SCUBA DIVING AT THE AIR FORCE OFFICER SCHOOL

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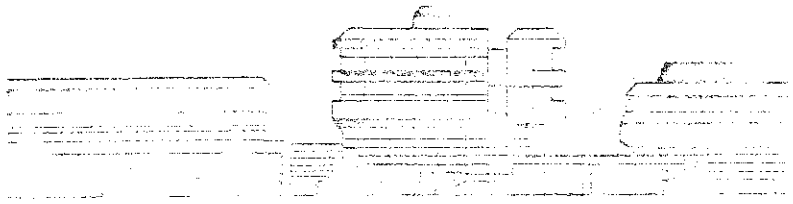
- The participation in diving courses at the Air Force Officer School is regulated by the order of 02 January 1993.
- The objective of the course is to learn scuba diving so that it can be performed without risk of one's own life or others.
- The training is free of charge. Hiring of the entire diving equipment will be the trainee's responsibility (air diving apparatus including filling, breathing control with inflator and finimeter, diving computer, underwater compass, stabilising jacket, wet suit, lead, fins, mask, snorkel).
- The training will be carried out in accordance with the guidelines of the Association of German Scuba Divers (VDST), member of the world association CMAS (Conseil Mondial des Aquanautes Sportifs).
- There are other numerous clubs and associations that offer diving courses and issue certificates such as VIT, VDTL, VETL, PADI, SSI, ANIS, BARACUDA CLUB, ACUC, RSTC etc. The training guidelines, however, are basically the same. The certificate of the Air Force Officer School is issued free of charge together with the diving certificate, log book and cheek card. CMAS Bronze* may be issued on request. The certificate issued by CMAS is subject to costs.

The training will comprise:

- Pertinent theoretical portions of the sports instructor training
- the German Lifesaving Badge (also a requirement)
- Training in sports swimming

Having successfully completed the above training, the participant will receive

1. the **Basic Diving Certificate** in the indoor swimming course



2. the **CMAS Bronze***, a new training cycle after the Basic Diving Certificate consisting of additional free-water diving runs which can be carried out with the Basic Diving Certificate any time during vacation at a diving school by the trainee himself (also means correct diving). This is strongly recommended, since our domestic waters are only partly suitable for training due to cold temperatures and poor visibility. It must be ensured that the diving sports fitness is confirmed in the diving certificate.

In general, it must be noted that as to scuba diving statutory regulations have not yet been established. This means that anyone can purchase scuba diving equipment and exercise diving sports and found clubs and associations.

Breathing under Water

There is hardly any other sports discipline that offers such an easy start as scuba diving. According to the principle from „easy to difficult", training does no longer start with mask, fins and snorkel, but right away with an air diving apparatus.

However, the newcomer must know the following:
- a symbol for the pressure in the water,
- direct pressure effects and practical consequences,
- handling of the air diving apparatus and breathing control
- observance of initial safety regulations and diving sports fitness.

Basics Part I:

1. **Pressure effects on air-filled spaces**

At the water surface the normal atmospheric pressure prevails to which we are used.
At a depth of 10 m the pressure has already doubled. The pressure increases by 1 atmosphere above atmosperhic pressure per 10 m of depth:

0 m	1 bar		
		-> 1st doubling of pressure	101
10 m	2 bar		
20 m	3 bar		
		-> 2nd doubling of pressure	51
30 m	4 bar		
40 m	5 bar		
50 m	6 mar	-> 3rd doubling of pressure	2,5 l
60 m	7 bar		
70 m	8 bar		

Figure 1: Pressure in the Water

We can illustrate all effects of the pressure on air-filled spaces in our body by a simple symbol, i.e. a balloon.

P + V = Const.

Boyle's Law

Let us fill a balloon with a volume of five litres. This could be equal to the volume of a man's lungs. It contains normal air with a composition (more precise details are not important for the moment of:

80 % nitrogen and 20 % oxygen

To fill the balloon, we blow the contents of our lungs (5 litres) into the balloon and imagine that it would now contain five molecules of air. Now we dive to a depth of 10 m and observe the balloon. According to the law: double pressure - half the volume, the balloon is only half as big. The lungs of scuba diver also function according to this law (Fig. left).

