30 METERS DEEP FREEDIVING MANUAL

A COMPREHENSIVE GUIDE TO THE ART OF BREATH HOLD FREEDIVING.

BY: BRIAN PUCELLA

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By: Brian Pucella

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This book is dedicated to all those who have perished while freediving.
Please remember

Never Dive Alone
Never Hyperventilate
Never Over Weight

Know your limits.
Respect Yourself,
the Ocean
and All Life!

Dive Safe & Have Fun!

Brian Pacella

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Author's Note

This manual is a collaboration of information that I have gathered over the past 12 years. It was at that time that I bought a sailboat and moved aboard with my girlfriend at the time, now my beautiful wife Jeannette. Each winter when we set sail for the tropical waters of the Bahamas and Caribbean it was my duty and passion to provide fish for us. Not being a great fisherman with a rod and reel, and wanting to be more proactive in my hunting I turned my focus to spearfishing while freediving. It was a passion that still burns strong within me.

In 2006 while sailing through the Caribbean we anchored off Long Island, Bahamas and serendipitously met William Trubridge. We witnessed William perform a world record no-fins freedive at Dean's Blue Hole and my life has forever been changed. Thinking about how that level of freediving could benefit my spearfishing as well as the draw to push my own limits of depth had me motivated to learn as much as I could about freediving. And so for the past six winters Jeannette and I have returned to Long Island, Bahamas to freedive Dean's Blue Hole and spearfish the amazing reefs.

In 2009 I became a member of Team Vertical Blue, an elite freediving school founded by William Trubridge. My position was as a safety diver for the annual Vertical Blue freediving competition. Over the next four years I have spent months at a time training with William and absorbing as much as I could about freediving. It was so much more than just an education in depth freediving, it was a journey within myself of discovery and pushing my limits. A discovery of efficiency in freediving as well as of my mental strengths and weaknesses. William has been my mentor in freediving and in his complete enjoyment of the sea, in all of its beauty and power.

The following season I became an assistant instructor for with Vertical Blue and was asked to be the Chief of Safety for the Vertical Blue Competition as well as for William's historic no-fins Hectometer dive to -101 meters.

Although most of my training has been with William and is based from both his education through the Apnea Academy and through his own experiences, I have also studied freediving through many other sources. I have attended courses with PFI (Performance Freediving International) instructors, been to seminars by Martin Stepanek, and had the privilege to dive with some of the most elite freedivers from
around the world that visit Dean's Blue Hole. And so it has been through all of these experiences that I have collected the information that is within the pages of this manual. 30 Meters Deep Freediving Manual is aimed to educate beginner to intermediate freedivers looking to reach 30 meters (or in the US 100') deep. It is a fundamental look into the world of freediving that you can adapt to your use according to your technical level and ability in the water. This manual is an educational tool and is to be used with common sense and awareness of your own limitations. 30 Meters Deep Freediving Manual does not take the place of an instructor, nor is it enough to read these pages before confronting the sea.

It is my wish to share the information within this book to bring about awareness of the proper techniques to use when freediving. So please share this book with your friends and dive buddies, it is information that could save their life or even your own by sharing.

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Welcome To Freediving

The Oceans of the earth are the last true frontier for exploration and discovery. Under the surface of the sea there are beautiful coral gardens, massive kelp beds, and unique fish that are in a world of their own. A world that provokes our creativity and imagination and of which many cartoons characters are based on. Diving and exploring these hidden treasures are the lure for many of us interested in freediving. Whether it is to photograph these amazing images, spearfish to provide food for our family, or simply as a wonderful form of exercise, freediving is the most simple and pure way to experience the underwater world. Unlike scuba diving where you are limited by
equipment and time, the freediver can spend hours upon hours exploring the sea. The only limit in freediving is within your own belief, or as the amazing freediver Umberto Pelizzari so beautifully put it, “The scuba diver dives to look around. The freediver dives to look inside.” Taking one breath and finding out how deep you can safely go is a true test of knowing one's self.

In this book we will look at equipment to help you comfortably and safely enjoy the underwater world. We will also examine what is happening with the body on an extended breath hold as we dive into the deep. This understanding of ourselves will allow us to be aware of what is happening and to read our body’s signals in order to reach our maximum performance, while always making safety and enjoyment of the dive priority. By combining the use of our equipment with the knowledge of the physiology of the body, we will learn to apply the best techniques in order to obtain the best results.

So prepare yourself to experience the underwater world like never before, with an understanding of your mind and body combined with efficiency and safety to make this the most enjoyable time you have ever spent in the water.

**Introduction**

We are born into this world having been created and living in a liquid world for our first nine months. Although we leave this liquid environment as soon as we are born, a part of that environment stay's with each and everyone of us. It is through freediving that we awaken these lost memories, allowing our body's natural response when being immersed in water to speak to us. This contact with our subconscious is likened to finding our zen when one meditates. Although it is a naturally occurring process of our subconscious that takes place each time we dive, just like meditation it takes practice to perfect. The more we freedive and make contact with

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this part of our subconscious the better we understand the strength of our mind and enjoy the quite and beauty that is found beneath the waves.

Many of us are reading this book because we already enjoy being in the water while scuba diving, spearfishing, or maybe for underwater photography. Others of you might just be interested in freediving for a way to experience the sea for the first time. Whatever your reason freediving will expand your view of yourself both mentally and physically. Freediving provides an amazing way to interact with yourself, your subconscious and the natural world within the ocean. The basis of this book is to provide you with the knowledge and technique to help you become a safe, confident and happy freediver.
Equipment

Before jumping in the water a freediver must overcome basic obstacles such as the inability to see clearly underwater, to breathe while submerged, to move efficiently and to maintain warmth. With modern equipment the freediver can be comfortable while overcoming these obstacles with a mask, snorkel, fins, and a wetsuit (which will also require lead weights in order to offset its buoyancy). Let’s take a closer look at each piece of equipment and what is is best suited for freediving.

The Mask

Because the human eye works best when looking through air a mask is required to allow the freediver to see the underwater world clearly. With advances in technology developing more sophisticated freediver specific equipment, the safety and comfort levels continue to increase allowing for a better performance of all apneist. With the mask this is true as there are two different mask styles available: low-volume and high volume masks. A high volume mask design is popular with scuba divers who are not concerned with efficiency and have plenty of air to equalize a large internal volume as the depth increases. For the freediver looking for every advantage of extending their dive time and going as deep as possible on a single breath a low volume mask design is more efficient and beneficial. A low volume mask design requires less air to equalize leaving more air in the lungs for equalization of the ears and providing more available oxygen. This category of low-volume mask can even be extended one more level to a few select, extreme low-volume mask that are best suited for competitive or serious deep freediving only. These extreme low-volume mask tend to have small lenses which limit visibility (such as the Cressi Minima) or curved plastic lenses which distort vision (the Aqua Sphere Sphera). The Sphera freedive mask by Aqua Sphere is the most popular dive mask used by freediving professionals. It’s extreme low volume and wide field of view is perfect for the most
hardcore deep freediver. The plastic lenses actually flex with the pressure of depth and therefore requires less air to equalize, allowing more air to be used to equalize your ears. On the downside the Sphera’s plastic lens scratch easily and distort vision compared to glass lens masks, making this mask less than ideal for spearfishing. When searching for a freediving mask the description will include if it is a low-volume mask specific for freediving.

Another beneficial feature to be aware of when considering a mask is the color of the skirt, the soft, flexible silicon flange that provides the water tight seal to your face. A black or opaque colored skirt is best. The reason is that it eliminates light from entering behind the lens and causing a distracting reflection off the back of the lenses. A black skirts enables you to focus on what is in front of you better and not eliminates light reflections from behind your field of view. For this reason a black skirt has been a trademark amongst spearfishermen and underwater photographers who need to be able to focus on the slightest movement of camouflage fish. Novice freedivers will find comfort and peace of mind from a black skirt by being able to focus on the images in front of them and not be distracted by light reflections. This same effect of a clear skirt can also be caused by side lenses commonly found in scuba style masks. It is also safe to say that any mask with side lenses will not be a low-volume mask and therefore should be avoided for both reasons.
Snorkel

The snorkel enables the freediver to breath on the surface while keeping the face submerged and viewing the underwater world. This allows one to relax and become comfortable while exploring from the surface. The freediver's snorkel should be comfortable and streamlined. The mouthpiece should fit your mouth (they do make different size mouthpieces for different size mouths) and be made of a soft material that will be comfortable for hours of continuous use. It should also be streamlined to reduce resistance while diving. Avoid snorkels with large protective vents on the top and self draining valves near the mouthpiece, both features are popular with common scuba style snorkels. These extraneous features produce a considerable amounts of drag reducing hydrodynamic efficiency. Since the snorkel will be removed upon the dive, having a streamline snorkel will be more comfortable since there will be less pull on the mask strap where it is attached. The snorkel is an important piece of equipment for the freediver and with proper technique and practice clearing all the water out is simple. In the photos below you can see how the freediving snorkel on the right is much more streamline than the typical scuba snorkel on the left.

![NO](image1.png) ![YES](image2.png)

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Fins

When considering fins for freediving there are a few different characteristics to evaluate. Footpocket features, blade length, blade material and blade stiffness should all be considered. With footpocket features there are two standard designs, open heel footpockets and full footpockets. Open heel footpockets are more appropriate for use with scuba where ease of donning and removing fins is important while performance takes a back seat. The opposite is true for the freediver where performance is priority. This is provided with a good fitting, full footpocket. Since full footpocket fins are not adjustable selecting the correct size is very important. If you will be diving in warm water they should fit snug on bare feet or with enough room for a thin neoprene sock. If you dive in colder water where booties must be worn this needs to be taken into consideration.

Blade length is another factor when selecting freediving fins. Most freediving specific fins have a long and narrow blade which will provide more thrust with less effort. Proper technique with these fins is important to let the blade do the work for you.

Blade material and blade stiffness are the final criteria of a quality freediving fin. With blade material there is a correlation between cost, durability and performance. The three basic blade materials are plastic, fiberglass, and carbon.

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<th>Plastic</th>
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<tr>
<td>Cost</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
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<tr>
<td>Durability</td>
<td>Good</td>
<td>Good</td>
<td>Fragile</td>
</tr>
<tr>
<td>Performance</td>
<td>Low</td>
<td>High</td>
<td>Best</td>
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Plastic blades are the least expensive, provide moderate performance while being extremely durable. Carbon blades are at the other end of this spectrum, being very expensive yet providing the best performance while also being the least durable. Fiberglass blades are in between plastic and carbon by providing good performance at a moderate price while being robust and durable.

