Open Water Diver

Part 2

Scuba equipment

2 Scuba equipment

There are many items and equipment available in the market and all or almost all have their usefulness, so describing in a first diving course each particular item would make this theory teaching overwhelmingly long and could discourage the student. It is not necessary to do so. We are going to indicate here, for the student to assimilate and understand, the basic and essential materials to dive safely, giving basic information of each item. Within each material we will indicate, there are many varieties in terms of characteristics, suitability according to the type of diving, aesthetics, prices...

Nor are we going to go into so much detail. As a student you must know the basics of the necessary equipment and, if you want to buy your own equipment, receive advice from your instructor (usually the one who can guide you best) or the specialized shop where you decide to buy, at least until, through experience, have a broader knowledge of the equipment and you can form your own preferences.

We will also mention other equipment that, although complementary, has a well-defined role in improving our safety as divers, but making a very short description of them.

The maintenance operations are indicated in each of the equipment and all coincide on the rinsing in fresh water and on avoiding the sources of heat. In this sense we want to make a **call of attention** as the inside of a car or its trunk, parked under the sun, can reach temperatures high enough to deteriorate or destroy most of the gear, so we should never leave the equipment inside the car, especially if it will be parked under the sun.

Let's start with the scuba equipment, consisting of tank and valves, regulator, pressure gauge, vest, and basic control devices (depth gauge, watch, tables, computer, etc.)

2.1 Tank or Cylinders

We need enough stored air to maintain normal breathing during our dive. The diving tanks are containers, usually made of steel or aluminium, in which air is injected under pressure by means of a compressor. Capacities vary, but the most common tanks are 10, 12 and 15 litres. This means that if a 12 litres tank were filled with water, 12 litres would fit inside.

In many places, they do not refer to tanks by their capacity in litres, but by the amount of air they hold, when filled, expressed in cubic feet, as well as measuring the pressure in pounds per square inch (psi). The most common are 80 cubic feet of aluminium which, if filled at 3000 psi (nearly 207 bar), means a capacity of 11 litres. The conversion of measurements is relatively easy, although somewhat cumbersome: 1 cubic foot equals 28.3168 litres; 1 bar equals 14.5038 psi and 1 metre equals 3.28084 feet.

The choice between aluminium and steel it is mainly due to manners or price. The steel cylinders, with equal capacity, are less bulky, weigh less and require less ballast to the diver, as empty, at the end of the dive, still have negative buoyancy. The aluminium ones are more bulky and heavy because of the great wall thickness they need to withstand the same pressure. When they are filled their buoyancy is negative but when they are empty it is positive. Both have corrosion problems, avoidable with primers and good maintenance, but the steel cylinders are more durable. However, aluminium tanks are usually cheaper.

It may surprise the information given that steel scuba tanks are lighter than aluminium tanks, but it is so, since aluminium, although lighter than steel, it is also much less resistant, so to get resistance for such a high pressure the walls of the tank have to be very thick, which makes them heavier.

Tanks are usually filled at a pressure of 200 bar (around 2900 psi), which means that, if it is a 12 litres tank, if 12 litres of air are injected 200 times, the filled tank could supply almost 2400 litres (around 85 cubic feet) of air at sea level ambient pressure. As our breathing intake is about 20 litres (0.7 cf) per minute, this means that in the tank we have air stored to breathe for a long time, if we were able to get the air out as we need it. We will see that with the regulator we can do it.

We are talking about very high pressures indeed, but the cylinder, to withstand these pressures, is built in a single piece, without welds and has thick walls that give very high endurance. We will notice that the air weighs, although we are not aware of it in our atmospheric environment, but the air weighs (with variations) something less than 1'3 kilos per cubic metre (1000 litres) or 0.08 pounds per cubic foot. We will experience the difference in weight at the beginning or end of the dive, as the air in the tank from the previous example, of 12 L to 200 bar (85 cf), weighs just over 3 kg/7 lb (1.3 * 2.4) kg. As we never use all the air, the tank will weigh almost 3 kg/ 7 lb less when we finish the dive.

Tanks are subject to high pressure gas regulations. Hence they all show several marks on their upper part where, among other information, the maximum working pressure, usually 200 bar/3000 psi and the test pressure, usually 300 bar/4500 psi (50% higher than the working pressure) is punched out. They must also have the date of their last inspection done by the relevant state agency or an authorized company punched out. The period for mandatory revisions is variable as it is established by the laws of each country. We do not indicate here the maintenance of the tank by its extension and because the diver rarely buys its own tank, so the maintenance is done by the dive companies which rent them. They also have their capacity engraved, the weight of the tank without the valve, the name of the manufacturer and date of manufacture, its serial number and the type of gas for which they are approved, in our case air.

The tank is complemented with the valve. It is the element where we attach the regulator which will allow us to breathe the air from the tank and has a knob that allows us to open or close the air passage at will and which is described next.