If we dive with an air diving apparatus and breathe from the breathing control, we are filling the lungs (balloon) at the water surface with five litres of air as well.

However, at a depth of 10 m, twice as much air streams from the breathing control (demand apparatus), i.e. 10 l. We just imagine that 10 air molecules would now be in there. The lungs (balloon) now have the normal size, because the internal pressure and the external pressure is equal.

Figure 2: Scuba diver

Figure 3: Free diver

The consequences from this insight are of greatest importance to diving sports. The life of an untrained diver would now be in danger.

Consequences:

Avoid accidents! Active pressure equalisation

Never stop breathing during ascent!

1.1 Lung Excess Pressure-Danger for Inexperienced Persons

If the diver would „shoot up" in panic form a depth of 10 m to the surface with his mouth closes, the volume of his lungs (balloon) would have to be 10 l. No lungs could withstand this load, and an accident due to lung excess pressure would be the result.

Figure 4: Accident due to lung excess pressure

What may be dangerous to the life of an untrained diver, is a „life insurance" for the trained diver. However, for the time being, this phenomenon is negligible during all normal diving runs with an air diving apparatus, since the diver permanently breathes in and out; the volume of the lungs corresponds to the respective pressure.

Never Stop Breathing!

But let us now consider a hypothetical dramatic case:

If, for instance, the breathing control fails at a depth of 30 m, (four bars - quadruple pressure), the trained diver has three options:

1. „Use the spare control" (ready at hand in front of this chest) -" gee, I forgot it";
2. „Use the diving partner's demand apparatus" (alternate breathing) „the guy has gone"
3. „Ascend with open mouth and call; uuuuup (to the surface)

With the „emergency ascent" as the last resort, the diver will return to the surface ever from a greater depth without harm for the moment, provided he exhales continuously („uuuup is easy to remember"). After all, his lungs have to bear four times the normal pressure. The probability that the breathing control fails, the spare control is not available and the diving partner has disappeared is extremely low in practice. Nevertheless, it is good to know that a remedy is available if the worst comes to the worst.

1.2 Pressure Equalisation in the Middle Ear

If you dive with an air diving apparatus and can breathe under water, you suddenly develop a feeling for the pressure on the eardrum. If you take a header into the water or if you only occasionally submerge as a swimmer, this distinct feeling is missing. The reason for this is that the hierarchic organisation of our body mainly reacts to the lack of air. Being forced to breathe makes us think of nothing else but to ascend to the surface. But now, not having to breathe, the pain felt at the eardrum can normally not be ignored. To avoid this pain from the very beginning (important), the pressure must be equalised. With the eustachian tube (Figure), we have a pressure relief valve, so to speak. You hold your nose and try to blow it. Since air cannot escape from the nose, it will stream through the „valve" from inside to the eardrum and puts it straight. The pressure is equalised.

Figure 5: Pressure equalisation in the middle ear

1. „Hold nose and blow"
2. Normal
3. During Ascent
4. During Descent

The pressure must be constantly equalised during descent. The decisive factor is:

There must be no pain. If you feel the pressure, you have to ascend a little bit to equalise the pressure. In a normal swimming-pool with a water depth of up to 4.50 m, this equalisation process has to be carried out twice. In other words, you have to take your time. In free waters, many inexperienced divers today have to be blamed for getting problems with their ears. In most cases because they descend too quickly and do not take their time for the proper pressure equalisation. As a newcomer you do not have to succeed right away. Cracking or whistling are quite normal sounds that everybody will hear in himself. Everything will become flexible by frequent exercises. Pressure equalisation will occur almost automatically. With many divers swallowing will do to activate the „valve".