Finally blade stiffness is usually rated with soft, medium, and stiff or with a numerical rating of 1 to 5. Typically 1 being the softest and 5 being the stiffest. Preference to blade stiffness is a bit of a personal opinion and can also be influenced by the type of diving they will be used for. Competitive deep freedivers along with divers with a short and stocky build seem to prefer a stiffer blade, while spearfishermen along with divers who tend to be tall and skinny prefer a softer blade. A stiff blade will provide more power at the expense of using more energy, while a soft blade will have a limited amount of power it can produce but will be comfortable to kick all day. It is advisable to go with a softer blade if you are unsure. A soft blade will be much more forgiving on your muscles and in return will be much more enjoyable. If you do not have much experience with blade stiffness try different fins out before making the purchase on an expensive pair of fins.
The Wetsuit

The wetsuit slows down the loss of heat from the body and allows the freediver to stay in the water longer. It also provides a protective barrier against reef, rocks, and floating marine life. Wetsuits come in many different styles and thicknesses appropriate for varying water temperatures and uses. Vest's and shorty's (short arm's and leg's) provide the least amount of protection and are used in warm waters where little thermal insulation is needed. Fullsuits come in one piece and two piece styles with thickness varying from 1 millimeter to 7 millimeter with 1.5 mil, 3 mil and 5 mil suits being the most popular.

Most wetsuits are typically made of open cell neoprene with a protective layer of nylon material on the outside. Competitive freediving wetsuits are open cell neoprene both inside and out providing a slick, hydrodynamic surface. The raw open cell neoprene on the inside of the suit requires a lubricant (soapy water mixture) to put on. Care should be used around sharp objects because even fingernails can cut exposed open cell neoprene when putting the suit on. In waters below 70 degrees a hood is needed to conserve body heat. Hoods also protect the face and neck from stinging creatures in the water.

Open cell suits are 20% warmer than closed cell suits. For example, a 5 mm open cell suit will be as warm or warmer than a 7mm closed cell (nylon lined) suit. This is because a closed cell wetsuit with its fabric liner holds more water against the skin which must be heated with body temperature. The benefits include greater warmth and comfort in a thinner wetsuit. With a thinner suit you have less flotation which requires less lead to control buoyancy. All of these benefits equal a more enjoyable experience in the water and is why all serious freedivers and spearfishermen prefer open cell wetsuits.

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Weight System

When wearing a wetsuit it is necessary to add lead weight to offset the buoyancy of the suit. Proper weighting is extremely important and will change due to varying wetsuit thickness as well as if your diving in fresh or saltwater.

The objective in using a weight system is to be positively buoyant on the surface and neutrally buoyant at a determined depth, a condition in which you neither float or sink. The depth to be neutral varies with your diving experience but for safety you must always be positive on the surface. For novice divers not going deeper than 10 meters (30 feet) a good starting depth to be neutrally buoyant is around 3-5 meters (10-15 feet). Below that and you begin to sink, above that and you float effortlessly to the surface. As you begin to dive deeper than 10 meters (30 feet) less weight will be required.

Proper weighting is important to help you float to the surface in the last stage of the dive where a blackout is most likely to happen. It is difficult to determine this without actually getting in the water and testing your buoyancy with the exact gear you will be diving with that day. It cannot be based on other people's weight requirements due to differences in individual buoyancy characteristics.

The freedivers weightbelt is a rubber belt with a quick release buckle. Unlike nylon weightbelts, a rubber weightbelt will expand and contract with your body as your lungs and wetsuit compresses at depth and re-expand upon accent. This will keep it in place and keeps the weights from slipping up around your chest as you descend in an inverted position. A quick release buckle is also a must for safety as well as knowing how to operate your partners quick release buckle. In any emergency releasing the weightbelt will make work getting to the surface and on the surface much easier.
Physics and Physiology of Freediving

In order to best apply yourself as a freediver you must understand both the physics of the aquatic world and how it affects your body. This knowledge builds confidence by taking aspects of fear of the unknown and turning them into science that we can explain. The first step is to understand how this liquid world works, then we can apply it to how it affects our body. Knowledge is power and in this section you will be given a basic understanding of the physics and physiology of freediving.

Physics of Freediving

Archimedes Principle of Buoyancy

Archimedes principle of buoyancy states that a body immersed in liquid receives a force upwards that is equal to the weight of the volume of liquid displaced.

A good example is that of an empty bottle and the same bottle filled with sand. If the bottle has a volume of 5 liters when it is submerged underwater it will displace 5 liters of water and will create an upwards force of 10 pounds (1 liter = 2 pounds). The weight of the empty bottle is 1 pound which has a downwards force due to gravity of 1 pound. So, if the upwards force against the bottle placed in the water is 10 pounds, and the downwards force is only 1 pound, then there is 9 pounds of upwards force on the empty bottle. Therefore the bottle has a positive buoyancy and will float on the water.

If you begin to fill the bottle with sand so that the combined weight of the sand and bottle is 9 pounds, there is 9 pounds of gravitational force pulling the bottle down. This will cause the bottle to sink farther into the water but remain afloat due to the 10 pounds of upwards force (greater than the 9 pounds of downward force) from the 5
liters of water being displaced by the volume of the bottle. If you continue to fill the bottle until the total weight is greater than 10 pounds (12 pounds for this example) the bottle will have more downward force than the upward force of the water being displaced and will no longer float. This is known as negative buoyancy and in the case of a freediver or any other object in the water will sink to the bottom.

For the freediver it is important to find the balance, where there is positive buoyancy on the surface (and 3-4 meters from the surface), neutral buoyancy at a given depth, and negative buoyancy below that. This allows for the most efficient diving where you can float and relax while conserving energy on the surface in preparation for the dive, use minimal effort to reach a target depth, then return with a margin of safety helping you float effortlessly the last few meters to the surface.
Boyle's Law

Boyle's law states that the volume of a gas at constant temperature is inversely proportional to the pressure exerted on it.

What this is saying is that as the pressure increases with a freediver diving to depth, all cavities of air (gas) decrease in the same proportion. To better understand this we must first establish that at the surface (sea level) there is a given force said to be 1 atmosphere. This 1 atmosphere is the total weight or pressure of the Earth's air (from sea level to the edge of the atmosphere) that we experience everyday. This same pressure is applied for every 10 meters (33 feet) of water we immerse ourselves into. When we take our final breath of air at the surface and begin our descent the pressure of the water has an immediate effect on all the air we take with us. When we reach 10 meters the pressure we experience will be twice (2x) as much as that at the surface. Therefore our volume of air will be inversely proportional to this by being half (1/2) the volume as that which we started with at the surface. As we increase our depth to 20 meters (another 10 meters/ 1 atmosphere) we now experience three times (3x) the pressure which will decrease our volume of air in proportion to one-third (1/3). This relation of pressure to volume of gas (air) will remain constant at any depth.

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P (pressure) x V (volume) = K (constant)

Surface \hspace{1cm} P (1) x V (1) = K (1)
10 meters \hspace{1cm} P (2) x V (\frac{1}{2}) = K (1)
20 meters \hspace{1cm} P (3) x V (\frac{1}{3}) = K (1)
30 meters \hspace{1cm} P (4) x V (\frac{1}{4}) = K (1)

The importance of Boyle's law is not only applied to the air in our lungs, but to the air spaces in our ears, sinuses, and mask. These air spaces are made up of rigid and semi-rigid material making it necessary to equalize the pressure within to match the increasing water pressure while descending to depth. To equalize the air space within the ears and avoid rupturing the eardrum there are several methods that can be used. The simplest method involves manipulating the muscles in the throat and jaw in order to open the Eustachian tubes. The other method for opening the Eustachian tubes and equalizing the inner ear air space is with the Valsalva Maneuver and the Frenzel Maneuver (both of which will be covered in a later section). *Note: It is important to stop any dive if you begin to feel pressure or pain in your ears and try another equalization method. Equalization of the sinus cavity is mostly automatic due to being better connected with the respiratory passages. Equalization of both the ear and sinus air spaces can be compromised by being blocked with mucus (from a cold or improper diet) and it is important to not dive if discomfort is felt in the descent.

The mask is another air space that's volume will be reduced with increased depth. The air space in the mask needs to be equalized to avoid damaging blood vessels in the eyes and surrounding tissues. To equalize the mask it is as simple as breathing air into the mask through your nose as soon as you feel a slight suction. Like equalization of the ears, the mask should be equalized often and before pain or discomfort is felt.
Resistance of Water and Velocity

*R (resistance) of water is proportional to V (velocity) cubed*

The resistance of water and its effect on objects moving through it is important to be aware of since small improvements in streamlining can have large results on efficiency. With water resistance proportional to velocity cubed, then each time a small amount of resistance is either added or subtracted, the velocity of that object either slows down three times or increases three times its original speed. In freediving this has huge implications where instead of applying more power and thus using more oxygen to increase velocity, by simply streamlining your form and/or technique you are able to more efficiently increase velocity. Streamlining can come from modifying the equipment you use or how it is used. It can also come from evaluating your form and technique when moving through the water. Obviously the easiest way to improve your resistance in the water is to streamline your equipment. This takes no training or practice. It is simply achieved by using freedive specific equipment which is designed to be the most streamlined equipment available. On the other hand what you can do to see the largest improvements usually comes from improving hydrodynamic form and technique in the water. This can be achieved through the use of video to review your technique but a professional instructor will be able to help point out areas to improve and get you to the most efficient form possible.
Thermal Conductivity of Water

Water conducts heat out of the body twenty times faster than air. For this reason thermal protection, found in a quality wetsuit, is necessary. Wetsuits work by capturing a layer of water between the material and the skin that is then heated by the body. For this reason proper fit is important, too loose and cold water circulates over the body, too tight and circulation of warming blood is reduced making the warming process not possible. Proper body temperature must be maintained in order to be an efficient diver. Being cold leads to shivering which uses energy to activate muscles to shiver as well as being mentally stressful which makes it difficult to relax. At the same time being too hot in a wetsuit causes dehydration as your body perspires, trying to cool the body which in turn thickens the blood and requires more energy to circulates. Being too hot is also mentally stressful and distracts ones ability to relax and focus on the task at hand. Wearing a suit that is too thick also requires more weight and is less flexible, both of which require more energy than is necessary for the conditions.
Physiology of Freediving

Now that you have a basic understanding of the physics involved with freediving and the aquatic world we will look at the physiology of freediving to gain an understanding of how the human body works in this environment. Many of the things involved with the physics of freediving will help you understand the physiology of freediving, or why our body reacts the way it does and therefore the best approach for becoming an efficient freediver.

Equalization

Equalization of the ears is also a result of shrinking air volume within the middle ear space due to the increasing pressure as you descend. In order to avoid damage to the flexible membrane (ear drum) separating the middle ear and outer ear, this air space must be equalized to match the increasing outside pressure. One of the most important factors for successful equalization is to equalize often, before you feel pain! This can start on the surface before the dive begins and be preformed every meter or so. The most important thing to remember is to equalize before you begin to feel any pressure on your inner ear. By equalizing often and at regular intervals you will avoid the pressure building to a point where you are no longer able to equalize and the dive must be aborted.