2.2 Valves

Valves cannot be built in steel, because although it is a hard material, it is also fragile. Generally they are constructed in chrome plated brass because being softer absorbs the possible blows, which protects us against an abrupt escape of air due to some crack. Definitely we have to avoid any blows, as although it does not present a safety risk, the valve becomes useless because when it is dented, the regulator no longer fits or the opening and closing knob becomes unusable. They usually have a safety disk so that the air escapes in case of excessive pressure.

The valve can be double, to fit two different regulators, or single, to fit a single regulator. The double valves have an opening and closing knob at each outlet. There are also manifolds for double tanks with an isolation valve which may or may not allow communication between the two tanks.

They are manufactured with 2 different systems for attaching the regulator: the DIN fitting (German standard) and the INT fitting (from International). In the DIN fitting the regulator is threaded to the valve and it has the seal (the O-ring) and in the INT fitting the O-ring is in the valve and the regulator is attached to it by means of a yoke. In the image we see a double valve with DIN fitting.

The INT fitting is more widespread than the DIN one, nevertheless, the DIN fitting is safer and reliable, with some tendency to move the INT fitting from the market. Currently, most valve manufacturers offer their valves with DIN fitting, but supply a small adaptor so that they can be used with a yoke regulator (INT fitting). There are also adaptors to convert an INT fitting to a DIN, so we do not have to worry about the compatibility, as if we have the regulator and the corresponding adaptor; we can use it in any tank. The adaptor to convert a DIN valve into INT is threaded and tightened with an Allen wrench. Do not forget to carry spare O-rings.

It is still possible to see some valves with a reserve lever. They are old valves (no longer made) that had a mechanism that closed the exit of the air when reaching a certain pressure. The diver, having run out of air, knew that he had reached the reserve, so he pulled a rod attached to the reserve lever and the valve started to supply air again, but the diver already knew that there was little air so he would start ascending to the surface. Obviously it is no longer used because of the danger involved; now we have a submersible pressure gauge that tells us at all times the available air.

Valve maintenance, as they are part of the tank, is also made by the diving companies that rent them. However, as the deterioration of the O-ring that makes the seal with the regulator is very frequent, it is highly recommended to carry spare O-rings.

You can download the file “tank_valves” in which you see an image with details of interest of tanks and valves.

2.3 Regulator

It is the device that allows us to breathe the air from the tank. Just like the valves can be with the DIN fitting or the INT fitting, the regulator can as well come with a yoke in the first stage (INT fitting) or with a thread in the first stage (DIN fitting) to attach it to the tank. The DIN fitting is safer so it tends to displace the INT fitting; nevertheless, the INT fitting is easier to attach.

The regulator is attached to the valve without over tightening and then the valve must be opened completely and then closed about ¼ of a turn or less, so that it does not reach the end of its thread pitch. The pressure of the air exerts a force so great that the regulator remains a block with the valve, so much so that we could not even remove it. To be able to remove the regulator again, it is necessary to close the valve and purge the circuit.

The regulator consists of a first stage that is attached to the tank and a second stage that is the one that we put into our mouth by a mouthpiece. Both stages are connected by a hose that sends air from the first to the second stage.

We need a supply of air at exactly the same pressure that we are in order to be able to breathe and, as we explained in another section of this course, the ambient pressure varies depending on the depth. It is the regulator job receiving the air from the tank at very high pressure and supplying it to our mouth at exactly the same ambient pressure at every moment.

The first stage, which we attach to the tank, receives the air at high pressure, but by means of a valve system, the air goes to a small chamber at, on average, about 8 bar / 115 psi above the ambient pressure (depending on the manufacturer). This intermediate pressure chamber communicates to the outside through a hole, in which we thread the hose that sends the air to the second stage.

The second stage is the one that we put in our mouth by a mouthpiece. In the connection with the hose that comes from the first stage, it has a valve balanced at the same pressure, connected to a lever that is supported by a large diaphragm, so that a minimum movement of the diaphragm causes the air to escape towards the mouthpiece.

When inhaling, we deform that large diaphragm so that the air floods the chamber and therefore our lungs. When we stop inhaling, the air that remains in the chamber restores the diaphragm to its natural position, so that the supply of air is cut until the next respiration.

On the outside of the housing, at its centre, there is a button that is also supported on the diaphragm, so if we press it we deform the diaphragm and it causes air to flow while we keep it pressed. It is what we call the purge button of the regulator, necessary to expel the water that floods it if we remove from our mouths the regulator underwater and to empty the pressure of the circuit in order to remove the regulator from the tank at the surface, because while it is pressurized we cannot remove it.

That's why it is called a demand regulator. It only gives air when we breathe and gives it exactly at the same pressure as we are, so that breathing is easy and smooth at any depth. The system seems simple (and it really is), but there is a lot of engineering work to achieve the balances in the two stages and design work, so that the breathing is as smooth as possible at any depth and with any flow requirement, for example, two people breathing simultaneously through a regulator with two second stages (octopus). The technical features of the regulator in terms of its smoothness and flow capacity are an important factor in its price.