Bear in mind:

- **Never equalise pressure by force**
- **When suffering from a cold, diving is forbidden („valve" clogged)**
- **Equalise pressure in time**

1.3 Pressure Equalisation in the Mask

The pressure in the mask remains the same, while the external pressure continuously rises during descent. There is underpressure in the mask which means danger for the eyes. Fine blood vessels may burst and cause hematoma. Therefore, we blow air through the nose into the mask and thus equalise the pressure. This must be done jest as often as the pressure equalisation in the middle ear. Our implementing instruction reads:

Following pressure equalisation in the middle ear:
„Clear nose and blow into mask"

Figure 6: Pressure Equalisation in the Mask

1.4 Pressure Equalisation in the Gastrointestinal Tract

A feeling of fullness and a bloated belly will often occur after meals. Particularly flatulent food such as leguminous vegetables etc. must by all means be avoided. It is advisable after all to refrain from having any meals a sufficient period of time prior to diving. In case of flatulence or meteorism, unrestricted and free evacuation of the bowels must be ensured. Just like the „uuuup" with the mouth during the emergency ascent, the same procedure has to be applied piquantly to the „second mouth". The vulgar but highly effective slogan „all holes open" is used in aviation where identical problems of pressure physics and/or pressure physiology are experienced.

Slightly paraphrasing a colloquial aphorism, one may also say: „Why don't you divers burp or fart, do you want to kill yourselves?

„Avoid flatulent food - all holes open!"

No, thanks

Figure 7: Pressure Equalisation in the Gastrointestinal Tract

Avoid Accidents - Passive Pressure Equalisation

We have chosen the balloon as a symbol for the pressure effects in the water. So far, we had to take an active part in equalising the pressure on air-filled body cavities such as lungs, middle ear and stomach as well as in the mask. We have no access to different air-filled spaces of the body, which means that pressure equalisation must occur by itself.

1.5. Pressure Equalisation in the Sinuses of the Head

1 - Sinuses
2 - Frontal sinuses
3 - Paranasal sinuses
4 - Maxillary sinuses

5 - In case of a cold pressure equalisation
in the sinuses is more difficult so that pain may be the result.

6 - Pressure equalisation in case of a cold (clogged „valve") not possible - diving not allowed.

Figure 8: Sinuses

1.6 Pressure Equalisation in the Case of Poorly Filled Teeth

The pressure equalisation problem in the sinuses can be compared with that of poorly filled teeth. Once pressure equalisation due to a poor filling occurs in a tooth during a diving run, the expanding air will cause damage and pain during ascent. Only precautionary measures are helpful.

1.7 Pressure Equalisation for All Other „Balloons"

For example, tightly fitting hood of the wet suit, watches, goggles etc.

2. General Equipment Features for the First Diving Run

2.1 The Air Diving Apparatus

The air diving apparatus (PTG) contains normal air that was filled in by means of a compressor. There are different sizes Common are air diving apparatuses with a volume of 10 l (water bucket) and 12 l. The filling pressure should be 200 bar. A bicycle tube which gives quite a bang when it bursts - although it only has a pressure of approximately 3 bar - should make us are of the enormous pressure in the air diving apparatus. Not fear, but correct handling of the apparatus is required. However, there is a great safety margin, since they are tested for approximately 300 bar and have a bursting pressure of about 450 - 600. In addition, they must - as every car - pass the technical MOT inspection every two years (except aluminium air diving apparatuses that are inspected at 6-year intervals). If we take off the air diving apparatus, we put it flat on the ground so that so one can bump into it; it is protected from falling.

2.2 The Breathing Control Unit

We draw the air from the air diving apparatus via the breathing control which provides the required quantity of air corresponding to the ambient pressure. The air drawn from the air diving apparatus (200 bar max) is first reduced to a medium pressure of about 10 bar at the high-pressure stage and than adjusted to ambient pressure at the mouth. In order to tightly connect the air diving apparatus with the air control unit, a rubber gasket is required at the thread of the breathing unit - the so-called O-ring which must

- be in place
- fit properly
- be free of damage

2.3 The Finimeter

The pressure indicator is called finimeter. It is connected to the high-pressure piece of the breathing control unit.