Methods for equalizing this inner ear air space include: (a) manipulating muscles in the jaw and throat, (b) the Valsalva Maneuver, and (c) the Frenzel Maneuver. Manipulating the jaw and throat muscles to equalize is the most simple method but it only tends to work for individuals with large and flexible Eustachian tubes. Although these muscles can be exercised to improve the odds of this method working it is usually only a case where it either works for you or not. It is also typical that people who are able to equalize using this method are unaware of what they are doing and it just seems to come naturally. Common techniques for this method include thrusting the jaw down and
forward to to hear a “pop” of the Eustachian tubes opening, wiggling your ears in a manner similar to how your ears move when you smile, or a movement in your throat like yawning without opening your mouth. You can test all these methods in just a few meters of water and if you are successful and do not feel any pressure or pain can probably continue using this method to depth as long as you do it very often and never allow pressure to build. Many people who master this technique are able to actually hold the Eustachian tubes open and never have to “pop” their ears since the pressure is being equalized nonstop. Consider yourself lucky if you are able to equalize using this hands free method.

Valsalve Maneuver

The Valsalve Maneuver is the next most common and automatic method to learn. With the nose pinched closed pressure is applied in the chest in an attempt to blow out the nose. This pressure is a result of using muscles in your chest and the diaphragm to create an positive pressure to equalize the ears. The problem with this is that the air in the lungs all the way to the ears has to be pressurized equally which limits its effectiveness due to shrinking lung volume during a dive. A good test to see if you are using the Valsalve method is to place your free hand on your chest and feel for movement. Since this technique requires the you to engage the muscles in your chest surrounding the lungs to create the positive pressure you will be able to feel this movement in your chest. Unlike other equalization techniques, the use of these large muscles in the chest each time you equalize also burns precious oxygen. Not only is this detrimental for the use of oxygen, but by tensing the muscles in the chest it also tightens the surrounding muscles all the way up the neck and to the Eustachian tubes. Holding tension in this area makes equalization difficult because the Eustachian tubes need to be relaxed and flexible in order for them to open and allow air to pass through them. Although this method is the easiest to perform, due to it's limited effectiveness and the large amount of energy required it should not be a focused technique for aspiring freedivers.

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Frenzel Maneuver

The preferred method for equalizing the ears is with the Frenzel Maneuver. This method involves using the tongue as a piston and pressurizing a small area of trapped air to equalize the Eustachian tubes. This technique involves pinching off the nose, closing the throat with the epiglottis (as if about to strain lifting a heavy weight), then actively moving the soft palate to produce the distinct “popping” noise that is produced when equalizing the inner air space. A good indication to tell if this method is being preformed properly is by watching to see if the nose inflates around the fingers pinching the nostrils and by feeling the “Adams apple” on the throat move up and down. You should also be able to place your free hand on your chest and NOT feel any movement. Unlike the Valsalve method which requires the use of multiple muscle groups in the chest, the Frenzel only uses the back of the tongue to press against the soft palate to compress the air in the nasopharynx. This air is directly connected to the Eustachian tubes so each time you put pressure on the soft palate and create a positive air pressure in the nasopharynx, it also pressurizes the Eustachian tubes and equalizes your ears. Since this function of equalization only deals with a small, isolated air space and is created by the piston action of the tongue which is a strong muscle, the Frenzel maneuver is effective to much greater depths.
Mammalian Dive Reflex

To understand the mammalian dive reflex let's go back to the womb and the first nine months of life. During this time we are suspended in a liquid world and this memory remains engrained in our genetics, awaiting the immersion in water to reawaken these reflexes that stay with us. These involuntary reflexes are apparent in newborns who naturally know how to swim, hold their breath, and have automatic physiological adaptions to conserve oxygen when placed in water shortly after birth.

As a freediver the more you are aware of this reflex, understand how it works and how you can benefit from it, the better your underwater experience can be. Although the dive reflex happens automatically it still takes time to have effect, especially for the novice diver who has left this part of their genetics untapped since birth. The good news is that with practice this reflex can be strengthened and the time necessary for it to take effect can be shortened. The dive reflex begins as soon as the face is submerged in water and grows stronger with the amount of time you are submerged and with the increasing pressure associated with depth. Effects of the dive reflex include a reduced heart rate, an increase in blood pressure and a general relaxation of all muscles. These are all survival mechanism of the mammalian dive reflex which are a result of steadily building Co2 levels and decreasing oxygen levels. These efforts are all aimed at conservation of oxygen. They are the body's natural defense to protect the vital organs (mostly the brain) in the event of a life threatening situation. These self defense mechanisms can be used to the advantage of the freediver by understanding what is happening and by going with the flow, allowing the body to do what comes naturally. Signals that alert the diver that the body has registered the mammalian dive reflex and has began it's automatic self defense system is through signals to the brain to breath. As the desire to breath increases so does the urge of the lungs to continue to breath against our forced breath hold. Holding these muscles motionless for an extended period along with a building urge to breath creates “spasms” or contractions of the diaphragm. These contractions are the muscle of the diaphragm trying to pull down in order to take a breath against the mind telling the body to hold the breath. Being aware of these signals and understanding how our body is reacting to them
is valuable knowledge. It is with these feelings and signals that we know the dive reflex is working and has been activated by our subconscious. Without these signals the body continues to operate at its normal levels, consuming oxygen and producing Co2 at a rate similar to that if breathing was still taking place. Although the mammalian dive reflex is not comfortable with its signals to breath and contractions of the diaphragm, it is a welcomed and needed response in order to have a safe dive.

**Blood Oxygen Saturation**

As blood is pumped throughout your body it carries and uses oxygen that is brought into the system via the lungs. The percentage of oxygen in your blood varies depending on the work load your body is under. The higher the work load the more energy is required, therefore the more oxygen is used. As a freediver this is an important concept not only after the final breath is taken, but also in the few minutes BEFORE the final breath. The goal here is to maximize the highest blood oxygen saturation level possible before the dive, which will lead to higher levels during the dive. The easiest way to achieve this is to relax and keep your movements to a minimum for three to five minutes before your dive. This is the amount of time it takes for your blood to make one complete circuit through your body and become replenished with oxygen. The more time you spend on the surface working to reduce your heart rate and minimize your movements, the higher the blood oxygen saturation rate. This state of awareness and relaxation is then carried over to the dive itself to once again conserve the limited amount of oxygen you have after the final breath.

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Blood Shift

One of the most common questions and mysteries of deep freediving is how the body can survive the pressures of the deep. How do the lungs not implode by the crushing pressure? It is a very logical question that can only be answered by understanding how the body adapts to protect its vital organs in a process called the blood shift. This blood shift has also been observed in many air breathing, deep diving mammals such as whales, dolphins, and seals. To understand what is happening to the body and the lungs in particular we must remember Boyles Law and recall that the volume of gas (air) is inversely proportional to the pressure exerted on it. As we dive the volume of air in our lungs decreases and in theory should at some point no longer be able to withstand the pressure and collapse. What the body does to keep this from happening is called the blood shift. The body moves blood from the extremities such as the arms and legs and moves it to protect vital organs including the lungs. This blood shift moves blood to occupy the vacant space left from the shrinking lung volume and since solids such as blood and bone are not compressible this keeps the lungs from being crushed.

The positive effects of the blood shift (besides allowing our lungs to continue to be compressed without damage) is an increase in blood pressure through vascular constriction. Vascular constriction is the shrinking of the arteries and veins that carry blood throughout the body. This is caused by the increasing water pressure being applied to our bodies as we dive to depth and is what causes the blood shift. This increasing blood pressure also allows our heart beat to decrease. A good way to visualize this is to think about two different size pipes carrying water and the pump is our heart. The large pipe will move a large volume of water and require a lot of force (or pumps from the heart) in order to move a certain amount of water. The smaller pipe (represented by vascular constriction) will move the same amount of water with less force, or less pumps of our heart.
Relaxation and Breathing Technique's

Approach to Relaxation

Learning to be aware of your breath and being in a state of relaxation is the best way for a freediver to prepare oneself for a deep dive or just a long and enjoyable breath hold. In the past freedivers used a more forceful approach to apnea (the art of holding your breath). This technique was based on a form of hyperventilation in which the diver forced the body beyond its limit with rapid inhalation and exhalation. The thought was that this type of breathing was purging the body of harmful CO2 and therefore increasing the level of O2 (oxygen). Unfortunately it is impossible to increase the level of oxygen in your body by increasing your breathing. The only effect from hyperventilation is a decrease in the level of CO2 going into the dive. The downfall of this technique is within this lowered level of CO2 which postpones the mammalian dive reflex. This has many negative results including a delay in reducing the heart rate, continued steady consumption of oxygen, and a lag time in alerting the body and mind of the need to breathe. This dangerous combination leads to a false sense of well being at depth until upon ascent where the water pressure declines, CO2 levels spike and oxygen is sucked out of the blood stream to refill the re-expanding lungs.

For this reason hyperventilation is the most common cause of freediver deaths with “Shallow Water Blackouts”.

Today technique's used by top freedivers are centered around an idea of “relaxed apnea”. This approach encompasses many components dealing with relaxation, such as stress and anxiety, both physical and psychological. To get the most out of this technique we must eliminate all sources of stress and anxiety and in the process use certain breathing techniques to help reach a state of relaxation necessary for a positive and enjoyable experience.

In order to completely relax and get the most out of each dive we must understand and confront all forms
of stress and anxiety. Anxiety is a sensation that arises from situations that we are uncomfortable with or that pose a danger. If not confronted, these situations then lead to an ongoing state of being otherwise known as stress. As a freediver many negative effects happen to the body from anxiety and stress. These include an increased rate of breathing, difficulties breathing (associated with a shortness of breath), vasoconstriction (a reduced amount of oxygen supplied to all tissues), which in turn increases your heart rate and oxygen consumption, and a general reduction in muscular activity producing feelings of uneasiness and discomfort. Anxiety and stress also have negative effects on the digestive system, bringing about nausea and indigestion which further distracts the mind and your ability to relax.