We also breathe out through the mouth, as the second stage has an exhaust valve, which expels the air from our breathing to the outside, through a part (sometimes called moustache or exhaust valve) that moves it away from our face, so that the bubbles which we emit do not bother us. As we can see, all our breathing is done through the mouth.

In the image we can see a complete regulator with alternative air system (octopus). The first stage has an INT fitting and we can see that it has a yoke for attaching it to the tank's valve. In one of the low pressure ports the black hose that leads to the second stage is connected, which is the one that supplies air through the mouth (we can also see the mouthpiece). In another of the low pressure ports the yellow hose is attached, which ends in another second stage to allow us to offer air from our equipment to a buddy in case of emergency, while we also breathe. The low pressure ports are usually marked as LP.

Other ports covered with a screw and its O-ring are also seen in the image of the first stage, so that the air does not escape. In another of its low pressure ports we would connect a hose to inflate our vest with the air from the tank and in a high pressure port, usually marked as HP, we would connect the pressure gauge hose, which gives us the reading of the pressure of the tank at every moment. The screws are removed or put with an Allen wrench.

If we observe the first stage, we will see that it has several holes (ports), sealed with a plug when we buy it, except for the hole where the second stage is attached. These holes are the ports of the first stage, usually a

HP port, communicated directly with the chamber where the air enters from the tank, so the air pressure in that port is the same as that inside the tank. We connect there the pressure gauge that gives us exactly the pressure inside the tank (we will explain it later). There are regulators with two high pressure ports.

We can also see that there is a black cap in the yoke. It is to protect the air inlet from the tank to the regulator. This cap must always be put on when the regulator is not in use, as it prevents the entry of dust, particles and water when we rinse it in fresh water. We name it the dust cap.

The rest of the holes are the so-called low pressure ports (the air is released at the intermediate pressure). As we have indicated, one port is already occupied by the hose of the second stage, the others, we can use them to install another second safety stage (octopus), to install the inflation hose of the vest (that we will see) or of the dry suit , or to install any ambient pressure air supply that we may need.

The regulator is the device that allows us to breathe underwater, so we must keep in mind that needs care and maintenance so that it does not fail underwater. When we attach it to the tank and open the air, the high pressure itself keeps it so tight that we can no longer remove it. To remove the regulator from the tank, you have to close the valve first and then you have to press the purge button of the second stage, to empty it of air and then we can remove it.

We must protect the air intake from the tank with a cap, usually supplied with the regulator, which prevents the entry of water and dirt. You have to rinse it well in fresh water after each dive, but putting the dust cap on first so that no moisture enters in the first stage; in the second stage, the only caution is not to press the purge while we rinse it. Never let it dry under the sun or in a heat source and we must have a padded bag or rigid box for transport protection. Nor should it come into contact with chemicals, such as cleaning products or spilled liquids in the trunk of the car. Revisions, maintenance and repairs must be carried out by qualified professionals.

You can download the file "regulator" in which you see an image with details of interest.

2.4 Pressure gauge

We have already mentioned it in the section where we explained the regulator. By definition, a pressure gauge is an instrument that measures the pressure and that is exactly the job of the pressure gauge used in diving, measuring the air pressure in the tank and giving us that information for our reading. The pressure gauge is attached to the so-called high pressure chamber of the regulator first stage by means of a hose that withstands high pressures; the pressurized air works on a needle that rotates more or less according to the pressure, as it is on a background with a printed scale, the needle indicates with sufficient accuracy the remaining pressure in the tank, so we know at all times the available air.

The beginning of the scale is marked in red, to help us visualize that we are already consuming the last 50 bars of air (if psi, 500) if the needle is there. Our instructor will tell us that, for safety, we should never consume all the air and we should reach surface with a minimum remaining pressure of 50 bars or 735 psi.

There are non-submersible pressure gauges for dry use, but their usefulness is limited to the professionals of the diving centres, who make them available to the customer who wants to check their pressure before leaving. There are also digital pressure gauges and dive computers, which we explain below, which fulfil the function of the pressure gauge as they communicate with the first stage of the regulator, by hose or by wireless means.

As the pressure gauge receives air at very high pressure, we must take some precautions when opening the tank, in case there is any damage: we must start the opening of the valve very smoothly, holding the pressure gauge by the centre of the hose and directing the glass covering the scale towards the floor, so if there was a sudden leak due to breakage, we can avoid damage to ourselves or others.

Maintenance is very simple; as it must never be removed from the regulator, it is rinsed in fresh water with the regulator after each dive and never let it dry under the sun or in a heat source. We must take care when packing away the regulator with its pressure gauge, so as not to force the hose with sharp bends. We must also monitor possible air leaks, easily detectable underwater, immediately changing the affected O-ring or changing the hose if it is damaged.

