Established therefore that we have to keep in mind the differences, we should answer a fundamental question: why do we have to breathe?

We have to breathe in order to constantly supply one of the reagents of the reaction upon which life is based: cellular respiration.

Respiration

Physiologically speaking, respiration refers to both external and internal (or cellular) respiration.

External respiration is the process responsible for maintaining the right ratio between oxygen (O_2) and carbon dioxide (CO_2) in the cells.

Cellular respiration is needed to transform nutrients into energy.

In order to transform the energy of nutrients, cells carry out cellular respiration. Cellular respiration is an exothermic redox process that consists of a series of reactions.

[1] Sykes K (1993). Comparison of conventional and light BA cylinders. *Fire International* 140, Sept, 23-24;

[2] Borghols EAM, Dresen MHW, Hollander AP (1978). Influence of heavy weight carrying on the respiratory system during exercise. EurJAppl Physiol 38:161-169

Energy production requires a continuous supply of oxygen and creates carbon dioxide.

The importance of CO_2

A high level of CO_2 is a sign of increased cellular activity and therefore of a higher need for oxygen.

This is why the rhythm and depth of breath intensify.

Our receptors often have a very low level of tolerance to CO_2 concentration and as a result the efficiency of the exchanges between oxygen and carbon dioxide decreases.

Once introduced into our lungs, oxygen has to get into blood and then has to be absorbed by the cells of the tissues in all our organs.

The presence of CO_2 helps the release of oxygen from haemoglobin to the cells of tissues.[3]

The shortage of carbon dioxide, which our low tolerance level made us eliminate, prevents the correct passage of oxygen to our tissues.

Thus, carbon dioxide is not only a waste product but it is essential to allow the passage of oxygen from blood to cells.

In which situation can we work at our best?

1. When we have a high level of CO_2 tolerance;
2. When we activate our respiratory centre in such a way that by unloading the CO_2 in excess it can reduce our heart rate.

That seems impossible to achieve. The greatest efficiency is reached when our body tolerates high CO_2 levels, which fosters the release of oxygen from blood to tissues. Yet at the same time you should foster the exhalation phase in order to unload the CO_2 produced and consequently reduce the heart rate.

Yet in which situation are we more likely to find ourselves?

1. When we have a low level of CO_2 tolerance;
2. When we hyperventilate because of the prevalence of inhalation on exhalation.

What does this entail?

The result is a chain reaction which makes sure that CO_2 is eliminated before it reaches optimal values.

When working on the fireground with a BA, if this circle is not interrupted it leads us to “throw away” the entire air supply available.

This is an aspect we must keep into account properly. It means that in case of an effort that involves an increase in breaths, we have to act on the depth and efficacy of the exhalation phase in order to reduce the heart rate.

More O_2 to accomplish our work, poor tolerance to CO_2 = hyperventilation.

But what does “hyperventilate” mean? Rather than “breathing too much”, it means breathing in a way that is excessive and not adequate for the needs of our body. The breathing technique that would be adequate during physical activity (when the body produces an amount of CO_2 that must been in part eliminated) is excessive and harmful if you are not doing an intense physical activity (for example when firefighters get an

[3] http://www.pathwaymedicine.org/bohr-effect

alarm). In this case the body reacts according to a primal instinct, the so-called fight or flight response. It is as if you were standing in front of a danger that is going to require intense physical activity and this triggers the impulse to breathe a lot in view of an activity which instead doesn't occur (because maybe it is only a false alarm). The frequency of these daily stress events leads to a phase shift in the breathing rhythm which becomes permanently a little more intense than needed, also when sleeping.

Breathing techniques that help to conserve air

We have established that **for our health and for our and other people's safety** we **must** optimise our respiration when using a BA. So here are several techniques (according to my experience as instructor and firefighter) to employ depending on the physical effort and the working conditions we will face:

1) **In through the nose – Out through the nose.** The breathing technique that allows to maximize respiratory efficiency.

   It consists of:

   - Breathing in normally through the nose;
   - Breathing out normally through the nose;

   Breathing in through the nose helps:

   1. Increase air humidity;
   2. Increase air temperature;
   3. Foster diaphragmatic breathing. In turn, the use of diaphragm:
      i) Allows a deeper breathing involving the most vascularized part of the bronchi;
      ii) Requires less energy. The movement of the diaphragm doesn't cause any other part of the body to move in contrast with chest breathing (when chest moves outwards and head upwards)
      iii) Reduces the possibilities of shortness of breath, which is the major danger for those who use BAs.
      iv) Fosters a deeper breathing. This entails a decrease in heart rate and an increase in fatigue resistance, which is an important aspect on the fireground;
      v) Delivers a higher amount of blood to the inferior organs.

   Breathing out through the nose helps:

   1. Reduce the amount of CO_2 dispersed because of exhalation;
   2. Reduce the amount of water dispersed. Because of the firefighter PPE, the sweat produced by our body can not evaporate and this makes thermoregulation inefficient. It is essential to keep high levels of body's hydration. Breathing out through the nose reduces by half the amount of water expelled when compared to using the mouth.

Always employing this technique allows to meet two different goals:

- Short-term goal. It is the technique that allows the best efficiency of air consumption and energy production;
- Long-term goal. It gets the body used to higher level of CO_2. Little by little the level of CO_2 tolerance rises.

When it is not enough to breathe only through the nose you have two possibilities. The first one is to reduce your workload. It would often be sufficient to simply slow down and maintain high levels of respiratory efficiency. If this is not possible you can change breathing technique.

2) **In through the nose – Out through the mouth.** Known as R-EBT. This technique has been developed by KEVIN J. REILLY[4];

R-EBT stands for **R**eilly **E**mergency **B**reathing **T**echnique

It consists of:

- Breathing in normally through the nose;
- Breathing out through the mouth, partially opening it, and extending the exhalation.

As you can see nothing complicated is required. What is distinctive about this technique is the fact that you breathe in through the nose and out through the mouth. By partially opening your mouth you extend the exhalation phase.

The advantages of breathing in through the nose are the same as the previous technique. Opening the mouth to breathe out allows to decrease the level of CO_2, which would otherwise force our body to increase the respiratory rate.

Therefore, in order to react to a higher workload that doesn't let us maintain the optimal breathing technique (nose-nose) you can extend the duration of the exhalation phase by using your mouth.

3) **In through the nose – Out through the mouth, in case of emergency.** Skip breathing.

It consists of:

- Breathing in normally through the nose;
- Taking a short pause (it must not be stressful)
- Breathing in normally through the nose;
- Taking a short pause (it must not be stressful)
- Breathing out through the mouth, partially opening it, and extending the exhalation.

It must be clear that it can only be used in case of emergency. It has to be the extreme solution.

It consists of breathing in and holding the breath. When you feel you need to breathe out you take another breath in and then you exhale slowly. After breathing out you have to hold your breath again until you feel the need to breathe. Yet you must not hold your breath until you feel uncomfortable. The length of the pause varies from person to person.

You may ask yourself: "Why can't I employ this technique every time I use a BA?" Because the one and only purpose of this technique is to be a "lifesaving tool" and not a method to improve work performances. Even if the technique is relatively simple, the mental concentration needed is considerable.

Conclusions

There are not many skills to be known and practiced in "peace time". Improvising must not be a choice but only the consequence of an imponderable event.

Being aware of what working with a BA on the fireground means is the best weapon a firefighter can have.

[4] http://www.fireengineering.com/articles/print/volume-161/issue-4/features/rethinking-emergency-air-management-the-reilly-emergency-breathing-technique.html