Causes of stress in freediving include the physical demands of the sport, mental challenges associated with your ability and of the marine environment, as well as equipment problems and environmental conditions. Conditioning yourself for the physical demands of freediving involve keeping physically fit, eating a proper diet, getting adequate sleep and not smoking or drinking alcohol in excess. The best exercise for freediving is freediving. The more we do an activity the better we become at it and the more comfortable we are, therefore reducing stress. Eating well, getting plenty of rest and not smoking or drinking keeps our bodies feeling and operating their best. This benefits our body both physically (by allowing it to operate at its best) and mentally (by feeling good we are more confident of our ability). Preparing yourself for the mental challenges means being in a clear and stable state of mind. This is viewed as being able to think clearly and positively so that you are able to react to situations as they arise in the best way possible. Through learning proper freedive techniques and practicing safety procedures you condition your mind to know how to deal with stressful situations so that when they do arise you are confident in your skills and know what to do. Practice makes perfect. Mental conditioning to reduce stress is also facing your fears and educating yourself about the facts. Sharks are a huge source of fear and stress for many people.
By educating yourself about sharks, their behaviors, the different kinds and learning how to behave when confronted with a shark you will be much better prepared once you do encounter a shark. Also the more you encounter sharks the less stressful each encounter will be. Stress involving equipment problems requires getting to know your gear through use, general maintenance and inspection. By doing this you will be able to foresee problems or at least know how to deal with them as they come about and reduce stressing over faulty equipment. For this reason it is best to use only quality gear and freedive specific equipment that you can trust. Evaluating environmental conditions to minimize stress involves doing everything you can to determine the situation you are about to put yourself into before you dive in. This includes monitoring wind strength and direction, water temperature, air temperature, currents, visibility, sea state and any other environmental condition that will affect your dive. Attention should be paid throughout the day because all of these conditions can change quickly and corrective actions should be taken to avoid a dangerous situation. By understanding all of these causes of stress you can begin to deal with each one in an effort to find inner peace and relaxation which will lead to an improved freedive performance.
Diaphragmatic Breathing

Since we breathe from the day we are born till the day we exit this Earth, most of us give little thought to this ongoing movement of life. Our everyday breaths tend to be shallow and short compared to our total lung capacity and for this reason the muscles involved are tight and restricted from not being used to their potential. But before working on stretching the muscles involved, we need to develop an awareness of our breath. This simply means taking the time to listen, feel and be conscious of how our breathing flows. By doing this we are then able to control our breathing and use this control as a technique to relax. This control and awareness during the preparation of a dive not only guarantees minimum use of oxygen by reducing the body's metabolism, but also brings about an inner peace and greater awareness of oneself and surroundings which in turn makes for a more enjoyable and safer dive.

Both yoga and meditation refer to respiration techniques that focus on diaphragmatic breathing to help bring a better awareness to the breath and the body. The diaphragm is the flat plate of muscle between the stomach and lungs and plays a fundamental role in breathing. Our lungs can be visualized as two pyramids with the widest segment and therefore the most volume at the bottom connected to the diaphragm. Knowing this it becomes apparent of how important the diaphragm is for the freediver looking to maximize lung volume. Breathing with our diaphragm is something we are born doing, but through social and cultural pressures we repress this natural form of breathing with a more restricted style of breathing that keeps our belly's sucked in for a more slimming appearance. To reconnect with diaphragmatic breathing we need to start by “feeling” our breaths and visualize each breath flowing in through our nose, filling our lungs, then flowing back out all in a fluid exchange. It helps to close your eyes, bringing all your attention to your breath. As you work on this concentrate on remaining completely calm and relaxed, which will allow you to address any discomforts, becoming more aware of your entire body and discovering new levels of inner peace. Strive for a slow and fluid exchange of your breath to find a pace in your breathing that promotes a relaxed feeling. Once you discover this rhythmic pattern

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practice it as often as you think about it throughout the day. As you explore your rhythm of breathing you can then begin to incorporate deeper diaphragmatic respiration techniques.

The most basic technique for learning to improve diaphragmatic respiration is best done by laying on your back with your knees up. Put one hand on your chest and your other hand on your belly. As you inhale, focus on the air flowing into the bottom of your lungs causing your belly to rise. To concentrate on only breathing with the diaphragm, take normal breaths and make your hand on your belly rise with the inhale. The hand on your chest should remain still. As you exhale push the air out with the muscles in your stomach area (the diaphragm), causing your belly to collapse and the hand on it to drop. Again the hand on the chest should not move. The purpose of placing your hands on your chest and belly are to feel your movements during your breathing, with the hand on the chest remaining still and the hand on the belly moving up on the inhale and down on the exhale. This also makes a physical connection with the signals of your brain that are controlling the muscles of the diaphragm. The more you practice breathing with the diaphragm the stronger the brain signals are connected to the diaphragm and the more automatic this style of breathing becomes. This way when you go to dive and have all kinds of other distractions you can simply place you hand on your belly, feel that you are breathing with your diaphragm, know that you are breathing correctly which will allow you to turn your focus on the dive. As you practice this technique you can begin to push your physical limit on both the inhale and exhale, actively exercising and stretching the diaphragm. This is a good exercise to do when you lay down to bed at night (do not use a pillow). Since you are already laying down for bed means you will be doing this at least once a day. Another benefit of doing it before you go to sleep is the connection of going into a relaxed state that comes from breathing with the diaphragm while performing the exercise.
Building on this basic technique we then move on to understand that each complete diaphragmatic respiration consists of three phases:

- abdominal (diaphragmatic)
- thoracic (chest)
- clavicular (top of the lungs/chest extending into the throat)

Again, visualizing each breath flowing in through your nose, first filling the lower cavity of your lungs and raising your belly in the process (abdominal phase). The breath then moves it's way up, filling the chest area (thoracic phase) and this time expanding the ribcage. Finally reaching the clavicular phase the breath then fills the top of the lungs and trachea, causing the shoulders to rise to gain maximum volume. In the exhale phase the same process should be experienced in the reverse order ending with the belly sucking in to push the diaphragm up, expelling the last bit of air. To help understand the correct inhalation process it is useful to picture your lungs as three different sections, each section having to reach maximum capacity before the next section is opened. For the exhalation process a useful image is to see your lungs as a bag with the air being rolled out from the top down, with the last bit of air squeezed out with the diaphragm flattening the bag. Another extremely important detail is that the breathing must remain fluid with the duration of the exhalation at least twice as long as the inhalation. This inhale to exhale ratio is fundamental to diaphragmatic breathing and promotes the body's automatic response for relaxation. Keep in mind that if at any point you become lightheaded or dizzy this signals hyperventilation and the technique should be slowed down. This technique will require a bit of practice and concentration to be preformed correctly, but will provide you with a solid foundation for the correct freedive breathing technique.

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Breathing Cycles

There is no “one” correct breathing cycle for all applications of apnea. The same technique is not used for a static apnea where you remain motionless on the surface as is used for a maximum depth dive or for the 50th dive of a day spent spearfishing. In each of these applications the body is in a different internal balance (different O2 and CO2 levels, blood pressure, heart rate, etc.) due to previous actions leading up to that point. Therefore the breathing cycle will be different for each. It will also be different because each of the dives requires something different from the body for the required task. Using diaphragmatic respiration to listen to your body's needs in combination with using it to reach a complete state of relaxation is a key fundamental in all applications. The overall focus here should be on diaphragmatic breathing.

For the purpose of this manual we will focus on learning the correct breathing cycle for a standard dive to depth. In preparation for a single dive to depth (where there has been a substantial surface interval between dives – for example, at least five minutes) the correct breathing cycle begins with normal everyday breathing. This type of breathing balances the O2 and CO2 levels in the bloodstream where the body operates most efficiently. Your body has an amazing ability to take care of itself and bring itself into balance with our normal respiration. As you become aware of your breath in this stage, a conscious shift to diaphragmatic breathing should follow. This shift should focus on using only the diaphragm with normal breathing inhalations, followed by slow, relaxed exhalations. If at any point you feel dizzy or lightheaded this is a form of hyperventilation and the breathing cycle should be slowed down.

Once you have been breathing for a few minutes using normal diaphragmatic respiration and feel relaxed and comfortable, it's time to take the last couple breaths before the final inhale. These last couple breaths, also know as purging breaths, are 2 to 3 full breaths to help bring fresh air into the deep part of your lungs. This should not be confused with hyperventilation which is an extended period of deep breathing that causes feeling lightheaded or dizzy. Hyperventilation should be avoided, and you feel these symptoms at any point during the breathing cycle further dive preparations should be aborted and normal breathing should be resumed. The final exhale before the last breath should be a full exhale using the diaphragm to expel as much air as possible. Doing this removes as much stale air as possible and prepares the lungs for the final breath. The final breath should be a fluid inhale that begins with dropping the diaphragm to pull air into the lower region of the lungs. As this becomes full this feeling of fullness should move up
into the chest cavity expanding against the ribs in an effort to get the largest breath possible. The last area to pack air in is in the clavicular (top of the lungs extending into the throat). As you gasp and raise the shoulders to fill this last region you now have a full breath of air to take with you on your dive. Remember the final breath for a freedive should be a full diaphragmatic inhalation, completely filling all three levels of the lungs.

Recovery Breaths

Although the breathing we do before our dive prepares us for a safe and enjoyable dive the breaths we take upon returning to the surface are the most important. These first breaths we take upon surfacing are known as recovery breaths. Recovery breaths consist of 3 “hook” breaths followed by deep breathing while under the supervision of your dive partner.

A “hook” breath is performed with a controlled exhale of only half your lungs volume followed by a full inhale that is held and put under pressure for 2-3 seconds. Two very important aspects of the recovery hook breaths are that the exhale is a controlled partial exhale (only about half the lungs volume) and that the breath in is put under pressure. A controlled partial exhale is fundamental for safety, whereas a full and forceful exhale at the surface can lower the partial pressure of oxygen to a level low enough to bring about a blackout. A partial exhale also saves precious seconds in being able to inhale sooner and make the difference between a clean recovery or what could be a surface blackout. The act putting your breath hold under pressure for 2 - 3 seconds on the recovery breaths builds up blood pressure which quickly delivers freshly oxygenated blood to key organs such as the brain.

This part of the hook breath incorporates the same technique that Navy fighter pilots use when going into high speed maneuvers that put their body under high G forces. Navy pilots must keep blood from being pulled from their brain while undergoing high gravitational forces which could ultimately lead to a black out. In order to force blood back to their brain they use pressurized suits and something called the Anti-G Straining Maneuver. Since as freedivers we will not be wearing pressurized flight suits we can look at the Anti-G Straining Maneuver as a way to force freshly oxygenated blood to our brain as quick as possible upon surfacing. To help us understand how to perform the Anti-G Straining Maneuver we can look at the United States Navy Flight Manual:
There are two components of the recommended Anti-G Straining Maneuver (AGSM)

1. A continuous and maximum contraction of all skeletal muscles including the . . . chest and abdominal muscles. Tensing of the skeletal muscles . . . assists in retaining or returning the blood to the thoracic (chest) area, the heart and brain.