2.5 Buoyancy control device (BCD)

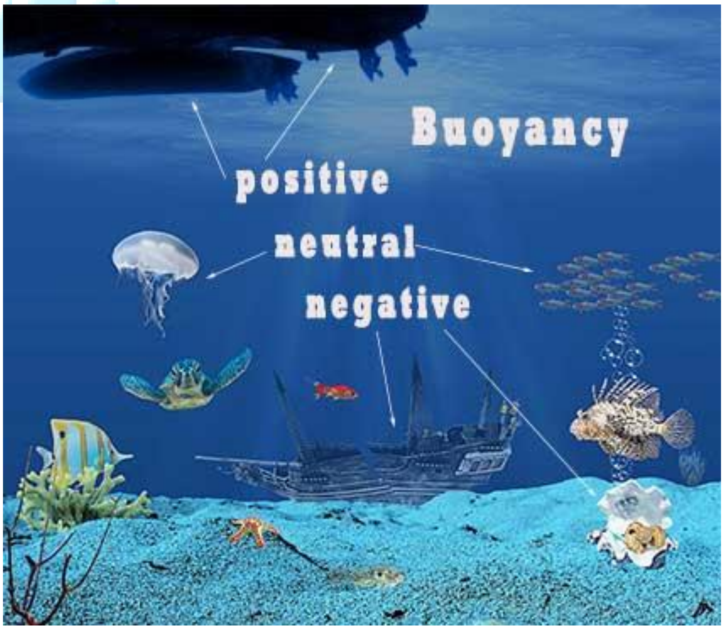
Too long a name. We call it BCD or BC (from Buoyancy Compensator). We wear it as a kind of jacket.

Before explaining its usefulness, let's review the principle of Archimedes: "*a body submerged in a liquid experiences an ascending thrust equal to the weight of the displaced liquid*".

We all know that if we get into a bathtub full of water the water overflows, this means that our body displaces water, both in a bathtub and in the sea, and the displaced water is equivalent to the volume of our body. What the principle of Archimedes indicates is that if the weight of the water that we displace is greater than the weight of our body, we will float; if the weight of the displaced water is equal to the weight of our body, we will maintain ourselves in hydrostatic balance, neither float nor sink, we will remain motionless at whatever depth and that is the balance we need to reach. On the other hand, if the displaced water weighs less than our body, we sink. It is the principle by which boats float.

We need to keep a completely neutral buoyancy when diving, that is, neither tend to float (positive buoyancy), nor tend to sink (negative buoyancy). In this way we manage not to waste energy in keeping ourselves to the depth that we want, expending effort only to advance, going up or down at will.

The main problem is that our buoyancy is continuously variable. The human body has an almost neutral buoyancy if we are in the sea motionless (some people sink very slightly and others float, also very slightly), but our body is wrapped in a neoprene suit which has a lot of positive buoyancy, so much that it is very difficult and hard for us to sink. To be able to sink we compensate with a belt with leads, but the neoprene is a material that varies its volume with pressure, so its thickness is different depending on the depth and, therefore, its buoyancy. Also our tank has a variable weight but always with the same volume, since the air weighs as we said, so as we spend air, the tank is weighing less but with the same volume, having almost 3 kg /6.6 lb of difference between the tank filled and the tank in reserve.



A big problem, as we can see, as buoyancy is continuously variable. That's why we need the BC. There are many models, but the most extended has the shape of a vest, which we adjust to the torso, through a system of tapes and buckles that prevent accidental loss and is composed of a bag-shaped inside to house air and a strong outside to protect it from friction or punctures. It has a trachea (a hose) that communicates with the inside, where we can inject air from the tank, by means of a mechanism that we operate with a button and where a low-pressure hose that comes from the regulator is attached. We can also inflate it with our own breath, blowing through the mouthpiece while pressing the button so that the air can pass, but under the water is less advisable for uncomfortable.

It also has its purge valve, that is, to draw air from its inside. The valve is usually placed in the inflation trachea (by pulling or with a purge button), although it also has other valves in other places to facilitate emptying with any hand and in any position.

The safety standard for any BC tells us that it has to have at least two inflation systems, at least two deflation or purge systems and at least one safety valve to prevent its inflation above its capacity. Usually, the purge valves are also safety valves, which open automatically when the pressure inside the BC increases, so if we try to inflate the BC above its capacity, it lets the air off as well.

With the BC we can solve our buoyancy problem. As we go a bit over weighted by the air of the tank and perhaps with more lead to sink the first metres too, as soon as we feel that we sink, we can press the inflation button so, when air enters the BC it increases its volume, and then we gain buoyancy until we achieve balance. The BC is frequently used while diving, as there are always variations in depth. If we go up, the air inside expands, so we have to purge it to achieve our neutral buoyancy and not to surface like a balloon; if we go down, the air inside is compressed, losing volume, then we will have to inject some more air to achieve our neutral balance. As we see, having to use it continuously to keep our balance, it is very important that we acquire a good skill in its use, but that is undoubtedly done during the practical classes of the course.

Good buoyancy control requires practice, as well as mastering the correct fin kick. During the diving course many buoyancy practices are done, as students are obliged to do it while they are diving, but it is possible to achieve only some minimum skills that allow comfortable dives. A diver is considered an expert when, with the experience, he has managed to master the fin kicking techniques and keep his neutral buoyancy at all times. Do not worry therefore if you think you're not getting it. If your instructor keeps you under water for the exercises, it is because your buoyancy control is enough to continue with the exercises or dives.

