

Copernicus

My Adventure in Cave Training

**Respiratory Loads During CCR
Diving – Part I**

Journey to the Dark Side

**How I Apply Technical Principles
to Recreational Diving**

Issue 19 – June 2015

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Editorial

Welcome to the 19th issue of Tech Diving Mag.

My book *Deep Into Deco: The Diver's Decompression Textbook* was an instant success. Thank you! Those who got it from Amazon, please put your reviews there. The usual question: how does it compare to other deco-related titles? This one has all the basic topics covered, and is more into decompression simulation/modeling and up-to-date research.

The contributors for this issue are Emmy award-winning cinematographer Jonathan Bird, commercial diving instructor Konstantinos Alexiou, diving instructor and boat captain Drew McArthur and on-and-off diver Dan Sumners. Take a look at their brief bio at www.techdivingmag.com/contributors.html.

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Asser Salama
Editor, Tech Diving Mag



Copernicus

By Asser Salama

A study was initiated in 2003 to determine the effect of decompression schedules on bubble formation following surface decompression using oxygen.¹ A pig was compressed to 40 meters (130 feet) for 90 minutes while breathing air. Three different ascent profiles were tested. The first was a USN staged decompression profile. The second was a profile using linear continuous decompression with the same total decompression time as the USN profile. The third was a linear profile with half the total decompression time compared with the first two profiles. The subsequent surface decompression at 12 meters (40 feet) lasted 68 minutes for all three schedules. The study illustrated that following the final decompression, the two linear schedules produced the lowest amount of vascular gas, with the fastest schedule producing significantly less bubbles in both the pulmonary artery and the jugular vein than the other two. This is an experimental demonstration that a significant reduction in decompression time can be achieved with a dramatic reduction in bubble formation.

So the key word is optimization. All decompression algorithms calculate the time to stay at each depth based on either supersaturation or bubble suppression. However, current models don't consider the initial ascent phase, although both experimental evidence and bubble growth theory suggest that bubble growth starts at that phase.

Another important aspect is that a lot of decompression models are empirically derived. For example, while developing ZH-L, Bühlmann's endpoint was the clinical symptoms of DCS. This approach requires an extensive amount of empirical data yet does not validate the actual gas dynamics and mechanisms behind DCS. The result is that the models are usually safe enough only in the regions they were developed, thus extrapolating them (mathematically deriving a model for helium from the existing nitrogen data, for example) would lead to less safe consequences.

Copernicus presumes that the evolution of vascular bubbles is strongly linked to the risk of serious DCS. Just like other dual-phase models, it tries to describe both the dissolved gas tensions and the distribution and growth of gas bubbles in the diver's body. The new feature is that it also tries to predict the mechanism for injury by the bubbles. In other words, the endpoint for Copernicus is not the clinical symptoms of DCS, it is the bubble formation in the diver's body. Using this approach, the development team led by Dr. Alf Brubakk will not need the extensive amount of empirical data Bühlmann needed, yet the validation will be more reliable.

Copernicus consists of a descriptive model of the mechanisms behind the occurrence of serious DCS (based on the evolution of vascular bubbles), a dynamic optimization algorithm to control the model parameters and a validation strategy through bubble measurement rather than the conventional DCS/no-DCS endpoint.

The model inputs are ambient pressure, breathing-gas composition and blood perfusion. During decompression, Copernicus will manipulate the ambient pressure (depth) and the gas composition to achieve the wanted outcome. Blood perfusion is estimated through measurements and is not an input the model wants to control. The output is a description of the evolved bubble spectra in the body. The optimization phase looks at getting the diver as fast as possible to the surface without letting the decompression stress exceed an accepted bubble score.²

Copernicus is still under development. One of its tentative conclusions is that dives with long bottom time (30 minutes or more) may benefit from deep stops, whereas dives with bottom times less than 30 minutes will not benefit from them.

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Excerpted from *Deep Into Deco: The Diver's Decompression Textbook*. The title is available in 3 forms: print book, eBook and package set (print book + eBook + 20% discount).

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"*Deep Into Deco* is a stimulating read which covers almost every facet of diving from breathing to technical decompression. It is well referenced and dives into (forgive the pun) great detail concerning the past and present of diving theories. I recommend this book for all divers from novice to technical expert because Asser Salama makes even the most difficult topics seem easy and understandable. No diving collection is complete without this super overview book. I will keep mine on the coffee table as a discussion piece."

—Commander Joseph Dituri,
US Navy Saturation Diving Officer (ret) and Vice President of IANTD

"This book is long overdue. And it's worth the wait. What Asser Salama has accomplished with this book is remarkable. He has taken that early history of experimental trial and error and produced a stunning reference text that brings the science into sharp focus."

—Bret Gilliam, founder of TDI

"Asser's book is the best general overview of decompression modeling I have seen. The information it contains is relevant to divers of all levels, from the occasional sport diver who wants to know more about how their dive computer works to the technical diver planning extended decompression dives. It certainly is a welcome addition to my dive library!"

—Jeffrey Bozanic, PhD, author of *Mastering Rebreathers*



ASSER SALAMA, a technical diver and instructor, is founder of *Tech Diving Mag* and developer of Ultimate Planner decompression-planning software. He has a bachelor's degree in engineering and a master's degree in business administration. A software developer with an interest in decompression modeling, Salama plans to implement computational algorithms based on credible research papers to prevent some pioneering work from fading into academic obscurity.



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My Adventure in Cave Training

By Jonathan Bird



Over the past few seasons of *Jonathan Bird's Blue World* production, we have done several segments in cenotes and blue holes in Mexico and the Bahamas. It first, I didn't have much interest in this kind of stuff. After all, I'm a marine life guy. I would much rather play with sharks than crawl through a shipwreck or film stalactites. On the other hand, the more I saw of the amazing underground world in caves, the more fascinated I became. A couple years ago I started thinking it was about time to get cave certified so I would be able to venture further into the most beautiful parts of the caves.

Cave diving is considered an extreme sport because of the obvious danger of being in an overhead environment—no way to get to the surface for air in an emergency. In the scuba diving world, if you are in a cave yet you can still see the light from the opening, or if the cave is only half full of water so you can surface and breathe, you are not technically cave diving, but cavern diving. Most of the segments we have done on *Blue World* where we are filming in a “cave” were technically, by scuba standards, caverns, not full caves. (This fine distinction is sort of lost on the general public, so we don't generally get into that level of detail in a *Blue World* episode). Furthermore, being the host of a TV show does have advantages—when our team shows up to film, we always have lots of local experts helping us out. Whenever we are filming in a fragile cave-like environment, we have a cave instructor with us who serves as our guide. Not only does he or she make sure we get the shots we need, but also makes sure we get back out!

In my travels though, I have heard about awesome caves here and there, mostly in the Bahamas, but also in the Yucatan, that require full cave certification. No way you are going to convince some cave instructor to take you in there without a cave certification. So it really was time for me to get that certification. Considering that I hadn't

had any formal scuba courses since my rebreather course more than a decade ago, it would be weird becoming a student again.