2. The respiratory component of the AGSM is repeated at 2.5 – 3.0 second intervals. The purpose of the respiratory component is to counter the downward G force by increasing chest pressure by expanding the lungs. This increased pressure forces blood to flow from the heart to the brain.

By incorporating these maneuvers into the “hook” breath we are able to take advantage of the same increased pressure to force blood to flow from the heart to the brain and a safe recovery. These are the most important breaths of a freedive and should be practiced on every dive, not just on difficult dives. By ingraining this technique of recovery breaths into our subconscious through repetitive practice it is more likely that we will automatically breath like this if we are close to a black out and not thinking clearly.

Following the hook recovery breaths is a return to more normal heavy breathing like that of being winded from a foot race. These breaths work at expelling the built up CO2 that have been accumulating during the dive. As the level of CO2 drops the level of Oxygen increases to a point where a black out is no longer a threat. This does not happen immediately but takes about 30 seconds after surfacing. For this reason it is important for the safety diver to watch the diver for these 30 seconds before they do anything else. If the diver was struggling on the surface and appeared to be close to a black out then the safety diver needs to continue watching the diver until a complete recovery is certain and then communicate what they observed.

A common guideline for a safe surface interval time is for it to be at least twice as long as the dive. So if you had a 1'00” dive, then you need to have a surface interval of a minimum of 2'00” before your next dive. If your dive was 1'30”, then your minimum surface interval should be 3'00”, and so on. This is only a guideline for minimum surface interval times to allow for a complete recovery. As always you should use common sense and listen to your body if you need more time than given by this guide.

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In Water Technique

In the following section we will look at basic techniques such as proper weighting, operation of a quick release weightbelt and the duckdive that can be applied while in the water to become an efficient and safe freediver.

Weighting

The proper technique for correct weighting is being able to be neutrally buoyant at a certain depth. Weighting is controlled with lead weights that are most commonly worn on a belt. The amount of weight required to be neutrally buoyant will change with factors such as wetsuit thickness, whether diving in fresh or salt water or extra gear. If you do not dive very often you might notice that changing body fat percentages will effect your buoyancy.

To find your correct weighting you will need to have on everything you are planning to dive with. If you are going to using a camera or any other equipment that is not neutrally buoyant you will need to have this with you as well. Finding your correct weight requirements should be done at the beginning of your dive session. This will help you to be the most efficient and safe from the beginning and is also a great time to test all your equipment while you are still close to the boat or shore. Since you will be doing this right after you put your wetsuit on and is the first time you will have been in the water it will be necessary to get out all air trapped in your suit. Flooding the hood, extending the arms up and diving down a few meters will all help get pockets of air out of your suit that will affect buoyancy. Once you have all your gear situated you need to determine the average depths you will be diving to. Neutral buoyancy is found by diving to the determined depth, assuming a horizontal position, and without moving you neither float nor sink. For beginners who might be diving to an

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average depth of 10m (33’) weight yourself to be neutrally buoyant at 3-4m (10-12’). As you increase in depth you will decrease the amount of weight required. So if your average depth increases to 20m (66’) you will remove weight in order to be neutrally buoyant at 6-7m (20-22’). The same theory continues as you dive deeper. So for a 30m (100’) dive you will continue to reduce weight in order to be neutrally buoyant at 10m (33’).

It is extremely important to remember that the last few meters of the accent are where a blackout is most likely to occur and therefore we should be positively buoyant for safety. Using this weighting technique to our advantage we can then put into practice slowing down our accent in the last few meters and allowing the positive buoyancy to assist us to float to the surface, conserving precious oxygen in the last stages of a dive. Being positively buoyant at the surface with a natural exhale is a must at all times. In the event of a black out this safety margin will keep you afloat where your recovery from your dive partner will be much easier. If you are the slightest bit negatively buoyant on the surface and have a black out you will sink with increasing velocity the deeper you go. This makes recovery extremely difficult or impossible if in water too deep to reach the bottom. In all diving situations being able to float on the surface will allow the diver to relax in preparation for a dive as well as help in the recovery after the dive is completed.

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Quick Release Weightbelt

Quick release of a divers weightbelt is an important skill to learn in the event of an emergency for yourself or in the recovery of a fellow diver. Once the weightbelt is released the diver becomes positively buoyant and will float on the surface. All diving specific weightbelts are designed with a quick release buckle, and all work on the same principal. In order to release a quick release weightbelt it is necessary to locate the tail of the belt and give it a pull to disengage the buckle. At this point the buckle will remain open and the belt can be discarded in order to assist with the diver in trouble. It is therefore important when sizing a weightbelt that the tail is not cut shorter than 6-8 inches when wearing your thickest wetsuit and all the weight you will be wearing. Most dive weights require you to weave the belt in and out of each weight which takes an inch or so of the length off the belt. Remember this fact when sizing and cutting your belt as the more weight you put on a belt the shorter it becomes. As the old carpenter saying goes “measure twice, cut once”. Once you have cut your belt to the correct length and have a solid 6-8 inch tail this will provide a positive handhold for activating the quick release buckle. It is also important to note that the tail of the belt should not be tucked under the belt. The tail needs to be easily accessible to your dive partner in the event of an emergency.

Duckdives

An efficient transition from floating on the surface in a relaxed and static position to propelling yourself into the depths requires correct form and technique. A proper duckdive demonstrates the abilities of a good freediver and will be fluid with an aesthetically pleasing style. A fluid duckdive is not simply a reflection of good style but demonstrates finally tuned efficiency. A forceful approach that incorporates all the steps of a duckdive may get the diver to the bottom quickly, but with movements that waste precious energy (and oxygen). Preforming a duckdive that has a rhythm where each movement flows into the next demonstrates maximum efficiency and aquatic skill. This skillfulness in the transfer of energy in motion is most critical at the surface where the freediver is most buoyant and has to break surface tension. For this reason a properly executed duckdive is one of the most important maneuvers to learn. The transfer from swimming on the surface to immersing oneself requires precise technique and can be done with either a square duckdive or a spearfisher's duckdive.
Square Duckdive

Floating on the surface with the face submerged and breathing through the snorkel is a comfortable position to maintain while we prepare for the dive ahead. With proper weighting we should be able to float with no effort. Our only movements should be slight sculling of the hands or fins in order for us to maintain position. At this point the body is relaxed and the focus is down into the depths. This will allow for our concentration to be directed to correct breathing with the diaphragm and relaxing.

Since most people's legs tend to be negatively buoyant and sink with the addition of long blade fins we need to generate a little forward momentum to get the legs up to the surface and in line with the body. This forward movement can be made with the arms by doing one breaststroke bringing the arms along side upon completion, or by a few small kicks that will bring the legs up to the surface and the arms along side. At this point the arms extend down in a reverse stroke to a perpendicular position which stops the forward motion. In rhythm with the arms completing this reverse stroke a bend at the torso begins. The bend at the torso initiates the directional change from along the surface to towards the bottom in a straight line. The legs should remain straight and as the bend in the torso nears a 90 degree angle both legs are lifted out of the water. The aim at this point should be to have a fluid yet aggressive transition into a straight form with both legs out of the water and aligned with the body.

Attention should be made not to over throw the legs causing them to either bend at the knees or pull the body into a back arch. Both of these will be detrimental in the goal of using the weight of the legs extended straight out of the water to drive the body down with no other movement necessary. The final position is with arms extended towards the bottom, head between the arms with the chin tucked in (not looking at the bottom – looking down hyper-extends the neck, arches the back and thrust the chest out – all of which create an inefficient position) back straight, legs together and straight with the toes pointed to keep the fins in line with the body. This “pencil” shape of the body aimed in a straight line towards the bottom is the most hydrodynamic and efficient shape to begin a freedive with. This shape should be held until the tips of the fins are completely submerged. Once the fins are under the surface begin finning in a strong and steady manner. Finning before the fins are underwater is a waste of energy since there is no resistance.

The square duckdive is the most efficient duckdive for deep dives since it generates the
most downward force by exploiting the weight of both legs above the surface. The key with executing this properly is finding the rhythm of the moves to have them flow from one into the next and with the correct amount of effort necessary without over forcing it.

Spearfisher's Duckdive

The spearfisher's duckdive is similar to the square duckdive but extends only one leg above the surface. By only using the weight of one leg to push you under this is not as effective as the square duckdive, but it can be done in a very smooth and quick motion which requires very little effort. For this reason it is chosen by spearfishermen for it's ease and stealthy approach.

With both style duckdives it is important to execute them properly and with maximum efficiency. Finning should never begin until the fin tips are completely submerged. Since the body is most buoyant at the surface and this buoyancy decreases the deeper you go, the more efficient you make this transfer, the less effort is required, meaning less oxygen is consumed, translating to a deeper and longer dive.
Get In The Water

In order to become an efficient and confident freediver time must be spent in the water practicing technique's and getting to know your body and your limits. The most ideal time would be spent focused on a set goal for the each session. By focusing on one goal or technique it is more likely that you will make improvements in that area than without having a goal to focus upon. With this approach to focus on only one goal each practice session will result in a greater improvement in that one area. By making substantial improvements each time you practice, the cumulative improvement in your performance will be greater than if you practice a lot of different things each session but never really spend the time to improve upon any of them. While this focused approach will provide you with the best results to becoming an efficient freediver, any time spent in the water will shape you into becoming a more confident freediver. All forms of water activities will help provide you with a unique relationship with the ocean. Whether you spend time swimming off the beach, playing in the surf, or on a boat, the knowledge that we gain from these experiences builds our confidence in us and in our relationship with the ocean. As long as we always remember to respect the power of the ocean, this confidence will allow us to relax and enjoy going into the ocean on a single breath like we never knew was possible. Spending time in the water also bring out our subconscious genius which unknowingly shapes our aquatic efficiencies. The more time we spend doing anything the more efficient we become, it's a simple human trait of evolution and the same principle is applicable to forming fluid and efficient style in the water. So get out there and get in the water, it's the best teacher.

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O2 & CO2 Training Tables

O2 and CO2 training tables are a great way to work on increasing our breath hold capability without having to get wet. These tables can be done almost anywhere, just make sure you will not be putting yourself or others in danger if you push yourself to a black out. They are best done while sitting in a comfortable chair where you are able to completely relax. It's also a good idea to let people around know what you are doing in case you need assistance or so you just don't frighten them. It will also keep them from asking you questions in which case you'll feel awkward by not answering or ruin your table and have to start over.

O2 tables work on building your tolerance to low O2 levels which come from extended breath holds. These tables are great for building an awareness of the steps your body goes through during an extended breath hold. By having a set recovery time that allows for a complete recovery of O2 and CO2 levels, these breath holds are designed to lower your heart rate and extend your breath hold time with each set.

