DIVING EQUIPMENT AND DIVING SIGNALS

Lesson Objectives

An introduction to the diving environment and the specialist equipment divers need. The lesson concludes with signals.

Achievement Targets

At the end of this lesson students should:

- Have a basic understanding of air, breathing gas mixtures and water pressure and the effects on the diver in the underwater environment
- Understand the purpose and function of Basic Kit
- Understand the purpose and function of SCUBA Equipment
- Understand the need for Diving Signals

Following items will be useful as additional Visual Aids

Mask, Fins & Snorkel

SCUBA Equipment - Cylinder, Regulator + Octopus, BC.

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DIVING EQUIPMENT AND SIGNALS

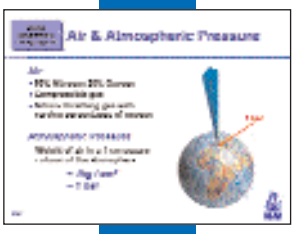
AIMS

Explain that before discussing diving equipment students need to have some understanding of the diving environment and its effects on divers and how equipment, both basic and SCUBA, is designed with this in mind. With Scuba equipment we cannot talk underwater so divers need a simple method of communication - diving signals.

AIR AND ATMOSPHERIC PRESSURE

To understand the effects of the underwater environment on diving equipment and divers, remind students that we are attuned to the earth's surface conditions.

- The air we breathe is approximately 79% Nitrogen and 21% Oxygen
- Divers often use breathing gas mixtures with oxygen percentages greater than 21%. These gases, including air, are generally known as Nitrox
- Air, being a gas, is compressible, e.g. bicycle pumps, tyres etc.
- Air surrounds the earth and has a downward force on the surface and this exerts pressure
- The weight of the air in a 1cm square column, stretching from the earth's surface to the edge of the atmosphere, is 1kg at sea level. Students can visualise this as a column of air about the size of a finger nail stretching up about 60 miles high. The reason we do not sense the weight of the air above and around us is that the body, consisting of lots of water and some air, is in balance or 'equilibrium' with the surrounding air pressure. We know the air gets thinner and weighs less the higher up the column and beyond, e.g. astronauts have to wear pressurised suits to be in equilibrium with the body for survival
- The 1kg per sq. cm is known as 1 Atmosphere or 1 bar, (barometric pressure) and although it varies a little due to weather conditions, we use this as a measurement for diving purposes

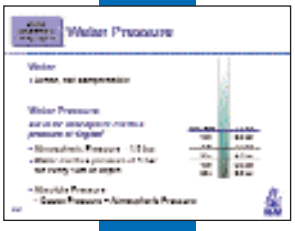


WATER PRESSURE

So what has air got to do with diving, other than humans need it to stay alive?

- Water, unlike air, is a very dense medium and is not compressible
- We have established that at sea level the air in the atmosphere exerts a pressure of 1kg/sq.cm – 1 bar
- Water on its own, in a column of 1 sq. cm, exerts a downward pressure of 1 bar for every 10m of depth, but as divers we have to combine with the air pressure plus the water pressure to give us the total pressure we will experience underwater. At 10m we will experience 1 bar atmospheric pressure+1 bar water pressure, etc.
- The "total" pressure is referred to as "absolute" pressure = gauge pressure (water) + atmospheric pressure

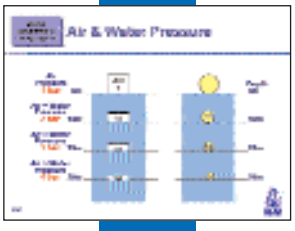
Divers use depth gauges - they measure the water pressure but the read out on the dial face is given in metres as divers need to know how deep they are. Understanding the absolute pressure is also important, as we will be looking at how this affects our bodies underwater



AIR AND WATER PRESSURE

If pressure is exerted on air, remembering that air is compressible, it will squeeze and reduce the air volume. The water pressure is exerted on the air and the deeper the air volume is taken down; say in an upturned open rigid container, the higher the squeeze on the volume of air. The compression of the air volume for every 10m water depth is fairly easy to remember.