Full cave certification is sort of like the black belt of scuba diving. It's among the most difficult and intense training a scuba diver will ever undertake. And there is a reason why—the consequences of an accident can be fatal. But surprisingly, the sport is statistically pretty safe, especially for trained cave divers who follow the rules. I wanted to be one of those divers. I also wanted to be trained by the best, so I called Brian Kakuk of [Bahamas Underground](#). He is a world-renown American cave explorer living on the island of Abaco in the Bahamas. It's no coincidence that Brian lives in Abaco. Abaco is home to what is probably the world's most exquisite submerged cave system. Brian's passion is to protect this cave system. He is in the process of working with the Bahamian government to get the whole system protected as a national park. Throughout Brian's career he has been a Navy diver, cave explorer, technical dive supervisor, and dive safety coordinator on dozens of films, including a few you may have seen, like *Into the Blue*, *The Cave*, and all the *Pirates of the Caribbean* Hollywood films. And yes, he knows Johnny Depp.

I asked Brian if he would train me as a cave diver, and allow us to film it as a *Blue World* segment. He was game. But not only would I need to learn cave diving, I would also need to learn a special kind of diving called *sidemount*. Obviously, cave diving requires redundant air sources—typically double tanks. Conventional cave divers wear their “doubles” on their backs. But when you wear them on your back, you can't fit into small openings (called restrictions) in the cave. Because the caves where Brian teaches have so many restrictions that are not backmount friendly, he only teaches in sidemount configuration. Sidemount is when you wear your tanks on your sides, just under your arms. As you swim along horizontally in the water, the tanks float along beside you. It sounds weird, but it's actually really comfortable, and much easier to use in the water than backmount tanks.



Brian invited me to take his “Zero to Hero” class, which actually consists of 4 classes in one. You start out a Zero on the first day (open water certified). You progress through Cavern certified, Introduction to Cave certified, Apprentice Cave, then finally Full Cave. This training would take 8 days minimum. (In my case, because we also had to add in the sidemount training, it ended up being 9 days.)

To film the training as a Blue World episode, I took along a crew, including Pierre Séguin (surface cameraman) and “Cameraman Todd” Kelly (underwater cameraman). Todd is already Cave certified, but just like me, Todd had never dove sidemount configuration, so he had some training to do as well.

On the first day, Todd and I spent some time sorting out all that new sidemount gear we had purchased. At his shop, Brian helped us adjust, fit and customize all the stuff we had to wear including the sidemount harnesses, sidemount regulators, clips, lights, spools, reels, etc. Once we had everything rigged, we had some classroom time with lots of theory and rules, and we went outside where Brian taught me some basic line handling techniques and rules.

The next morning we loaded everything in Brian’s van and drove over to an old quarry near the ocean where they had once cut limestone blocks out of the iron shore as building materials. Now it’s a perfect open water dive site with protection from the ocean surge and good enough visibility to do some basic sidemount training.

Brian started us out by getting our trim adjusted and demonstrating a few sidemount techniques. Then we both had to pass a rigorous series of tests designed to evaluate our buoyancy skills. Unlike caves in some other places, the caves on Abaco are absolutely full of fragile formations, and poor buoyancy control was absolutely not acceptable.

One of the exercises involved putting my hands behind my back, swimming up to a structure and gently touching the tip of my nose to it, then swimming backwards away from it. It had to be done 5 times in a row with feet only, no hands. I also had to practice point turns over a specified place with my hands behind my back while holding a constant depth.

Next I had to perform some of the line drills I had learned on land. Then I had to do them blindfolded. Working underwater without being able to see gives a whole new appreciation for visibility, even bad visibility. I also had to be able to flood and clear a mask completely upside down, which isn’t really that hard when you think about it. Instead of holding the top of your mask and blowing the water out the bottom, you do it the other way around, holding the bottom of your mask against your face, and blowing it out the top.

After our morning at the quarry we finally got to head over to Dan’s Cave. There are over 5 miles of passages that Brian has mapped in Dan’s cave, but for the first two days, I would only see the cavern zone. We could go as far back as the “stop sign” which is placed at the limit of light penetration from the opening. The first two days of my training, I would be earning my cavern diver certificate, so I was learning everything from the point of view of a cavern course. I found this a little confusing because first I learned one set of rules (cavern rules) then we changed them as I went into the Intro to Cave class, and so on. Every time I had the rules memorized, they changed. So when the Full Cave final exam came, I had to be sure not to get all the different rules confused. For example, on doubles, Cavern Divers are not supposed to use more than 1/6 of their air on the way in to the cavern. Full Cave divers can use up to 1/3 on the way in. All cave divers must have a minimum of three sources of light, but cavern divers can count sunlight from the opening as one of them.