CO2 tables work on building your tolerance to high CO2 levels. In a normal breath hold the CO2 level increases as the O2 level decreases and it is the increased CO2 level that sends the signal to the brain that we need to breath. These tables do not allow the body to expel significant levels of CO2 and therefore each preceding breath hold starts with an increased level of CO2. This brings an awareness of the feelings associated with high levels of CO2 such as contractions of the diaphragm and a strong desire to breath. Working with this awareness and pushing our tolerance level in spite of the effects of high CO2 levels in turn will increase our overall breath hold time.

Tables can be modified for personal goals by increasing/decreasing Apnea times by multiples of 15 seconds. For O2 tables the initial time of apnea should be 50% of personal best. For CO2 tables the apnea should be 50-60% of personal best.
<table>
<thead>
<tr>
<th>O2 Table</th>
<th>CO2 Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recovery</td>
<td>Apnea</td>
</tr>
<tr>
<td>1.</td>
<td>2:00 min</td>
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<tr>
<td>2.</td>
<td>2:00</td>
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<tr>
<td>3.</td>
<td>2:00</td>
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<td>4.</td>
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<td>5.</td>
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<td>6.</td>
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<td>7.</td>
<td>2:00</td>
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<tr>
<td>8.</td>
<td>2:00</td>
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</tbody>
</table>

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Freedive Training Apps

There are also Apps for freedivers on iphone's and android smartphones. These are cheap and fun Apps that you can take with you and that keep track of your progress so you can see your improvements. The following Apps are for iphone's.

**HoldBreath – Freediving Trainer by Kamil Bujniewicz ($2.99)**

This is a training App that helps Freedivers improve their breathold using a number of tables such as CO2 and O2 training.

The App features the following:

- CO2 tables
- O2 tables
- MIXED tables
- Custom tables
- SOUND FEEDBACK
- CONTEST MODE (voice) with AIDA rules counting
- VIBRATIONS feedback
- STOPWATCH to measure your apnea times with easy, big stop button and optional warmup time
- LOGBOOK to track your performance with optional note
- GRAPH VIEW for logbook to see your performance in more interesting way
- PLAYLIST selection used for both training and stopwatch – use your own music during trainings

The App has a clean appearance, loads quickly and covers all the bases when it comes to breathold training. The ability to have a logbook, store personal bests and add playlists of music is a nice touch.
Apnea for Free Divers by Netanel Software ($3.99)

Apnea for freedivers is designed to work with both iPhone and iPad.

Here are the features available:

- The application contains exact instruction how to use and improve your diving time
- Apnea’s breath test will automatically generate CO2, and O2 intervals to start your workout
- support customize workouts
- unlimited workouts Log
- option to copy log results to Email
- All possible workout alerts (Man/Woman speech, relaxing sound, vibration)
- log Management (delete all/single workout)
- Application supports both iPad and iPhone

iApnea by powerLABS (FREE)

Another training CO2 and O2 App that has logging capabilities. Functionality is the same as the other Apps, however the main difference for this App is that it is free.
Other Training Techniques

Obviously the best training for freediving is freediving itself. Unfortunately most people are not able to go diving on a regular basis and alternate forms of training are required to continue improving. A term that describes the best approach to training is “specificity”, meaning the closer your training is to your specific goal the more effective the result. This is why if you are looking to improve in depth freediving the best training is by going out and diving to depth as much as possible. If you are looking to improve your breath hold time then practicing static apnea in a pool or working on CO2 and O2 tables will give you the greatest result of improvement. The problem is that if you only practice one specific thing over and over it becomes extremely boring and difficult to keep motivation levels high. Most people discover the sport of freediving through a much more recreational sense where there is a lot of enjoyment found in being in the water. Whether the pleasure is found through being weightless in the water, learning about fish and all the aquatic creatures or through spearingfishing and the sense of accomplishment that comes from it, our best training can be done if we incorporate some of this enthusiasm. There's no better way to kill your passion of the sea and diving than with training that is not enjoyable. Normal training cycles take an athlete through progress and setbacks and it is during these setbacks that it is fundamental to keep a sense of fun with your training. Nobody is able to train with only continual improvement, setbacks are a part of the learning process and should be expected to keep you form being discouraged. Incorporating play with training will take your mind off criticizing your abilities and help you to improve through a more natural progression than with a forced effort.

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Open Water
Games and ways to incorporate fun in open water include:

– Spearfishing
– Videoing friends freediving, marine life or yourself (be sure to have a dive watch and keep track of your dive time. It is very easy to become preoccupied and lose track of time. Always dive with a buddy and treat this activity with caution)
– Freestyle swimming – it's as simple as bringing out the kid in you and doing underwater flips, twisting and turning and just acting silly in general all while holding your breath.
– Underwater dance party (Only in calm sea conditions) While wearing a wetsuit for buoyancy take off your fins and all your weight to increase your buoyancy, then flip upside down and dance on the bottom of a boat or platform. Use common sense to avoid sharp objects and the danger of a pitching boat.
– Timed underwater races. Take turns timing each other diving to a predetermined depth to see who's the fastest. Change this up by diving with fins, with one fin, without fins, carrying weights or any other creative way you can think of to have fun.
– Practice blowing bubbles rings. Stick your tongue out and try different techniques to get a ring of bubbles to form. An instructional video of this is available at www.brianpucella.com.
– Fill a bottle at depth with air and watching the volume expand as you ascend. You can actually make cool bottle rockets by filling a plastic bottle with air at depth, screw the lid on and when you reach the surface the expanded air has pressurized the bottle. See if your good you can get the bottle to blast off when you unscrew the top.

In The Pool
Games and ways to incorporate fun in the pool:

– Filming and reviewing technique/streamlining. With the introduction of video cameras such as the GoPro, underwater filming is fun and a great way to learn about streamlining and critique form as well as getting to know the operations of the camera.
– Timed underwater distance races. Take turns timing each other or having side by side
side underwater races for a predetermined distance. Change this up by swimming with fins, with one fin, with no fins, carrying weights or any other creative way you can think of to have fun.

- Practice putting on gear underwater without surfacing. Lay your weightbelt, fins, mask and snorkel on the bottom. Practice diving down and putting on all your gear including clearing your mask in one breath. If this becomes too easy try doing it after exhaling half your air or all your air. This activity also helps you become familiar with your equipment and being able to put it on in the water or in not ideal conditions.

**Dry land training**
You can do this at home, work or wherever you have some free time and space.

- **Yoga.** Almost all forms of yoga are wonderful ways to improve your freediving through their connection of mind and body. One particular form of yoga known as pranayama focuses on the breath. Training and working on your mind to breath connection is a major focus of all competitive freedivers and improves depth diving, breath hold times and general enjoyment in the water. An instructional video of this is available at www.brianpucella.com.

- **Apnea walking.** Keep track of your performances by counting your steps or using a stopwatch. It’s best to do this on grass or on a soft surface in the event that you experience a blackout. This is a good way to push yourself and experience the effects of raised CO2 levels so that when you get in the water you can recognize the signals and stay within your limits.

- **Diaphragmatic stretching.** Working on the flexibility of your diaphragm aids in being able to achieve a larger volume of air with the inhale. More importantly having a flexible diaphragm during a dive to depth allows your lungs to compress to a smaller volume which in turn provides greater ability to equalize. The major limiting factor for freedivers looking to increase their depth is problems with equalization. Flexibility of the diaphragm is the best way to increase your ability to equalize with increased depth. An instructional video for this is available at www.brianpucella.com.

- **Meditation.** There is no doubt a large part of freediving is physical conditioning, but the mental aspect of the sport cannot be ignored. Being able to control your thoughts to reduce your heart rate, relax tension, reduce stress and ultimately
enjoy your time in the water plays a major role in advancing your freediving ability. Meditation is a conditioning of your mind to maintain control of your thoughts, and like anything else it takes practice and training.
Safety

In general freediving is a relatively safe activity if a few safety guidelines are always followed. In a confined water environment such as a pool there is little risk of injury aside from a slippery pool deck. In the open ocean you have more concerns with weather, currents, waves and marine animals, but the risk of personal injury is still low if common sense is used. The highest risk across the board with freediving is the risk of drowning. So with such a low risk of personal injury and a high risk of death by drowning it is necessary to focus our attention on how not to drown while freediving.

Any activity in or around water carries the potential for drowning. This is why the buddy system is so important, AT ALL TIMES! It only takes a few inches of water to cover a persons airways and if you are unconscious and without anyone to keep your airway clear it's possible to drown in something as shallow as a bowl of water.

The Buddy System

In freediving the most important safety rule is ALWAYS DIVE WITH A BUDDY! Your buddy should be a trusted dive partner who also has proper knowledge of freediving safety procedures and that you have practiced emergency freediving situations with. With correct planning and practice both you and your dive buddy will be able to explore your diving potential with confidence.

Your dive buddy should be trained in the importance of providing direct supervision while you are preforming any breath hold activity. Direct supervision means always making your buddy the most important focus and not being distracted while they are diving. When you think about it, you would only want the same respect and attention while you are diving. It's just like the golden rule of life: One should treat others as one would like others to treat oneself. By building a trusting relationship with your dive buddy, whether it's your first time diving together or

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through years of diving together, you will both be able to enjoy your freediving by having confidence in your safety partner. Proper instruction in cardio pulmonary resuscitation (CPR) and basic first aid skills are also important. Direct supervision while freediving is observed in the actual act of the freedive and after the diver reaches the surface. More specifically maintaining direct supervision during the dive with the one buddy up and one down rule, with communication once the diver reaches the surface (are you OK?) and in a grace period of at least 30 seconds after reaching the surface. Let’s look at each of these for a complete understanding of how to be the best safety partner possible.

One Up & One Down

The one up and one down rule means that when diving in open water, one partner stays up on the surface and provides direct supervision while the other person is down freediving. While on the surface the supervising partner should be paying attention to the freediver, their dive time and be prepared to dive in the event of an emergency that would require them to provide assistance. Communicating your dive plan including target depth, total dive time and how you feel about the dive will provide useful information for the surface partner. It is also the responsibility of the diver to stick to this plan and to be honest about how they feel about the dive at hand. In recreational freediving where you are not diving on an ascent line and will be moving horizontally as well as vertically it will be necessary to anticipate ascent location. This will be much easier to determine by communicating a dive plan and discussing variables such as current and horizontal distance to cover. The surface supervisor should

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also be “breathing up” (see Diaphragmatic Breathing and Breathing Cycles) in preparation for their own dive, but also in case the freediver needs assistance. This exchange of roles will allow for both buddies to get the most out of their time in the water in a safe and responsible manner.