The BC used in recreational diving also have a back pack for holding the tank, usually consisting of one or two wide straps, with an adjustment buckle to tighten each tape, so that it is the BCD that supports the tank. Others BC, to achieve such holding, incorporate a hard back pack and shoulder straps that allow the adjustment of the tank to our body regardless of the BC fit. In any case, currently the BC forms a set with the tank and the regulator in diving. There are BC that allow the fastening of the tanks by metal rings attached to your rigid back pack. This system is usually used in cases where you dive with more than one tank.

Here we are showing you and explaining the Jacket type because it is the type of BC that should be used in recreational diving. You can find other types of diving BCD in the market, such as those called "wings", but which are designed for some types of technical diving. They are not recommended for recreational diving because of safety reasons.

It should be rinsed in fresh water after each dive, taking care that all its parts are rinsed well. If water has entered inside, something frequent, we must remove the salt water through the mouthpiece; we can introduce some fresh water by the same place, shake well and take the water out again, so we also rinse its inside. We dry it slightly inflated, in a place protected from the sun and any source of heat.

You can download the file “vest” in which you see an image with the details.

2.6 Control devices

We call this section this way although one of the items to be described is not a device, but a simple table with information. In addition to the images you see here, you can download the file “other_devices” in which we also include images of equipment and devices that you do not see in this text.

As explained in the corresponding section of this theory training, we need to have control of the depth to which we are, the maximum depth reached, the diving time and information on the maximum time so as not to enter into mandatory decompression. This information is obtained with a suitable watch for diving, a depth gauge that measures the depth and tables with a relation of time and depth. Let's see this equipment and also a device that has replaced all of them, the dive computer.

2.6.1 The watch

Must be suitable for diving and waterproof to the depths we can go down. The watches indicate, either in atmospheres or in bars, the pressure they are able to withstand under water. The suitable watches for diving are those which indicate 200 metres depth or more. If it is a watch with needles (analogical) it must have a graduated crown on the outside that rotates in one direction, counter clockwise and that we put the 0 pointing the minute needle when starting the dive, so we will know at any time the total time that we are submerged without having to remember the hour and minute of entry. If we opt for a digital watch, it must be one that allows operating the buttons under water, as we will need its different measurement functions and chronometers. The watch is also used to regulate our ascent speed and the times for the safety stop or decompression stops, so it must be able to give total and partial times. The maintenance after the dive is as plain as showering with the watch on.

2.6.2 The depth gauge

Is a device we wear on the wrist, like a watch, and which through a mechanism that can vary according to the manufacturer, a needle on a numbered background, gives us at all times the current depth and also another needle or a retainer, gives information on the maximum depth reached along the dive. There are depth gauges that are installed in a housing located next to the pressure gauge (this is called a console). Either system is valid, as it gives us the information of our real depth and they are easy to read.

Analogical depth gauges can be capillary, bourdon tube or diaphragm usually, being the diaphragm one far better than the bourdon tube and, indeed, to the capillary one, which we will hardly find. The diaphragm one has greater precision and ease of reading, especially in the first metres. In the image we see a console composed of a pressure gauge and a membrane depth gauge.

Lastly, digital depth gauges are powered by a battery and are sealed; they have a pressure sensor and a timer, so they show on a screen all the information we need from the watch and the depth gauge (and even more), so that with a device we replace two. They are also more accurate than the analogue ones and with more functions. It is not even necessary to remember to turn it on, as when it gets wet it turns on automatically. However, due to the ease of purchase of dive computers because their affordable price, digital depth gauges are barely used.

2.6.3 The deco tables

Are, as the name suggests, a ratio of column depths and times in each depth in rows, which indicate the maximum dive time without the need for mandatory decompression stops and, in case of exceeding such times, the depths to which we have to stop to decompress and the times that we must stay in those depths, in order to avoid decompression sickness.

There are submersible plastic tables, where a relation of depths and times is indelibly printed, with a colour code and bold to improve the identification of the data. In the diving course you have to learn to identify the data offered by the decompression tables, which is what we are talking about. Usually the submersible tables are anchored with some type of restraint and stored in a pocket of the vest.

Just now we limit ourselves to describe what the decompression tables are, indicating that they can be either on paper or in digital format to see them on our device screen, as well as in their format of submersible tables. In another section of the course, we will explain how they work and how to use them to calculate our dives.