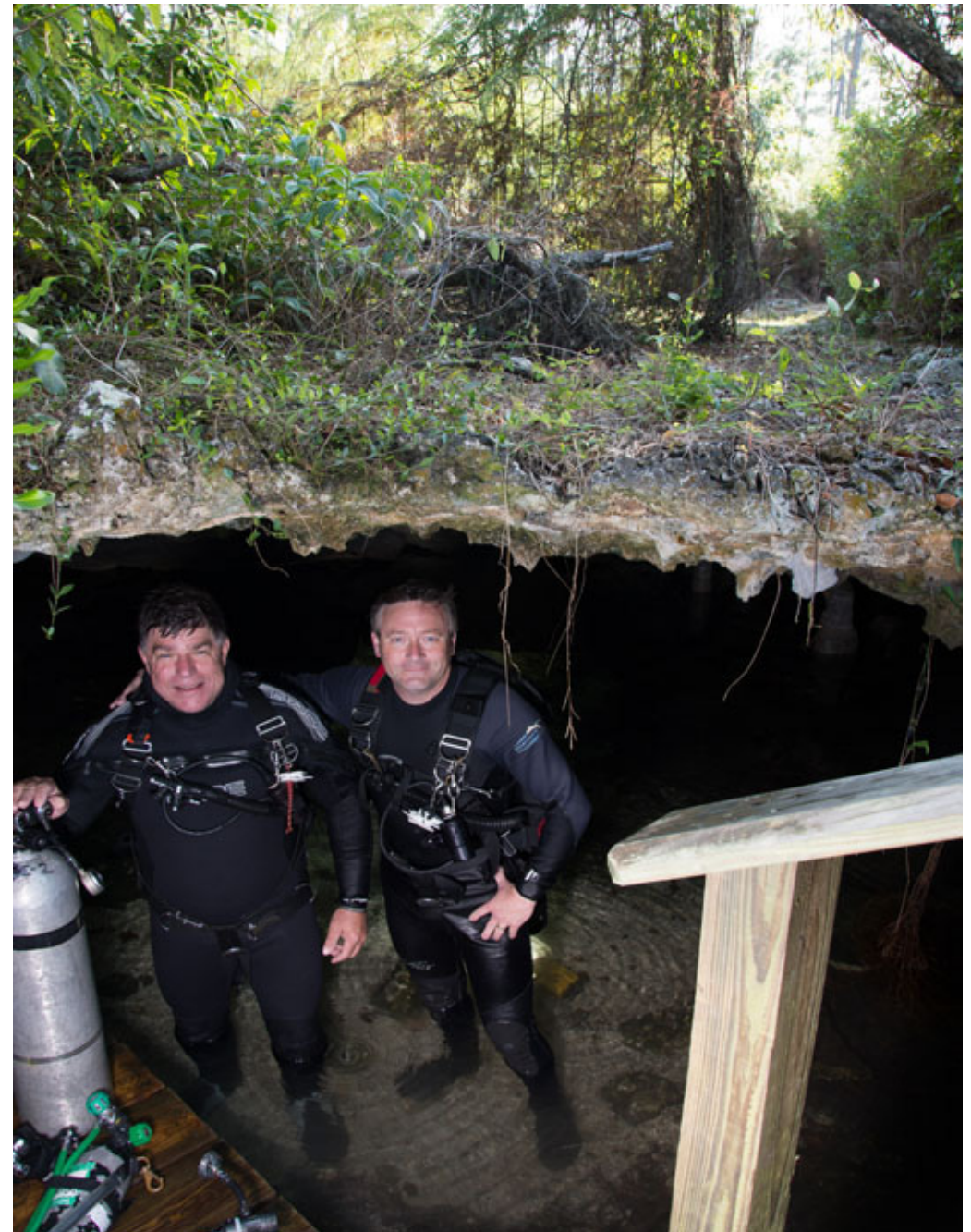


Brian was relentless in quizzing me and making sure I understood everything. He also wouldn't let me "cheat" on any of the exercises or gear requirements. At one point we noticed that one of my brand spanking new backup lights had flooded just before we were about to start a dive. Even though between the three of us we still had 10 (!) lights (because Todd had 5 if you count the video lights), I would not have my minimum 3 lights, so we had to stop everything, take our gear off, run up to the van and grab another spare. Brian continually stressed that cave diving is actually really safe when you follow the rules, and almost all of the cave diving deaths are people either skirting the rules, or not knowing them in the first place—improper training.

Much of the classroom training was entirely new material for me, like how to use line markers, how to calculate dissimilar tank turn-around pressures, cave-specific hand signals and line navigation. I learned about how caves are formed, what types of sediment are the most likely to create silt, some basic cave survey techniques, the list goes on and on! But then there was a lot of review—stuff that I knew once, but the review showed how much of it I had forgotten, like using the dive tables to calculate repetitive dive profiles. (Oh how dependent on dive computers I am now!)

We started each day in Brian's office/classroom with his dog Otis sitting on the couch listening intently to the lectures with me. Then we would head out to his shop and configure some gear. There was usually an exercise each day outside in the yard—usually involving me, blindfolded, trying to navigate using a guideline, or learning to tie line tie-offs blind. Later in the day we ended up at Dan's Cave where we did underwater training. These were long days, 12 hours minimum. And Brian didn't take it easy on me because I'm such a nice guy. No, if I wanted to graduate, I would need to be able to do

everything right and remember all the rules.





My favorite stuff was the in-water training. For whatever reason, I really enjoyed the challenge of trying to do something I had mastered in air or underwater with zero visibility. On every dive Brian would at some point come up and make the hands-over-his-eyes sign that meant I had to close my eyes. (“If you cheat, you are only cheating yourself.” He would say.) Normally he would do this kind of thing with the lights off, and sometimes we did. But other times Todd needed to film it so we needed lights on. I would clench my eyes shut tightly so there was no question they were closed, and go about the exercise. We practiced literally everything in the dark, starting with simple things like just following the guideline out of the cave. Then it got harder...one of us would be out of air and breathing from the other’s “long hose” spare second stage. Then we would swap and the other would be out of air. Then it would involve restrictions. Then it involved more complex navigation off the main line. Then there were lost line drills, which were the most challenging. Brian would shut the lights off and spin me around and around so I had no idea which way was which. He also swam me off away from the line. Then he just plopped me on the bottom. My job was to find something to serve as a reference, tie a spool onto it and go out in a radius from that point until I found the line. One of the times, it took me nearly 20 minutes to find the main line again. Let me tell you: that will make you think long and hard about ever allowing yourself to lose the line in the first place!

Another fun exercise was the free-flowing regulator drill. Brian would swim up to me in the middle of a dive (always without warning) and just push the purge button on my regulator and hold it, venting my precious air at a shocking rate. My job was to change regs to the other tank, shut down the free-flowing reg, assess the situation, and then cautiously switch back to the freeflowing reg and breathe from it while “feathering” the valve to minimize the air loss. This is a drill

that is only taught in sidemount because of the accessibility of the tank valves.

Speaking of swapping regs, that was one skill I got a lot of practice with. Proper sidemount technique involves switching back and forth between tanks every 300 PSI or so, not only to keep the tanks balanced from left to right, but making sure that you always have a similar amount of backup gas in both tanks for emergencies. Quickly swapping regs and stowing the other one doesn’t sound hard, but doing it while holding lights and a reel, maintaining perfect buoyancy at the same time takes some practice to be smooth and quick—especially when you start carrying a camera later and only have one hand to do it with. “Building muscle memory,” Brian would say, “is the key to being able to do it quickly.”