A great way to incorporate the one up and one down rule with spearfishing is to carry one gun between two divers. By carrying one gun the surface safety diver is able to focus all his attention on the diver down, where it should be. This eliminates any chance of the surface safety becoming distracted and chasing after fish while his partner is down, leaving him without a buddy and essentially diving alone. Another benefit of two divers spearfishing with one gun is that in the event of an emergency the safety diver is not burdened with extra equipment and has both hands available. With the expensive cost of most spearguns it is not too easy to discard one even if it is to help a diver in trouble. This can lead to fumbling around with two guns while trying to help a diver causing an already bad situation to become worse. Loosing one gun is not as bad as loosing two guns, and no gun is worth the life of your buddy. Trading one gun between two divers is a fun way to hunt and builds a sense of teamwork when working together to land a good fish.

The one up, one down safety system is not limited to groups of two, but works particularly good with a group of three. In this system you have the freediver (position A), the secondary safety who is also preparing to dive next (position B), and the primary safety (position C). In this rotation the freediver (A) becomes the primary safety (C), the primary safety (C), becomes the secondary safety (B) and prepares to be the next diver, while the secondary safety (B) is now the freediver (A). This way there are two safety divers ready for an emergency, and at the same time allows plenty of time for recovery and preparation for the next dive.

This group of three divers working together also works great for spearfishermen. The thing to remember is to hunt with no more than two guns in a group of three. This way the primary surface safety never has a speargun in their hands and is ready to give assistance to the diver down. In a group of three with two spearguns it is also possible to assist landing a good fish or fending off sharks with the extra gun. By working together like this you form a good feeling of camaraderie and accomplishment while diving in a very safe and secure manner.
Surface Communication: Are You OK?

In competitive freediving a surface protocol must be done within 15 seconds of the divers' airway breaking the surface. This protocol consists of the removal of all facial equipment (mask, goggles, noseclip, etc), looking at the official judge and giving the “OK” signal and saying “I am OK”. All of this has to be done in this order and within 15 seconds or the diver is given a red card and the dive does not count due to failure to complete the surface protocol. The reason for this is to assure the consciousness level of the freediver. The protocol tests the divers coherence in both motor skill and verbal skill to assure they are not close to a black out. It is not enough to get only one out of the two test correct as sometimes the diver is able to give an automatic response from muscle memory and then proceed to slip into a black out. Knowing that this is possible it is important that as recreational freedivers we incorporate a similar surface protocol on every dive.

A minimal surface communication between dive partners is once the freediver has surfaced and recovered from their dive, an “OK” signal must be given and returned. A better procedure would be to give and return the “OK” signal and to also verbalize this by saying “I am OK”. By adding this one extra step of verbal communication the surface supervisor is better able to determine the consciousness of the diver. The “OK” signal by itself could be a response mechanism and automatically given even in the event of being close to a black out. If this is the case by including verbalizing “I am OK” into your surface procedure the diver may give additional indications such as not being able to clearly say “I am OK” or not looking at you while saying it. Never assume they are fine just because they gave the “OK” signal, hypoxia dulls the senses and cause faulty judgment. Be a prudent dive buddy and read the signals. If you suspect the freediver is not OK move into position to provide assistance and communicate your observations to them. Stay with them until a full recovery is observed.
Observe The Freediver for 30 Seconds

Again if we look at competitive freediving and the AIDA (Association International for the Development of Apnea – the governing association for all competitive freediving) guidelines that are implemented for safety it will give us a good idea of rules we can incorporate whenever we are freediving. In competitive freediving once the freediver has surfaced the stopwatch begins and the diver has 15 seconds to correctly perform the surface protocol and must also keep their airway above the surface without assistance for a full 30 seconds. This is the amount of time that it takes for freshly oxygenated blood to cycle through the body and reach the brain. Although the diver may not be fully recovered from the dive with fresh oxygen reaching the brain the risk of a black out after 30 seconds is extremely low. If the diver seems to be struggling or having a difficult time recovering from a dive extra time should be spent with them to ensure a full recovery. You want to make sure that when you switch the one up one down roles that you have a safety diver that is up to the task of assisting you before you begin your dive.

For this reason maintaining direct supervision of the freediver for a minimum of 30 seconds after they surface is a must. After they have recovered, are no longer at risk of a black out and had a chance to catch their breath, they will in turn be prepared to supervise you.
Open Water And Depth Supervision

While freediving in an open water environment and with depth diving your goal there are certain safety considerations to be aware of. Depth freediving under ones own power is also known a constant ballast and is the most respected discipline form of freediving due to the incredible amount of effort required by the athlete. Acknowledging the physical and mental demands of depth freediving is the first step in becoming a safer freediver. The possibility of hypoxic problems can be further exacerbated by the environment in which it takes place with variables such as visibility, current, sea surface conditions, cold as well as many other factors that arise when exposed to different environmental conditions.

With the introduction of these obstacles it is important for the supervising diver to be prepared and remain diligent to the task at hand. In limited visibility water (due to water suspended particles or low light levels) when the diver goes out of sight this is particularly true. Using an accent line and remaining within arms length of the line will greatly reduce the stress levels for both the diver and surface supervisor. In addition to knowing where the diver is even when they go out of site it is possible to use the line as a communication tool through a predetermined set of pulls. For example at the bottom of the dive there will be one pull as the diver changes direction. By keeping one hand on the ascent line the surface safety diver feels this single pull on the line and knows the freediver has reached the turnaround point of the dive and should be on the return. If the freediver is tired or in question of making the dive they may begin pulling on the line to assist with their ascent. The surface safety will again feel the multiple pulls on the line and know that the freediver is having difficulty and be able to dive down to meet the freediver and provide assistance if needed. This communication of knowing where the freediver is throughout the dive even without being able to see them improves safety and confidence dramatically. Additionally the ascent line provides a visual reference point for the freediver, letting them know they are heading in the right direction and are going the shortest distance to their target depth and back to the surface.

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When using a dive line in open water to focus on depth or technique it is important to have the line hanging straight down in the water column. If current is observed at the dive location this will cause the dive line to pulled off at an angle by the force of water flowing against it. The best solution when current is present is to free drift with it. By drifting with the current you will no longer be in constant flux with the current, but rather flowing with it and a part of it traveling at the same speed. This will make the dive line hang straight and allow you to freedive at the same speed as the ascent line, making it feel like there is no current. If this is not possible and you have to anchor or there is still the effects of a current you need to take this into consideration and be prepared to observe the area around the dive site in case the freediver drifts off the dive line.

This is a common problem when spearfishing where we are not following a dive line and focused on hunting a specific location. Prior planning and creating a dive plan with your buddy is essential. One tactic is to anchor the boat up current of the desired hunting grounds and trail a long floating line (commonly called a tag line) with a float on the end off the boat. This tag line should float directly over the target area. Your dives should start up current at the boat and as you drift with the current you should be able to surface near the tag line and use it to pull yourself back up current. The safety diver should be able to stay on the surface and let go of the line at the same time the diver starts the dive. This way both the surface safety and diver will be drifting at close to the same rate and in low visibility situations help in being close to each other when the diver surfaces.

Another tactic to use in helping keep track of a diver when spearfishing in low visibility conditions is using a floatline. A floatline is a line that has one end attached to either the speargun or is rigged as a break-away setup where it is attached to the shooting line. The other end is attached to a float that remains on the surface at all times. By using a floatline the surface safety is able to follow the line and use it to determine the approximate location of the diver down. Other safety features of using a float line include being able to abandon the speargun in emergency situations to improve speed to get to the surface without worrying about loosing the gun. Once back to the surface you can recover the speargun hanging on the end of the floatline. You can also use the floatline to pull yourself back to the surface. This has two advantages in that it helps you conserve oxygen by using your arms instead of your legs and it signals to the surface safety that you may need assistance.
Being a proper dive buddy also means thinking ahead and knowing your partners freediving style and habits. Learning this comes through open communication before diving while discussing the dive plan and once your in the water through observing their style and form. This includes watching them on the decent for signs of fatigue or anything out of the norm that may indicate forthcoming problems on the ascent, as well (and more importantly) observing their style during their ascent. What is their normal fining rate the last few meters, do they drop their arms at a certain depth? Observing and knowing your buddy's style in the ascent will allow you to know if there is something wrong and in the case where he is unable to signal to you, you will be able to provide assistance from using your intuition.

Proper weighting and practicing removal of quick release weightbelts is important in open water depth freedive training. Remember that 90% of blackouts occur at the surface and the problem is easily managed if proper weighting guidelines have been followed and the safety freediver is ready to respond.

<table>
<thead>
<tr>
<th>FREEDIVING RULES</th>
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<tbody>
<tr>
<td>- Never Freedive alone.</td>
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<tr>
<td>- Never hyperventilate.</td>
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<tr>
<td>- Never be over-weighted. Modify weighting to be positive between 5m-10m from surface, depending on target depth.</td>
</tr>
<tr>
<td>- Always use a signal buoy and diver down flag.</td>
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<tr>
<td>- Always equalize ears and mask before feeling pain.</td>
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<tr>
<td>- Make a dive plan and stick to it.</td>
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<tr>
<td>- Always remove the snorkel from your mouth while freediving.</td>
</tr>
<tr>
<td>- Never exhale underwater or forcefully upon surfacing.</td>
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<tr>
<td>- Never dive at the same time as your buddy, follow the one up one down rule.</td>
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<tr>
<td>- Do not freedive if you are not in optimal condition.</td>
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Static Apnea Supervision

Since not everyone has easy access to deep water for depth diving, static apnea in a pool is popular among freedivers looking to train in a controlled environment. Although static apnea is simply a timed breath-hold at the surface of the water, it can be dangerous with black-outs and the possibility of drowning. Just like with open water diving direct supervision while training static apnea from a trained buddy is a must.

The proper technique for training static apnea include setting a target time and communicating a set of signals to be used throughout the breath-hold attempt. The safety supervisors' signal is given by two taps on the freedivers shoulder and asking the question “are you OK?” This is the first signal and is given a minute before the target time, then again 30 seconds before the target time, at the target time and every 15 seconds past the target time. In response to the supervisors' signal the freediver signals back by lifting one finger in a direct and purposeful manner. This indicates that they understand the question, are feeling OK and will continue with the breath hold. If at any time the safety diver observes a questionable or weak response the safety should immediately give two more taps on the shoulder to ensure coherence of the diver. At this point if the signal is not clear or questionable in any way the freediver should be brought up and the safety diver should be prepared to assist the freediver until a full recovery is made. If this happens the freediver should discontinue breath-hold training for the day.

An example of the sequence for a target breath-hold of 3:00 minutes is:

0:00 – 1:59 No signals
2:00 - 1st signal - Safety - Two taps on the shoulder and verbalize time
    - Diver – Responds by lifting one finger
2:30 - 2nd signal - Safety – Two taps on shoulder and verbalize time
    - Diver – Responds by lifting one finger
3:00 - 3rd signal – Safety - Two taps on shoulder and verbalize target time has been reached
    - Diver – Responds by lifting one finger
3:15 and every 15 seconds after target time - Safety continues with two taps on the shoulder and verbalizing time. It is also important to observe all body language and judge coherence of diver.
    - Diver – Responds by lifting one finger and observes feelings and response to building CO2 and dropping O2 levels.