Table A: Residual nitrogen group (RNG) and safety or decompression stops

Depth	Dive length in minutes (safety or deco stop code)											
6 m	30	60	90	120	150	180	240	300	360	420	480	600
9 m	30	45	60	90	100	120	150	180	190	210	240	270
12 m	22 (S)	30 (S)	40 (S)	60 (S)	70 (S)	80 (S)	90 (S)	120 (S)	130 (S)	150 (S)	160 (1)	170 (1)
15 m	18 (S)	25 (S)	30 (S)	40 (S)	50 (S)	60 (S)	75 (S)	85 (1)	95 (1)	105 (2)	115 (2)	124 (3)
18 m	14 (S)	20 (S)	25 (S)	30 (S)	40 (S)	50 (S)	60 (1)	70 (2)	80 (2)	85 (3)	92 (4)	
21 m	12 (S)	15 (S)	20 (S)	25 (S)	35 (S)	40 (1)	50 (2)	60 (5)	63 (5)	66 (6)		
24 m	10 (S)	13 (S)	15 (S)	20 (S)	25 (S)	29 (1)	35 (2)	48 (5)	52 (6)			
27 m	9 (S)	12 (S)	15 (S)	20 (S)	23 (1)	27 (2)	35 (5)	40 (6)	43 (6)			
30 m	7 (S)	10 (S)	12 (S)	15 (S) 18 (1)	21 (2)	25 (5)	29 (5)	36 (6)				
33 m	6 (S)	10 (S)	12 (S)	15 (1)	18 (2)	22 (5)	26 (6)	30 (6)				
36 m	6 (S)	8 (S)	10 (S)	12 (1)	15 (2)	19 (5)	25 (6)					
39 m	5 (S)	8 (S)	10 (1)	13 (2)		16 (5)	21 (6)					
42 m	5 (S)	7 (S)	9 (1)	11 (2)		14 (5)	18 (6)					
RNG	A	B	C	D	E	F	G	H	I	J	K	L

Deco code	(S)	(1)	(2)	(3)	(4)	(5)		(6)	
Minutes:	3	5	10	15	20	5	10	10	10
Deco depth	4,5 m	3 m	3 m	3 m	3 m	6 m	3 m	6 m	3 m

2.6.4 The dive computer

Has meant a before and after in terms of monitoring the parameters of our dives. It is, as the name suggests, a computer that receives data from pressure sensors (depth), a time counter and, together with a computer program that it incorporates, give us all the necessary data of the watch, the depth gauge and the tables on its screen. It informs us of the maximum depth reached, the current depth, the time we have been diving, the time we can keep diving without going into decompression and, if we get into decompression stops (never advisable), the time and depth of each stop. It also tells us if the ascent speed is correct, activating an alarm if we surpass it and other information of interest, for our information and record keeping.

There are computers which communicate with the first stage of the regulator, so they also replace the pressure gauge, as they give us the tank pressure, analyze our breathing rate and tell us the air time still available at any time (discounting the reserve). They have optical or acoustic alarms or both to warn of any risk situation, such as excessive ascent speed, imminent decompression stops needed, failure to respect the depth of the decompression stop, air alarm those that have air management, etc.

They have practically displaced the watch, depth gauge and tables, as they are not subject to human error even to be switched on. They switch on when getting wet. Of course, you have to worry about looking at the screen from time to time to check that everything is fine. As they keep the profile for successive dives, the computer is strictly personal, **we cannot lend it to another diver**, unless 24 hours have passed since its last use and, in that case, when we take it back, we cannot use it for our dives during 24 hours.

There are computers (used as equipment rental) that allow the reset of all the data, in which case they can be used by several divers in different dives but **look out**, not for successive dives. If we are going to do successive dives (a diving trip), we can rent the computer but it must be in with us every day that the dive trip lasts, without being able to lend it to anyone, returning it at the end of the last dive.

Its maintenance is to rinse in fresh water after each dive, do not dry it under the sun or on a heat source and do not store in a bag until it is dry, to preserve the life of the battery, because it does not switch off until it is dry (you can accelerate drying with a cloth). In some computers the change of a used up battery must be done by qualified professionals (usually batteries last from 3 to 5 years). They also warn of low battery when you still have several hours of remaining power, to prevent running out of energy while diving.

2.7 Other equipment

Up to this point we have described the basic diving equipment to perform a dive, breathing air and keeping the necessary control for a safe dive. Now we will describe other equipment or items that we can describe as auxiliary, although some could be essential according to the dive, place or conditions and others that can be described as complementary, but all useful for our safety or comfort.

2.7.1 Knife or cutting device

We can find abandoned or lost fishing nets or lines underwater, with which we could become entangled by not seeing them or by carelessness. If that happens, trying to free ourselves can be laborious and stressful, so the easy and safe solution is to cut the threads with our diving knife (or cutting device). The knife can have other uses depending on the type of dive, but the one described is important for safety. Of course, it must be stored in its case so as not to accidentally cut us. Depending on the type of knife or cutting device, it can be fixed on our leg, our arm, on the vest straps, etc. In the image we see a classic knife, with its cover and holding straps.

It has to be a tool designed for diving, so it has to be protected against rust. They are manufactured of stainless steel, but the problem is that a real stainless steel is not compatible with a good cutting edge, which is what we need, so the knives are susceptible to rust. To avoid this, we must keep all metal parts covered with Vaseline or silicone grease, taking care to also protect the joints with the plastic or rubber handle. So, the water does not contact the metal and therefore the knife does not corrode. You have to rinse it in fresh water after each dive, check that the protective grease layer covers all the metal and renew it if it were not so and keep it always inside its cover for safety.