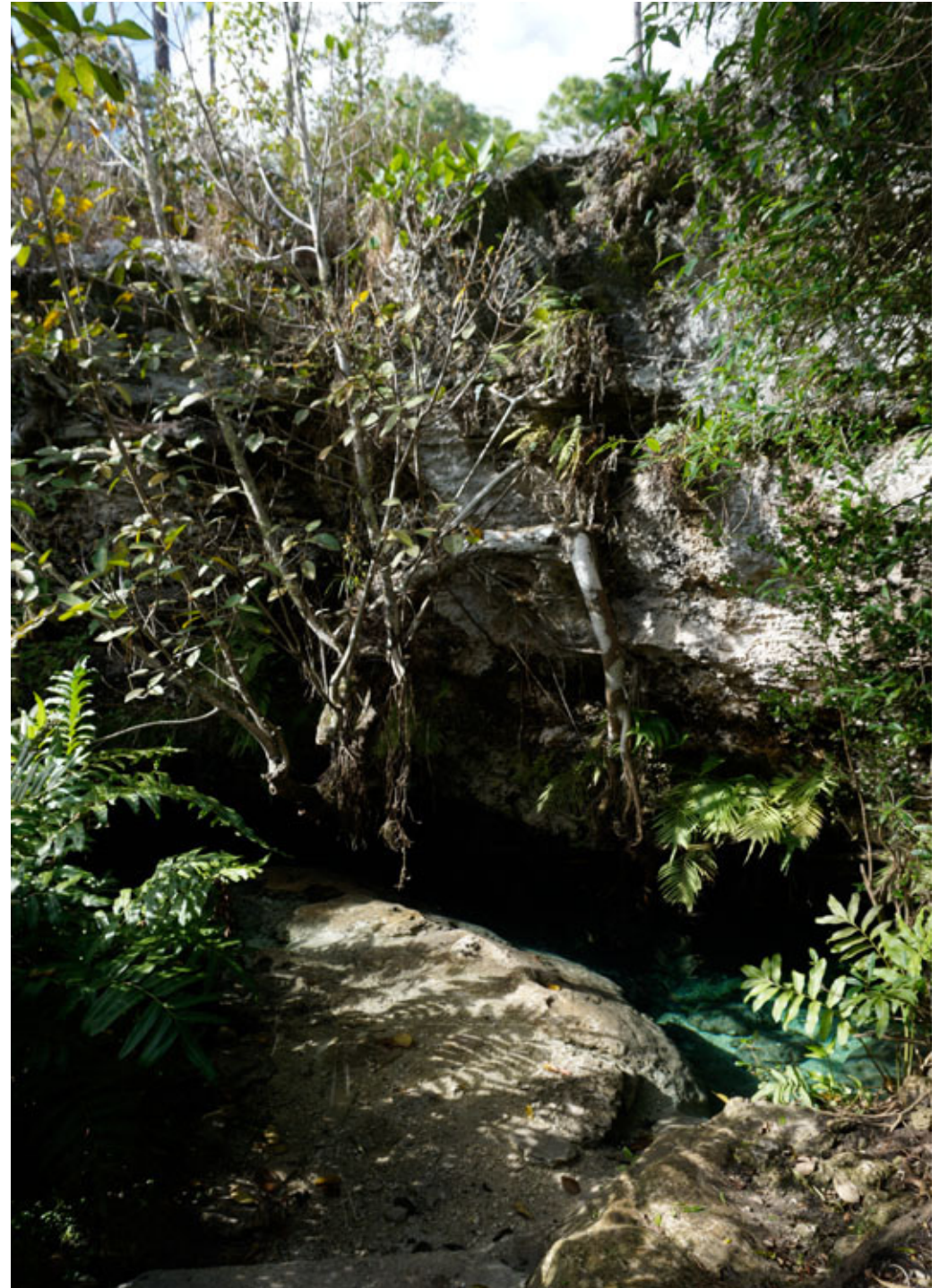
By the end of the training, pretty much nothing bothered me. Virtually anything that was thrown at me was something I had practiced over and over. Out of air? Reg free-flowing? Visibility gone? Lost the line? No problem. I had become extremely self-sufficient and easily the best diver I have ever been. Then there was the matter of the final exam. Everything and anything I had learned was fair game on the exam. The hardest part was an essay where I explained every single consideration in planning and executing a cave dive into the “Badlands” section of Dan’s cave. Afraid I would leave something important out, I spent more than 90 minutes typing the essay up. The final took a little over 3 hours. But I passed and Brian declared me a cave diver. It was exciting, rewarding and fun!



But the adventure wasn't over. Because now, you see, as a trained cave diver, Brian allowed me to take my camera into the cave. (Can you imagine me diving for *nine days* with no camera? Good grief!) We started in the larger, easier sections of Dan's Cave, where we did some great filming with Brian backlighting the formations to make them pop. We didn't have time for this kind of photography during the training. Mostly, Todd was just following us around filming all the crazy training exercises Brian was doing with me. But now, we could get more creative, light things better, and focus on what makes these beautiful caves so special.

Once Brian was satisfied that I could handle my big Gates housing in the cave and the camera wasn't messing with my buoyancy, he agreed to let us film the Holy Grail of Caves: Ralph's Cave! (Now, I know what you are thinking! *Ralph's Cave*—that doesn't sound very exciting. I have to agree, it needs a better name. Like *Crystal Cave*, or *The Most Amazing Cave in the World*, or something like that.) Anyway, this cave is full of the most delicate crystal formations I have ever seen. Brian describes it as swimming into a chandelier, and that about sums it up. My ultimate goal was to film the insanely beautiful and fragile *Glass Factory* room where we would see formations that Brian calls "Frozen Rain." We went first with no cameras to get a feel for the place. The next day we went back with the cameras. And I'm proud to say we didn't break a thing.

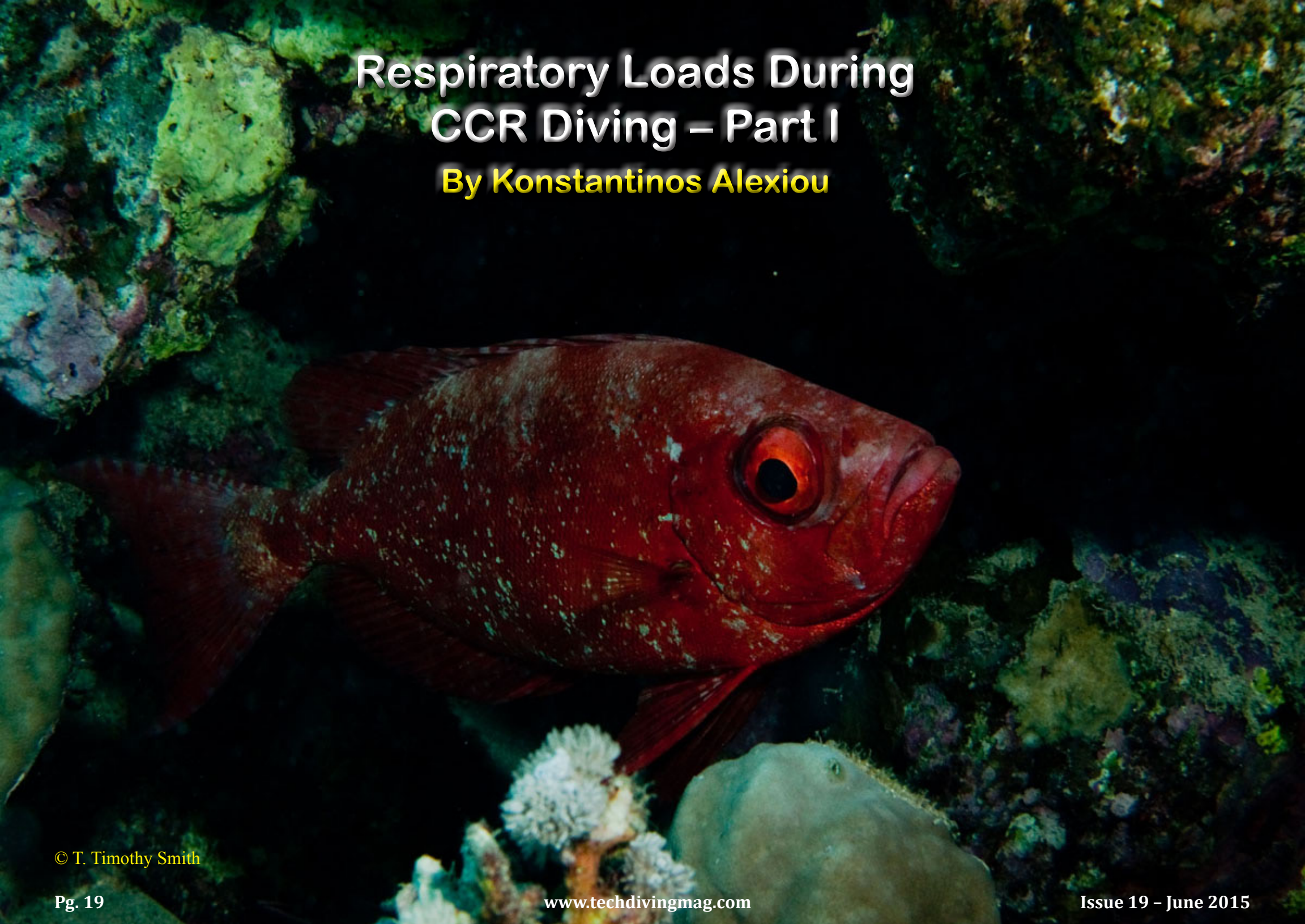
The only problem is that now I want to go back and do more cave filming, more cave exploring. When I first got into this, I told myself there was nothing interesting to film in caves and I wasn't that interested. I might have even believed it. Well, that is long gone. There is no question now that I have been bitten by the cave diving bug and there's no turning back. I'll be back to Abaco to dive with Brian again because those beautiful caves are calling me!