2.4 Connection of the Breathing Control Unit

Always use the same procedure for connecting the breathing control unit:

- position yourself „behind" the air diving apparatus
- check the O-ring
- screw on the breathing control unit from the right
- screw on with the pressure of two fingers

1. Medium-pressure hose
2. Inflator hose
3. Mouthpiece
4. Inflator connection
5. High-pressure hose
6. 2nd Stage
7. Bubble deflector
8. Overpressure gage

- open the valve of the air diving apparatus counter-clockwise, at first carefully (if air escapes, you can close it again immediately
- then fully open the valve and screw it back about one turn
- check the air supply and press the air shower button (carefully)
- check the pressure of the air diving apparatus

2.5 Mask and Fins

The diver's mask must be airtight. Put on the mask and make sure that
- no hair are in the mask
- the rim is not bent
- you breathe in slightly with the nose

If you let go the mask and it remains on the face, it fits tight. It should be treated with an anti-mist compound before diving. Spitting into it will also do, but, please, only in the shower.

The fins are put on and taken off only in the water. Walking with fins on land involves the danger of accidents.

2.6 Putting on the Air Diving Apparatus

Put the air diving apparatus on the back with the aid of your diving partner. The straps are adjustable just like those of a good rucksack.
The valve should be just in reach
Now go into the water (chest-deep) and put on the fins. Whoops, your breathing control unit suddenly releases air. No problem - it just reacts to the water pressure when submerging. Try the following:

- put your breathing control unit into the water, mouthpiece upward - air is released
- put it into the water, mouthpiece downward - no air is released

3. Descending - Ascending

Advance Information

Put the mouthpiece in your mouth and first always blow air into the mouthpiece in short deep breaths. This way you make sure that water is blown out. Then you draw in air just like tasting hot soup. In other words, you breathe in carefully, because if there is still water in the mouthpiece, the air must stream over it and you will have to repeat the procedure of blowing out water. If, however, the mouthpieces is „dry", you keep on breathing as usual. Here once again what you always have to do *when you start breathing from the breathing control unit:*

at first **blow**
taste carefully
then **breathe**

Now only submerge your head, take a few breaths and then come up again slowly.

Kneel down on the button of the pool, take a deep breath and take the mouthpiece out of your mouth. Put it back in your mouth and proceed as learned: *blow - taste - breathe.*

Now dive to the bottom of the pool at a depth of approximately 4m and apply the rules for descending and ascending. Put in mouthpiece - equalise pressure - ascend calmly and keep on breathing normally: Never stop breathing:

pressure equalisation middle ear
pressure equalisation mask
look up and turn and hold up your arm
breathe calmly - never stop breathing

Figure 19 Descending - Ascending

Repeat the skills you learned several times to stabilise them. Since submerging and pressure equalisation in the middle ear is normally something completely new, the individual sensation is quite different. The phenomena already mentioned (see pressure equalisation in the middle ear) are normal. If, however, pain is felt, the diver must rise to a lower depth and try to repeat the pressure equalisation procedure.

Completion of the 1st Diving Run

Remove the fins in the water and go under the shower with the entire diving equipment: Both chlorinated water and salt water will in the long run damage the equipment and has to be washed down. The breathing control unit remains on the air diving apparatus and is still under pressure.

Basics Part II:

1. The Bends

We used the balloon as a symbol for the pressure in the water on air-filled spaces. However, the pressure also has effects on the liquids in our body, i.e. on the blood, lymph and all other liquids that are not recognisable as such at first but that are present as a main substance of the body like in fat, muscles etc. These liquids are affected by the pressure just the same as the balloon, but need more **time** to adjust to it.

If we are as a diver at a depth of 10 m with an air diving apparatus, the comparison with the balloon (10 air molecules) and the dissolved air in the blood (10 nitro-gen molecules) is very helpful (More details on the dissolution of gases in liquids can be obtained from technical literature).

If a diver using air diving equipment does not take into account this phenomenon and ascends uncontrolled, bubbles are virtually formed in the body liquids. To illustrate this phenomenon, a champaign bottle.

It is the nitrogen content of the air which acts as a „carrier gas" and is responsible for the bends. How is it prevented?

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