- At 10m, 2 bar pressure, the volume of air reduces to one half of its original



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volume

- At 20m, 3 bar it reduces to one third of its volume
- At 30m, 4 bar, it reduces to one quarter of its volume and so on

Fortunately, as humans have a high water content in the body, 70 - 85%, most of it can adapt to the increase in water pressure sport divers go to. However, there is one important area of the body that is an air space, the lungs. Not a rigid air container like a bucket, but more like two balloons, the lungs are a flexible air space. As we breathe in and out the elasticity of the lungs allows expansion and contraction. If a swimmer takes a breath and dives down, immediately the water pressure squeezes the air volume in the lungs and they reduce in size. We don't feel this reduction unless we dive down very deep.

- Take students through the reductions in volume of a balloon, the lungs on a swimming dive. (Expansion of air in lungs on ascent is covered under Diving equipment later in this presentation).

We need equipment that enables us to adapt to the underwater environment and the next section covers basic and SCUBA equipment

BASIC EQUIPMENT - MASK, FINS AND SNORKEL

To move easily through the water and see life below us from the surface or to dive down to have a closer look, we need basic diving equipment - mask, fins and snorkel.

BASIC EQUIPMENT - THE MASK

Divers need a mask to see underwater. The eye is designed to work in air not water – open your eyes underwater and everything is blurred. As masks come in a variety of sizes and designs, it is important that it fits the face comfortably. Features to look for are:

- A mask frame should be rigid to hold the glass
- For safety reasons the glass or mask lens must be tempered glass. Rather like car windscreens, if it breaks it will "pebble" rather than "shard". For divers who wear glasses, masks with prescription lenses are available
- The mask should have a flexible seal or 'skirt' that moulds easily to the face. Most seals are made of silicone rubber
- The mask skirt must enclose the nose. Remembering that a volume of air will compress even in shallow water, being able to breathe into the mask will equalise the pressure with that of the surrounding water. If the pressure is not equalised, the mask will be squeezed onto the face and become uncomfortable. The seal inside the mask skirt under the nose pocket is designed so that if water enters the mask, generally seeping in because stray hairs have broken the seal, breathing out through the nose will displace the water from the mask, something you will learn on the practical sessions
- To secure the mask comfortably, it should be fitted with an adjustable strap
- For maintenance, a mask should be washed in fresh water after each dive and not dried in direct sunlight, as this affects the flexibility of the silicone rubber and therefore the fit' of the mask

BASIC EQUIPMENT - FINS

As a liquid, water's resistance to body movement is considerable. Using a 'paddle' as an extension of the diver's foot provides a higher surface area to propel the diver through the water more easily and with less effort. Fins come in a variety of shapes and sizes. The consideration before buying a set of fins is that the style of fin suits the type of diving being undertaken.

- There are two basic styles, the shoe fin and the strap fin. The shoe fin has

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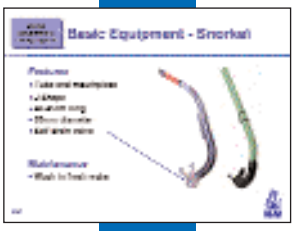
a foot "shoe" pocket and is generally used in warmer water conditions. The strap fin has a foot pocket designed to go over boots and an adjustable strap around the heel for holding the fin in place

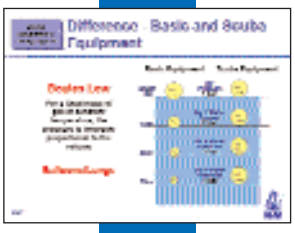
- The most important consideration is that the fin is the right size - foot size for shoe fins and boot size for strap fins. If fins are too big or too small it will generally result in cramp
- The basic design of a fin blade should include stiffening ridges to maintain the shape of the blade, the blade itself graduating in stiffness to allow some flexibility as the legs move up and down with the finning action. Too rigid, too flexible or overlong fins will increase strain on the legs. Most fins include slots, grooves or shaped blades that assist the finning action
- For maintenance, wash the fins in fresh water after each dive and dry standing up on the shoe end - standing fins up on their blades can distort their shape over a period of time



BASIC EQUIPMENT - THE SNORKEL

The snorkel is a simple breathing tube to allow a diver to breathe whilst face down on the surface observing the underwater scenery.