Respiratory Loads During CCR Diving – Part I

By Konstantinos Alexiou



Introduction

Immersion, the use of every type of underwater breathing apparatus (UBA) and the breathing of gases at densities higher than air at one atmosphere absolute impose loads on the diver's respiratory system. The above elements have significant effects on respiratory function. The respiratory load during diving consists of resistive, elastic and inertial components. Diving induces an increase in all three components (5). These loads and the way they affect the diver are of high relevance to divers regardless of the UBA they are using and the nature of their diving operations. However, they become more important for technical divers who operate in deeper depths whilst using advanced diving procedures and sophisticated diving systems like closed-circuit rebreathers.

Respiratory mechanics and physiological stressors while diving

The external loads on the respiratory function while diving include breathing resistance, elastance, hydrostatic imbalance (static lung load) and inertia. The diver's airway resistance, pulmonary compliance (lung's ability to stretch and expand) and gas density can be classified as the internal respiratory loads (7).

Water Immersion. When diving, the human system trying to adapt to the new hostile environment, presents with a number of physiological responses that have an impact on respiratory system function. During water immersion, irrespective of the diver's position, there is a redistribution of 500–800 ml of blood from the legs into the large veins and pulmonary vessels. This is due to peripheral vasoconstriction and the loss of the gravitational effect. The blood volume in the pulmonary circulation increases and this change makes the lungs little "stiffer", which may increase the working effort required to maintain normal ventilation. In addition, this increase in blood volume around the core area is incorrectly interpreted by the body's blood volume control as

an indication of fluid overload. The human system in an attempt to maintain homeostasis signals the kidneys to produce more urine (4, 5).

Hydrostatic imbalance (static lung load). Static lung load (SLL), or transrespiratory pressure (P_{TR}) gradient, imposed by underwater breathing apparatus can affect breathing comfort and mechanics, especially during physical exertion. Absolute pressure increases with the depth. This establishes a vertical pressure differential in the water column between the diver and breathing apparatus. Consider a rebreather diver with a back-mounted counterlung lying horizontally in the water (Figure 1. C).

The diver's airways are in continuity with the counterlung which lies slightly shallower and therefore at lower absolute pressure than the lung centroid. This means that the lung airways are subject to a negative pressure equal to the vertical height of the water column between counterlung and lungs. The resulting negative transrespiratory pressure (P_{TR}) would make inhalation seem harder and exhalation seem easier. Of course, these effects are not limited to rebreather divers. Similar phenomenon appears in the case of open-circuit divers where there is a vertical pressure gradient between the mouthpiece (demand valve providing gas flow at ambient pressure) and the lungs, depending on the relative position of the diver in the water (Figure 1. B, D).

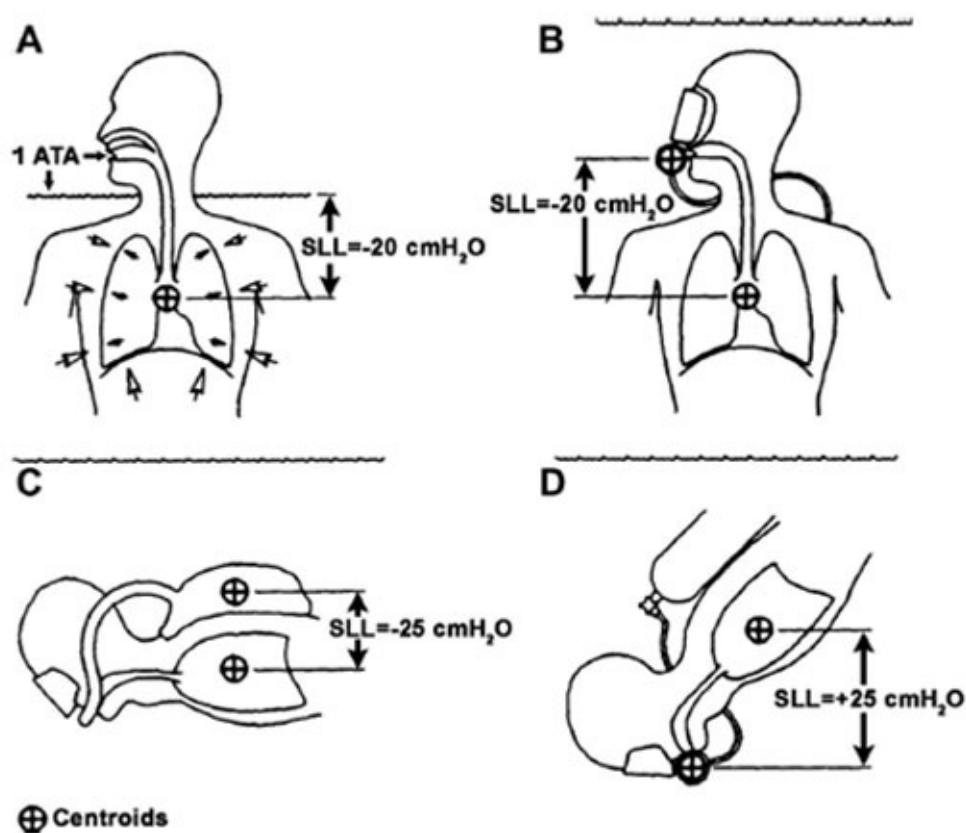


Figure 1. Representation of the static lung load (SLL), or transrespiratory pressure (P_{TR}). A: a person immersed to the neck (negative P_{TR}). B and D: an open-circuit diver with a demand regulator that provides the diver with gas at ambient pressure. In the head-up position, P_{TR} is negative; in the head-down position, P_{TR} is positive. C: a closed-circuit rebreather diver, for whom the back-mounted counterlung is at a lower absolute pressure than the lung centroid (negative P_{TR}). [Source: 5].