2.7.2 Dive lights

Or flashlights, essential in night dives, of course, but also useful in any dive. In the section corresponding to phenomena of light we explain the loss of colour in depth and how the use of a flashlight restores the fullness of the colours. We also need the spotlights for video if we want to record all the colours correctly.

You have to rinse the dive lights in fresh water after each dive and keep the o-ring seal clean and lubricated to prevent flooding, which would ruin the equipment. It is very impoHence, to remove the batteries when the flashlight is not going to be used, to avoid sulphating and the accumulation of hydrogen inside it.

2.7.3 Compass

The compass is very useful when we know how to use it properly. We must practice on land before using it under water to learn how to use it. We find compasses specifically for diving in shops. The most recommended are those that have a reading window on its side. The compass must be in a perfect horizontal position so that the limb rotates freely without rubbing against the housing. The outer mounting should rotate to allow us to fix a course and follow it. The maintenance, like the rest of the equipment, is to rinse in fresh water after each dive and not to dry it under the sun or in any heat source.

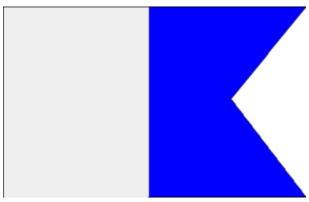
It is a very useful item to plan a dive, for search and rescue operations, for orientation, drawing up plans, etc., but such topics are not taught in this course but in more advanced ones. Even, ACUC has a specific specialty course of Underwater Navigation.

2.7.4 Slate

We talk about a rigid plastic slate, white or very clear, in which we can write anything with a pencil. A normal pencil writes perfectly underwater in these slates. Since we cannot talk underwater, the slate serves a possible basic need for communication in case that by the peculiarities of the dive, the underwater signals learned are not enough. In the shops we can even find notebooks with several plastic sheets.

2.7.5 Buoys

Basically, there are two types of buoys used in diving. The first one we describe is the surface buoy. It is a buoy that is used to signal the presence of divers to other boats, so that extreme precautions if they approach. Its use and precautions to be observed are regulated by international navigation standards. It is used mainly in dives in which we let ourselves be carried by the current, to permanently signal our position as one of the divers drags it with a rope. Our own boat, when deploying the diving flag, does the same legal function as the buoy.



The diving flag is a signal regulated by international maritime traffic laws, mandatory to indicate the presence of divers underwater and it is known as the Alpha flag, white and blue as we see in the image. The flag that we see in the buoy, although it is not the official one according to international standards, it is well known as a diving flag and we can see it in many diving related items.

There is another kind of buoy that we use as divers and we carry it while diving. It is a long, cylindrical tube that we have folded and anchored to our equipment. If we are not going to emerge near the boat, before reaching surface and at a minor depth than the length of the buoy line, we deploy it and introduce a little air from our regulator inside the tube. It will reach the surface completely inflated due to the expansion of the air when going up, so we will signal our presence by means of a long inflated tube.

2.7.6 Log book

It is not diving equipment but it can almost be described as essential for every diver. The log book serves to log our dives, a kind of diary, where we record all the important and complementary data of each one of the dives that we do. We will need the log book to demonstrate the experience acquired, information which is required to take other advanced diving courses or specialties. Many diving centres may ask us to show them the log book in order to organize the dives according to our registered experience.

The data that we must necessarily keep in our log book is the number of the dive, which will be correlated, so the last number indicates the total number of dives done, the cumulative dive time, which will be the sum of the previous accumulated time in each dive plus the time of the actual dive, so, the last dive shows the total accumulated time underwater.

Furthermore, we log the dive place, the equipment used, the maximum depth, the decompression time if needed, the date, the water and air temperature, the name of the buddy or buddies, the name and data of the dive centre, etc. With etc. we mean other additional information that you consider appropriate to add in, including our own comments regarding that dive. As you can see, it is our personal dive log. Each dive must have a space reserved for the signature of our dive buddy and the stamp of the dive centre, as a confirmation of the basic data of the dive.

In this ACUC OWD elearning course, you are offered to download a dive log sheet, which you can print to register the 4 dives of the course, as they are your first dives and they count as experience. ACUC also makes available to anyone who wishes it, a dive logbook with rigid covers, rings and blank registration sheets, which you can see in the image and that you can acquire through your instructor or directly from ACUC.

2.7.7 Bag

Our equipment must be gathered and kept safe every time, we must not disturb our buddies having our equipment spread all over the boat or the dive centre; also it can be damaged or broken by blows, in addition, for safety, we must have everything always at hand so that nothing gets lost.

That is what diving bags are for. Mainly there are two types, the so-called transport bag and the grid bag, for use on the boat. The transport bag is large enough to fit all our equipment; we can buy bags of different sizes (depending on the equipment we have) and even large bags with wheels. We use these bags to store our equipment during transport (plane, train, bus or car) and to keep our equipment stored, in the dive centre, between dives.