- It comprises two main parts - a mouthpiece, which is gripped by the teeth (rather like a gum shield) and a rigid or semi rigid open topped tube. This allows the diver to inhale air without having to lift the head and gives a comfortable breathe even in a choppy sea
- Usually forming a 'J' shape to fit close to the head, the length of the snorkel is around 40-45cm and the bore of the tube about 20mm. Anything narrower or longer will require too much effort to breathe. If the tube is too wide, it will be more difficult to blow clear of water following a dive
- There are various design features, which can include a self-drain valve at the bottom of the snorkel. This assists in clearing water following a dive
- Snorkels can be worn under the mask strap or connected to the strap with a small attachment
- Maintenance is washing well in fresh water after each dive



THE DIFFERENCE BETWEEN BASIC AND SCUBA EQUIPMENT

- Using basic equipment, the lungs react as a balloon does, the air volume compresses but we do not feel this. The reason for returning to the surface is the urge to breathe
- In order to spend more time underwater divers need to take their breathing supply with them. If the lungs are compressed the action of breathing becomes difficult so divers need a gas supply that will maintain, as near as possible, their normal lung volume by delivering breathing gas at the same pressure as the surrounding water. This means that a higher concentration of air is needed to maintain this balance at whatever depth a diver goes and this is incorporated in the design of SCUBA equipment
- This illustrates one of the laws of physics, Boyle's Law. The mass of gas will need to increase its pressure in proportion to the surrounding pressure to maintain its volume

SCUBA EQUIPMENT

Taking an breathing supply that is independent of the surface allows the diver the freedom to remain underwater for a period of time. This is provided by Self Contained Underwater Breathing Apparatus - SCUBA - also known as the Aqualung. SCUBA equipment comprises a Cylinder, Regulator and BC, Buoyancy Compensator.

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SCUBA EQUIPMENT - THE CYLINDER

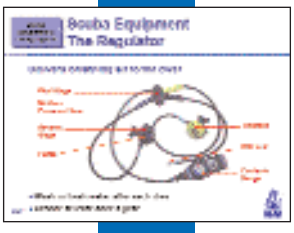
The cylinder holds the diver's breathing gas supply. A cylinder containing a breathing gas of normal atmospheric pressure would not last very long; the gas needs to be compressed and the cylinder is filled from a compressor via:

- The cylinder's pillar valve, which opens or shuts off the cylinder's flow
- Diving cylinders are of a very strong design, made in steel or aluminum, and are manufactured to strict safety standards marked on the neck of the cylinder. The base of the cylinder is protected by a rubber boot

The VA indicates the current British Standard but within the UK, older BS markings may still be encountered. Outside the EU, instructors should substitute the corresponding local requirement.

- There is other information stamped into the neck:

  Cylinders can have different capacities which is measured in litres, or put another way, how much water the cylinder could hold - hence the term Water Capacity (WC)
- The pressure of compressed breathig gas they have been designed to hold. Sometimes marked WP or CP
- There is another mark indicating the test pressure (TP), higher than the working pressure
- The date of cylinder manufacture is important, as all diving cylinders must be tested
- A cylinder test covers visual inspection and hydraulic testing with a visual inspection every two and a half years and a hydraulic test every five years. Test certificates are issued and the cylinders date stamped. Divers need to ensure their cylinders are "in date" or a filling station will refuse to fill them. *(Outside the UK, Instructors should substitute the corresponding local requirements)*
- In the EU, cylinders should also be labelled to show the gas they contain. Additionally, cylinders used for Nitrox mixes, need to be cleaned and certified for use - currently annually, but under review. *N.B. if filling by premix or continuous blending below 40% O_2, cleaning and certification is not necessary.*
- Cylinders should be washed in fresh water after each dive and the boot removed periodically to clean the base of cylinder



SCUBA EQUIPMENT - THE REGULATOR

The gas in the cylinder is at high pressure, on average about 230 bar. It would be impossible to breathe directly from the cylinder so the regulator is equipment designed to reduce the cylinder's high pressure gas and deliver it to the diver so it is easy to breathe underwater whenever the diver breathes in. The regulator is also referred to as a demand valve, or DV, for this reason.