It is reasonable to claim that the existence of a negative SLL is the case in the most of the open- or closed-circuit diving scenarios. Even in the rebreathers on which the counterlung is mounted over the shoulders

the lungs' centroid is located slightly below the counterlung – air will accumulate to the highest point on the shoulders (4). The P_{TR} is a complex issue but also a major determinant of exercise performance in divers. Positive P_{TR} during immersed heavy exercise is associated with a reduction in dyspnoea, while negative P_{TR} provides a significant impact on the diver's respiratory function causing elevated levels of dyspnoea (6). Negative SLL places greater demand on the inspiratory muscles. The shifting of the blood volume from the extremities to the thorax, which decreases total lung capacity, residual volume, and lung compliance, magnifies the stress of the negative SLL on the respiratory system. In total, these changes affect the elastic work of breathing.

Diving Equipment. The use of a breathing apparatus imposes a breathing resistance that otherwise would not be present if the diver breathed from their own airway. This contributes to increased work of breathing and inadequate ventilation. Therefore, the designer of an UBA should aim at minimizing the induced breathing resistance due to the diving gear. However, some resistance is inevitable; the CO₂ scrubber canister in a rebreather will always pose a resistance to gas flow. Typically, the expiratory resistance is somewhat higher than the inspiratory (8). Warkander (8) et al. conducted a study in order to determine where on the breathing circuit is better to place components that cause unavoidable breathing resistance, such as a CO₂ absorbent. After separating the equipment-related breathing resistance into inspiratory and expiratory components, they showed that expiratory resistance is better tolerated by the divers in terms of physiological changes, such as dyspnoea and increased levels of end-tidal CO₂. Unavoidable resistances like the one caused by the CO₂ scrubber should be placed on the expiratory side of the counter lung and not the inspiratory side.

Increasing Gas Density. The density of any given breathing gas increases linearly with depth. Technical divers substitute helium for nitrogen in gas mixes for deeper diving, which substantially reduces density. Airways resistance is affected by changes in gas density. As gas density increases, the resistance to flow becomes greater. This consequently limits the ventilatory performance. If a diver, breathing air at 30 metres, ventilates as hard as possibly, the maximum volume he/she can shift over a minute is only half of that at the surface (4). The increasing depth decreases the diver's ventilatory capacity, therefore their ability to cope with the work of breathing and/or any other physical exertion at depth. This increased work of breathing loads the muscles of inspiration, which may cause respiratory muscle fatigue and possibly dyspnoea (2).

Work of breathing and diving. Any physical effort, in general, requires energy. During metabolism, each cell combines nutrients and oxygen to produce energy in the form of adenosine triphosphate (ATP) and waste products, mainly carbon dioxide and water. The body obtains the nutrients through a variety of processes, but the most common are through inhalation, as in the case of oxygen, and ingestion, as in the food we eat. The primary function of the respiratory system is to exchange gases at the capillaries of the lungs, or conduct respiration. Oxygen flushes into the cells and carbon dioxide is disposed. The process of respiration includes ventilation, diffusion of oxygen and carbon dioxide between the blood and the pulmonary alveoli, and finally the transport of oxygen and carbon dioxide in the human system. Ventilation, or pulmonary ventilation, is the process of moving air in and out of the lungs and consists of two phases: inhalation (inspiration) and exhalation (expiration) (1). It is important to remember that breathing is a form of physical work performed by the diver. The lungs are elastic, therefore work must be done during inhalation to counteract the elasticity and stretch of the lung and move

the "weight" of the chest wall, muscles and other soft tissues during the inspiration process. In normal atmospheric conditions, we do not notice that as we are well adapted to the normal respiratory demands. On the other hand, the immersion, use of an UBA and the increasing gas density, require additional effort by the diver to overcome those factors. This work is, of course, translated to consumption of oxygen and production of CO₂. Respiratory muscle exhaustion or failure to respond to increased work demand for any reason will result in inadequate ventilation (hypoventilation) and an increase in arterial CO₂ (4).

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No-Fly Time Accelerator

O2[%] in the surface rich mix (99 or 100 for pure O2) 0

Use only pure O2 or Nitrox mixes (not Trimix or Heliox)