Grid bags are to carry on the boat, its mesh fabric allows water to circulate well through it, so, when gathering the equipment in the boat after diving, the water that soaks it can keep draining.

The weight belt should not be stored in any type of bag, because although they are strong enough to house and protect our equipment, the ballast is an element of great weight and small size, so when moving it can hit and break the equipment. In addition, this great weight, greatly accelerates the damage and breakage of our bag.

2.8 Summary

Cylinders (also called tanks or bottles).- They are usually made of aluminium or steel. There are tanks of different sizes and the most used are those of 12 and 15 litres (80 cf if aluminium tank). Its working pressure is usually 200 bar / 3000 psi, the test pressure is 50% higher, then 300 bars / 4500 psi. The hydraulic test is mandatory and the countries' legislations establish their periods. The tank must have a mark on the neck with the date of its last revision. The valve is its complement.

Valve.- Single or double valve, they can be DIN or INT fitting. The DIN fitting has a thread where the first stage of the regulator is screwed and the INT fitting has an O-ring, where the regulator is attached by means of a yoke. We need to avoid blows because they may deform and become unusable. Each outlet has its knob to open and close the air flow from the tank. There are double valves for twin tanks. We must avoid the blows in both the valves and the tank.

Regulator.- It is the device that allows us to breathe the air from the tank, consisting of first stage, second stage and hose that connects both stages. Besides, in the first stage there are other low pressure ports for the alternative second stage (octopus), for the vest inflator, the dry suit or for whatever we need and at least one high pressure port to attach the pressure gauge. The first stage can be DIN or INT fitting, being the DIN safer but somewhat more uncomfortable to attach.

It has a dust cap that protects the air intake from the tank, which must always be on when the regulator is not in use. In the second stage we find the mouthpiece that is what we put in our mouth to breathe. This second stage also has an exhaust valve where the air we exhale goes out and a purge button to force the air out to, for example, clear the water from the inside of the regulator.

Pressure gauge.- It is attached to the high pressure port of the regulator first stage and it gives us at any time the reading of the remaining air pressure in the tank. The first 50 bars/500 psi are marked in red to indicate the reserve air, with which we have to reach surface. The hose should be held at its centre when the tank is opened, keeping the pressure gauge facing the ground and opening the air gently.

Vest.- BC or BCD, allows us to keep neutral buoyancy at any time as we can blow air inside or extract it. It also helps to float comfortably at the surface. It must have at least two different inflation systems, two different purge systems and at least one safety valve. Usually, purge systems are also safety valves.

The inflation is achieved by connecting a low pressure hose, from the regulator first stage to the automatic inflation system, so when pressing a button it is inflated. It has to be worn so that it cannot become detached accidentally.

Watch.- It can be analogical or digital. It is the gear that allows us to know our dive time and control decompression times. If it is analogical, it must have an outer crown that rotates in one direction, counter-clockwise. If it is digital, it must allow operating the buttons under water.

Depth gauge.- The capillary and the Bourdon tube are not recommended for their inaccuracy. The diaphragm one must have 2 hands, one that indicates the current depth and another one that is dragged but it does not go back, so it will indicate the maximum depth. The digital one is much more accurate and gives us more safety information, but it has been displaced by computers.

Dive tables.- They are plastic tables where the decompression tables are indelibly printed, so that we can read them underwater and proceed on their information to do the decompression.

Computer.- It has meant an extraordinary improvement in diving safety. It shows us on screen the current depth, the maximum depth reached, the dive time, the time we can keep diving without needing mandatory decompression stops, it indicates the right ascent speed and if we go into decompression it indicates the depths to stop and the time that we should be at each depth. It also keeps the data in memory in case of successive dives.

Knife or cutting tool.- It is often an essential security tool. Its task is to allow us to get away quickly and safely in the case of getting entangled with fishing nets or lines abandoned by fishermen. It must be always kept in a case to avoid hurting ourselves or a buddy.

Dive lights.- Useful if we want to see the real colours and it is essential in night dives. Flashlights are necessary to record the real colours when filming in video as well as a flash is necessary in photography.

Compass.- It has the same purpose as surface compasses and it is used mainly for underwater navigation, also having other more specific uses.

Slate.- Usually made of matted plastic, in which we can write underwater using a common pencil.

Buoys.- They are used to indicate the presence of divers underwater. If you dive in the vicinity of the boat, they are not necessary as the boat performs the legal function of the buoy. There are also buoys that we carry deflated and rolled and, shortly before reaching the surface, we inflate them with our regulator to signal our presence and position.

Log book.- It is where we keep all the data of our dives, having a space for the total number of dives done and the total time of those dives. It is usually bound in a book of hard covers, although it can also be digital. It can be requested to dive or to enrol in another more advanced course.

Bag.- It is where we keep safe all our equipment except weights and tank. Transport bags are tough and can be up to the size of a suitcase with wheels; grid bags are to keep our equipment gathered on the boat.