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Since most static apnea is practiced floating in a face down position, observing body language as well as the communication signals are important for safety.

The supervising safety freediver should be aware of the body language that indicates the natural progression of a difficult breath hold and not a freediver in trouble. Contractions are the most common signal that a breath hold is becoming difficult. This is the muscles of the diaphragm having contractions in an effort to begin breathing again. The frequency and strength of these contractions should be observed in order to know your partners static apnea style. Communicating breath hold habits and setting an appropriate target time will allow you to progress safely in static apnea while your dive buddy will feel comfortable and be able to focus on any abnormal body language that could indicate a problem.

Upon surfacing after a static breath hold a surface protocol should be observed just like in open water depth diving. Allowing the diver to recover from the dive and then communicating with both the “OK” signal and by saying “I am OK”. The same risk for black out during recovery applies to static apnea and the safety should continue observing the freediver for at least 30 seconds and be ready to provide assistance if needed.

The final phase of a static breath hold is the most difficult and requires the most control for the best results. As the breath hold becomes unbearable and the end is nearing the diver should grab the edge of the pool to assist in recovery. This seems to also provide a
mental affirmation that everything will be alright and provide a positive feeling that can help extend the breath hold. When the time comes to lift the head out of the water use the edge of the pool for support to hold your face out of the water. Never stand up or rush into an upright position as this will cause blood to flow with gravity out of your head and lead to a potential black out. Instead calmly lift only your head out of the water using your arms and immediately begin hook breaths followed by recovery breathing until you are fully recovered.

Blackouts

Holding the breath voluntarily to remain in apnea brings the possibility of a blackout or near-blackout also know as a Samba or Loss Of Motor Control (LMC). Both conditions are due to a gradual consumption of oxygen in the lungs. This consumption of oxygen in the lungs therefore reduces the oxygen levels within the blood and body tissues as well as a corresponding increase in carbon dioxide levels in both areas. At some point these levels become life threatening and the body will shut down as an emergency response system for the conservation of life. This last resort emergency shut down is better know among freedivers as a black-out. In the case where a freediver surfaces just moments prior to a complete black-out, although they are still conscious will experience symptoms of a near-blackout also known as a samba. A samba as it is referred to by competitive freedivers due to the loss of motor control resembles the convulsion style of the “samba” dance. Common displays of a samba are spastic shaking, rolling of the head and desperate efforts to hold on to something or keep the head out of the water. Samba's, or near-blackout's are the most common form of hypoxia amongst freedivers and almost always happen at the surface after ascending. In both a black-out and near-blackout the freediver should be monitored to ensure a complete recovery and further freediving be discontinued for the day. Any dive where you experience a samba or a full black out should be carefully reviewed for mistakes and incorrect techniques. Use this information to learn what lead to the negative experience and what you were feeling throughout the dive. Use this experience to make you a better and safer diver in the future.

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Signs of a Near-Blackout (Samba)

The following signs are indicators that a freediver is close to, or is having a samba. It is important for the supervising safety diver to understand what conditions to look for to correctly identify a near blackout in order to respond quickly. In the event that a freediver experiences a samba the dive should be reviewed from both the diver's perspective and from the safety diver's point of view. The diver needs to recall thoughts and feelings before, during and after the dive as well a review of the techniques used that lead to the samba. In almost all near black-out experiences the freediver is unable to clearly recall the last moments of the ascent and the what happened at the surface. The surface safety can fill in the blanks from their observations and provide useful information to understand what went wrong. By studying the sequence of events that caused the samba you can use this information for corrective procedures to avoid this from happening again.

Signs of a near blackout are:

- Confusion and/or unable to communicate clearly - Unable to respond to surface safety protocol, or directed in the wrong direction.
- Loss of Motor Control (LMC) - Underwater on the ascent the freediver may kick in an abnormal style, arms may fall to the sides, or the head may roll forwards or back. On the surface the freediver may have difficulty breathing due to diaphragmatic contractions, the eyes are unable to focus on you, and/or the muscles in the face may quiver due to LMC.
- Blueness of the skin – Due to low levels of oxygen in the blood this is visible in areas such as the lips and around the eyes, where blood vessels are close to the surface of the skin.
- Any physical or emotional behavior that is abnormal – This may include laughing, giggling, or crying.
Symptoms of a Near-Blackout (Samba)

The following are symptoms the freediver may experience with a near-blackout. It is up to the freediver to be honest with oneself if any of the symptoms are ever experienced and take corrective actions to avoid further near blackout situations or potentially a full blackout.

Symptoms that a freediver may experience that indicate they have experienced a samba include:

- Confusion or loss of memory – During the surface protocol questions and signals are confusing or sounds unclear. Any loss of memory or blank spots of dive or during the recovery are symptoms of a near-blackout and signals that you were only seconds from a full black-out.
- Emotional instability – This can be either a feeling of overwhelming happiness (usually accompanied by uncontrollable laughing or giggling) or a sense of despair (usually signaled by crying or whimpering).
- Loss of Motor control (LMC) – Involuntary movements or inability to control movements such as speaking due to quivering lips. You may still be able to keep your airway above the water but be shaking or have muscle tremors.
- Any abnormal physical conditions or emotional feelings – Physical conditions such as tingling or numbness in the face or hands, or unclear vision after a dive. Abnormal emotional feelings of extreme happiness or depression/fear.
Assisting a Near-Blackout

In order to be prepared for emergency situations that arise from a near blackout which could potentially turn into a full blackout it is important as a responsible freedivers to educate yourself on the signs that a diver is experiencing a samba or near blackout. Next we need to know how to assist the diver in need of help and practice emergency procedures for dealing with these situations. How we deal with these situations depends on the severity of the samba and the environment it takes place in. Practicing worse case scenario’s and recognizing that a near-blackout can quickly become an unconscious victim are the first steps in being prepared. Most importantly, always freedive with a buddy. Without a buddy to keep your airway above the surface death by drowning is certain in the event of a blackout!

In most cases a freediver experiencing a samba or near-blackout at the surface will still be able to keep their airway above the surface but needs assistance in the event they suddenly loose consciousness. If a diver surfaces with blue lips, shaking uncontrollably, or shows any abnormal behavior that could indicate they are experiencing a near blackout you should react quickly and move into a position to provide assistance. If the diver is unable to recover and fresh oxygen does not reach their brain with their first couple breaths the situation can escalate into a complete blackout.

Therefore the safety diver needs to first recognize the signs of the samba and quickly maneuver into position to provide assistance. The best position to move into is within arms reach and at a 45 degree angle from directly in front of them. From this position you can still read their eyes, facial expressions and communicate with them. By not being directly in front of them you will be in a better position to catch their head if they loose consciousness and their head falls back. From this position you will also be able to quickly provide support by hooking one arm under theirs. It may also be necessary to provide assistance by supporting them under the arms or with a leg under their bottom so the diver is able to stop swimming, allowing for a quicker recovery. At all times be prepared to protect their airways from going under water. Be ready to catch them under the chin if they fall forward or with a hand behind their head if they fall back.

Another important aspect in assisting a near-blackout is with continuous talking and encouraging the diver to “breath”. During a near blackout a freediver will occasionally forget to breath at the surface due to the effects of hypoxia and its ability to cause faulty judgment. By talking to them in a calm and reassuring manner they will have a quicker

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and more pleasant recovery. This sense of control will also be felt by the safety diver who will be dealing with a stressful situation and by speaking this way it will help them be in more control and make better decisions. It can also help to remove their mask for greater ventilation and the fresh air across their face will help stimulate natural breathing. Just remember if there is wind and waves to protect them from water splashing up their nose or in their mouth.
Signs & Symptoms of a Blackout

The signs and symptoms of a blackout are the same as a near-blackout, but the freediver becomes unconscious and is at risk of drowning due to their inability to keep their airway out of the water. It is important to recognize the signs and symptoms of the near-blackout because many blackout's begin with these and unconsciousness can suddenly occur. For this reason the supervising safety diver needs to move into position to provide assistance anytime signs of a near-blackout are observed. The most important role of the safety diver is to keep the blackout victims airway above the surface of the water and clear of obstructions.

Assisting a Blackout

The main goal when assisting a blackout is to keep the victims airway's out of the water, prevent water from entering the nose and mouth and to clear any foreign obstructions that might be blocking breathing. A blackout scenario can be an extremely stressful experience for the safety diver. It usually looks worse than it is and with proper assistance your buddy will regain consciousness and be functioning on their own in a short period of time. Through practice and a complete understanding of the event you can minimize the stress for both yourself and your partner and ultimately use the experience as a learning tool for yourself and others.

As the supervising safety diver it is of utmost importance to be familiar with the signs of a near-blackout (since the diver usually passes through this stage before becoming unconscious) and move into position to provide assistance. On the surface this means hooking one arm under the victims arm to provide support and gain control of them in order to keep the airway's above the water. Position them onto their back to keep their face above the water while using the hand of the arm that is hooked under their arm to support the back of their head. This is best achieved by using your left arm to hook under the victims right arm (if you are on their right side), or by using your right arm to hook under their left arm (if you are on their left side). By positioning them on their back and locked arm in arm with them at your side, you can slowly swim laterally with the victim to help keep their body on the surface. If conditions allow remove their mask with your free hand and tap the side of their face while blowing across their eyes and nose. Both these actions will help stimulate sensors on the face that will help resume spontaneous breathing. Speaking in a calm and positive manner for them to “Breath”

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will also help to reach their subconscious and get them breathing on their own again. If you are in the open water with waves that threaten to cover the divers face leave their mask on and protect their mouth with your free hand. Between waves you may be able to lift the mask an inch or so off the face and blow across their nose and eyes to help stimulate the breathing receptors, but be prepared to lower it immediately to protect their airway.

When a diver has a blackout it is the body's self defense system to conserve valuable oxygen. A common mistake of untrained freedivers is to “shock” the victim back from unconsciousness by slapping, shaking or shouting at them. Not only does this raise the safety divers apprehension of the situation which leads to poor decisions, but it also signals to the blackout victim that the body is still in danger and may cause them to remain unconscious. In these cases when the diver does awake from this aggressive behavior they tend to struggle and fight against their safety diver, confused by the situation and only making matters worse. Instead by remaining calm and speaking in a positive and encouraging manner such as “It's ok, breath, breath, your at the surface” the diver will feel comfortable and more likely to begin breathing sooner. Remain positive to help reduce both your stress and the stress of the freediver.
Thanks for reading

30 Meters Deep Freediving Manual

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