Minutes of breathing the rich mix on the surface 0

Minutes of breathing normal air before applying the rich mix 0

Accelerate

Breathing Mix Calculator

Depth 90.0 m ppO2 1.4 EAD/END 40.0 m

O2 Narcotic

O2 [%] 14.0 He [%] 50.0

Calculate



Altitude Settings

Dive altitude 0.0 m

Hours at altitude 4.0

Diver acclimatized at altitude

Starting acclimatized altitude 300.0 m

Travel hours 8.0

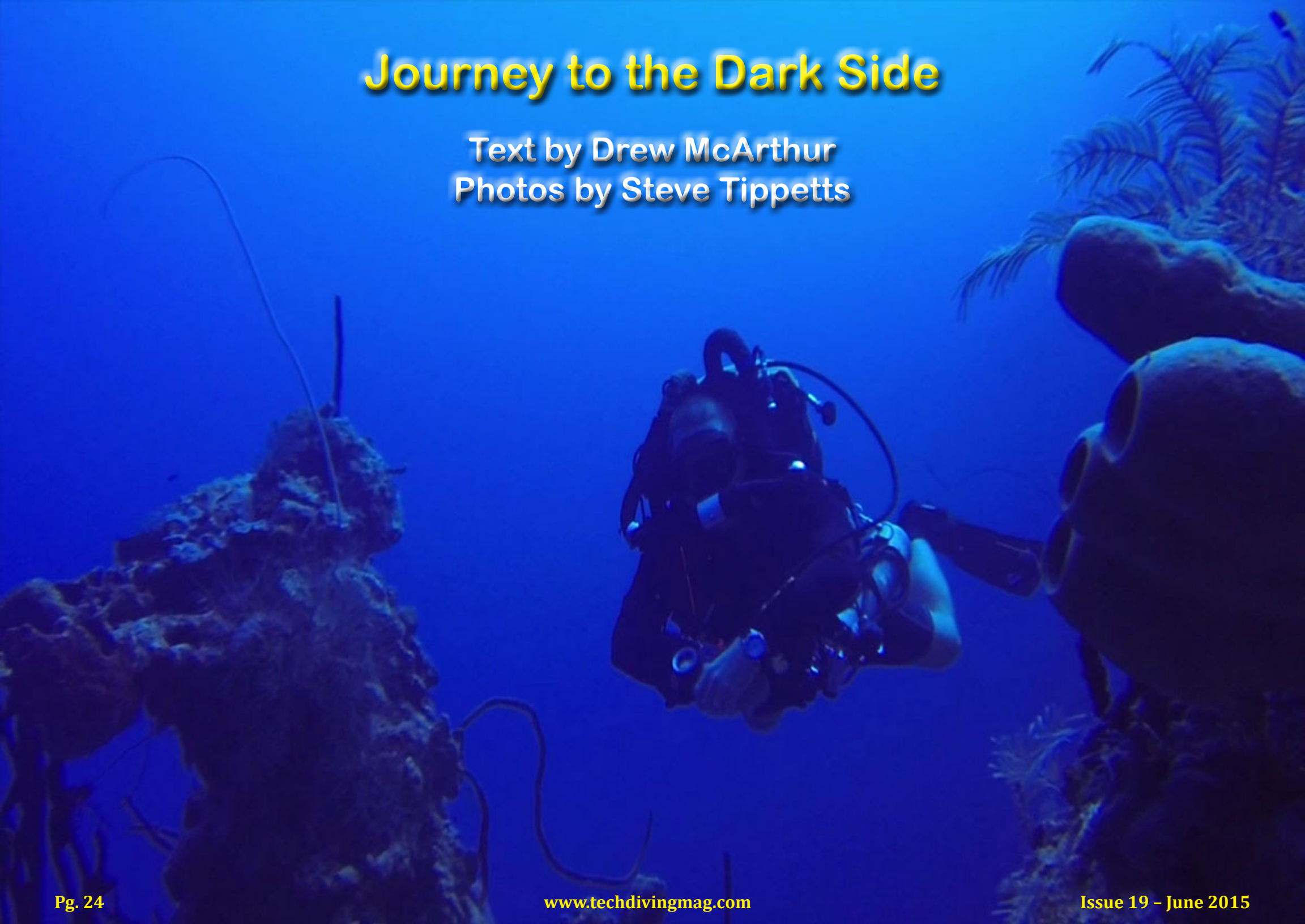
OK

== Probably the most advanced / user
friendly decompression software on
the market! ==

Ben Reymenants
Instructor Trainer (TDI, SSI, PADI)

Journey to the Dark Side

Text by Drew McArthur
Photos by Steve Tippetts



I like sitting at the bar talking nonsense, I'm good at it and it's where I feel comfortable, once there, the idea of leaving becomes preposterous. Metaphorically, my comfort zone is the same, offering protection and sanctuary from what lurks outside. As nice as it sounds, I know I can't stay in the bar forever, there is a whole world outside that should be explored. With this in mind, I recently leapt out of my comfort zone and changed everything I knew about diving. I finally made the step in to the silent world by getting certified as a rebreather diver.

For years I have given lots of thought to rebreathers, I have read articles and probably like many others, have heard mixed opinions about their safety. "Rebreathers are just death boxes and their users deserve to die!" That was a quote from a customer I heard recently. OK, agreed it is a little blunt, but it does kind of highlight one school of thinking on rebreathers. I find it interesting to hear the difference in opinions within the dive community on the subject. Some love them, some hate them and many do not know enough about them to comfortably form an opinion.

What is a rebreather? Well, apart from a very big strain on your bank balance, a rebreather is a unit that recycles exhaled gas by filtering out carbon dioxide and giving the user good gas to breath. The APD Evolution (Evo) which I am now certified to use monitors the gas in "the loop" and will give me the best mix possible based on the depth I am at, within the parameters that I have set it. The Evo is a Closed Circuit Rebreather which means that the gas constantly travels through a circuit without being expelled apart from during ascents.

I remember the first time I saw a rebreather, it was on a dive boat somewhere off the south coast of England. As the divers loaded their gear on to the boat, I noticed the conspicuous yellow boxes and recall having no idea what they were or what they did. Being relatively new

to the sport, I did not want to expose my ignorance by asking silly questions. Throughout the trip, I kept a suspicious eye on the strange looking devices and their owners hoping to get some clues. When the rebreather divers were getting out of the water and help was required to stow their units on the boat, I was reluctant to get involved thinking that if I grabbed one in the wrong place it may explode. Back on dry land, I went home and started to research these mystical devices, later feeling something of an authority on the subject as I had been near one once.

The main reasons why I had not tried rebreather diving earlier in my career were cost and availability, I expect these are the biggest constraints for most people. I was initially concerned about the safety aspect so spent quite a bit of time researching rebreather accidents and incidents. Time and time again, I came back to the same theme – user error. Like in open circuit, complacency kills. Writing this, I am reminded of a Mark Powell quote "diving is safe as long as you remember it is dangerous" – very true whether you are talking open or closed circuit.

On the subject of safety, I came to learn that modern units themselves are reliable and most often will do what they are built to do. When divers cut corners due to cost, time, laziness or just plain stupidity then accidents happen. My conclusion was to study the hell out of the subject to become as knowledgeable as I could, get good training, stay focused and tread carefully.

As an avid open circuit tech diver, my interest in rebreather diving is depth. The cost of helium is limiting and aside the startup cost, rebreathers are far more economical when using Trimix due to their lack of wasted gas. My initial turn offs were their complexity, required time and effort to get ready for the dive and reliability (I have seen

many a frustrated rebreather diver have to remain topside due to some fault or another).

My instructor was a bastard named Steve Tippetts. I don't think he'll mind me (affectionately) referring to him as such because I firmly believe that he prides himself on being a hard ass instructor. As I mentioned earlier, I wanted good training and Steve's tough regimented way fit the bill perfectly. I had worked with Steve for over a year in Divetech and in that time we became friends. Steve took this as fair game to try his hardest to make me cry during the course and I expected nothing less. An IANTD IT, he has had years of honing his skills and developing a whole host of nasty little tricks which he has a habit of pulling out of the bag at the worst times possible. Of course I am dramatizing, by "tricks" I mean carefully placed training scenarios that made me think about what was going on and how to use what I had available to solve the problem. IANTD say that training is paid for but certification is earned, in my experience I fully concur, there was no plain sailing in this course.

During the training, the hardest thing to come to terms with was buoyancy. Losing the ability to control position in the water with my lungs was a challenge. On open circuit I can hang in the water perfectly with next to no movement from my body whatsoever. My first foray in to closed circuit must have looked like one of those air puppet things that you get outside car dealers. It seemed as though my dive skills that took over a decade to acquire had evaporated in to think air. Time to park the ego and get back to learning some basics.

Having the luxury of being surrounded by some very accomplished rebreather divers, I noticed that the style looks different to open circuit. The perfect trim and motionlessness that I had spent years striving to develop is not how it works on a rebreather. Even very skilled closed

circuit divers often have to fin gently in a slightly diagonal position in order to maintain their depth.