- The regulator is attached to the cylinder's pillar valve by either an 'A' clamp (also known as a yoke) or by a screw fitting (DIN)
- When the cylinder is turned on, the regulator's first stage immediately reduces the high pressure breathing gas from the cylinder to an intermediate pressure of around 10 bar, which is carried by an intermediate, or medium pressure hose, to
- The second stage where the breathing gas pressure is further reduced to the surrounding water pressure, delivering air to the diver when they breathe in
- When a diver breathes out the exhalation is expelled via the exhaust valve into the water
- If water enters the second stage it can easily be cleared by either breathing out or pressing the purge button
- The fail-safe design of regulators usually means that they will "free flow" - continuously delivering air if a mechanical fault occurs. Diver training

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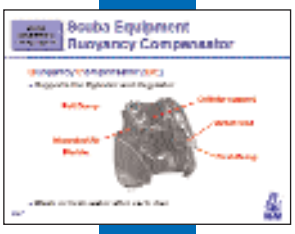
includes how to breathe from a free flowing second stage

- An additional hose and second stage is added to the first stage to provide a back up system for the diver if their dive partner, their buddy, has a gas problem, or if a diver has a problem with their own second stage. This additional second stage is commonly known as an "octopus" and, as a back up system should be easily identifiable. Yellow marked hoses and second stages are a common method of identifying this 'back up' air system. As a back up system, an octopus regulator should be of equal standard to the primary regulator
- Divers need to know how much gas is in the cylinder at all times throughout their dive, so a contents gauge is connected via a hose to the first stage. This has to be a high-pressure hose as it delivers high-pressure gas for the gauge to "read". This 'contents' gauge is sometimes mounted in a console that also includes a depth gauge
- Regulators should be washed in fresh water after use

  Warn about ensuring not to press the purge button whilst washing as water can enter the hoses and the first stage should not be submersed in water unless sealed with the cover for the same reason
- Regulators should be professionally serviced at least once a year. Remember they are a diver's 'life line'. Problems with the gas supply or lack of it, are not conducive to happy diving!

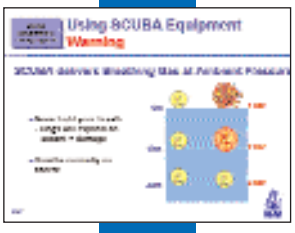


BUOYANCY COMPENSATOR (BC)

The BC carries the cylinder. It is basically a jacket or harness system. They are manufactured in various styles but common to all is that they have

- Integrated gas bladders to give support to the diver and equipment on the surface by means of a connection, called a direct feed, which connects via a hose to the first stage of the regulator and to the gas in the cylinder. A simple 'push button' operation will inflate the BC. BC's also have a back up oral inflation mouthpiece and an over-inflation pressure relief valve and some have an alternative method of inflation from a small cylinder
- There is a manually operated "dump" mechanism that allows easy venting from the bladder so a diver can descend. Students will learn in the pool/sheltered water how the BC is used to trim a diver's buoyancy which is discussed in the next classroom presentation
- Wash in fresh water after use

Although air passes into the bladder, do not breathe from a BC. The bladders build up bacteria and breathing from it may cause respiratory problems.



USING SCUBA EQUIPMENT - WARNING

As SCUBA Equipment delivers breathing gas at ambient pressure when a diver ascends, regardless of depth, they must never hold their breath. To do so will mean the breathing gas volume increases in the lungs and, unless a diver breathes out, could cause serious lung damage. It is very important that divers breathe normally on ascent to equalise pressure in the lungs to that of the surrounding water. If a snorkeller were to dive down and take breathing gas from a diver, they would increase their lung volume and would need to breath out on ascent to avoid lung damage.

DIVING SIGNALS

It is impossible to talk underwater through a regulator but divers need to communicate with their instructor or buddy. Divers use an international and simple hand sign language.

The important point to emphasise is that all signals require a clear and unambiguous response.

The best visual aid for signals are the hands and the VAs can be used as a revision

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SUMMARY

This lesson has given you a basic understanding of air and water pressure and the effects on the diver in the underwater environment.

Introduced you to the purpose of various items of basic and SCUBA equipment. Introduced you to the signals that you need to communicate underwater.

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