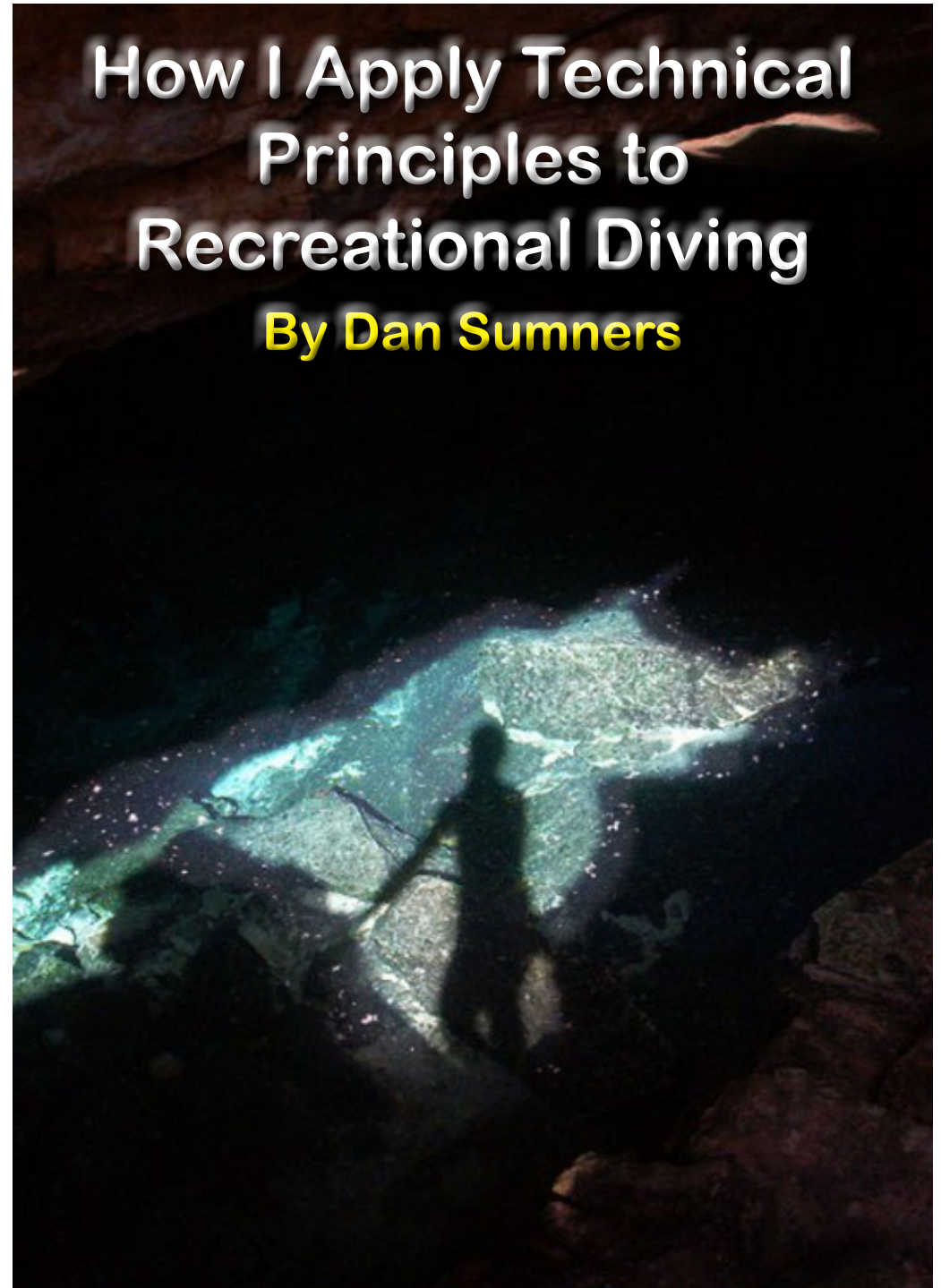
But that's the whole thing about new experiences; of course there will be differences. As humbling as it was to go right back to square one, the excitement of learning something new and completely different was more than worth it.

So having completed my basic training and done 30 or so dives, what's the verdict? I like rebreather diving very much, against closed circuit there are advantages and disadvantages. Trimix is a way off yet but drops to 130 feet or so are comfortable. My current opinion is that a rebreather is a tool and is the best tool for some jobs. For example, the stretch of coastline between our two dive centers is 3 km long, I have now dived it both open and closed circuit. On open circuit I carried five 80cf tanks (twins and three staged) and enough weight to sink them all when empty. On closed circuit, I had my neat little rebreather unit and a 40cf bailout. If nothing else I had a very good night sleep after the open circuit dive which took an hour longer due to the considerable increase in drag and weight. I'm able to shoot far more lionfish without bubbles to scare them away and I imagine that photographers will note similar benefits. However, I do love the simplicity of open circuit and having a full understanding of how each component of the inside of a regulator works is reassuring.

And now my comfort zone has expanded. To carry on the metaphor, the bar just got a lot bigger, has more people in it but the cost of the drinks has risen somewhat. For me, rebreather diving will not fully replace open circuit. I love the capabilities a rebreather provides and it is a perfect vehicle to take me to the depths I want to go to. However, for light recreational diving, I prefer the simplicity of open circuit. Maybe in the long term, my opinion will change, but for now, my perfect world is big enough for both technologies. As far as plans for the immediate future go, all this talk about bars has got me thirsty, time to have a little toast to the new adventure.

How I Apply Technical Principles to Recreational Diving

By Dan Sumners



On returning to diving after ten years I discovered technical diving. Whilst not pursuing it, I have applied its principles to my recreational diving. In this article I explain why and how.

When I was about eight, my younger brother and I were excited to read a notice at our local swimming pool: learn to scuba dive!

We rushed excitedly to mum. Her response: don't you think you should learn to be better swimmers first?

We weren't so young we couldn't see the logic in her argument. So we diligently set about training, in time becoming junior members of the local team.

We didn't know it was also her way of distracting us. The thought of her boys messing about at depth petrified her.

The beginning

Fast forward to 1999, and I finally took the plunge (my brother, although now a swimming instructor, sadly hasn't). Whilst on Ibiza for an extended holiday I helped a PADI instructor as he went from hotel to hotel, touting for try-dive business. As well as developing my knowledge of SCUBA, I benefited from a half price Open Water course.

What immediately appealed to me – and mum when I told her all about it – was the emphasis on safety. The whole course concerned not dying whilst having fun.

I know that's not always the way with recreational courses delivered at tourist destinations. I benefited from a good instructor, and we spread the course over six weeks or so.

Unfortunately I didn't return to diving until 2002, a refresher followed by the Advanced Open Water diver course in Playa del Carmen, Mexico. On that trip I also ventured into some caverns with a guide, something I wouldn't do now.

The reason for that is the greater understanding and appreciation I now have for safety as it relates to scuba diving. True, the guide gave me a good briefing, demonstrating his long hose and explaining why he used it. And I was aware of surfacing points at all times. But my own knowledge and skills weren't enough if something had gone wrong.

Now, if anyone asks me, "isn't scuba diving dangerous?" (as my neighbours recently did, as they prepared to venture onto London streets on their bicycles), I reply, after Mark Powell, "scuba diving is safe as long as you remember how dangerous it is". And that's what I didn't fully appreciate when I entered those cenotes, even though it was the focus on safety I had liked most about my training.

Discovering technical diving

When I decided to dive again, ten years down the line, I began with another refresher and a few dives. Then I started reading. First, I returned to the PADI materials, brushing up on the basics of gas laws and dive planning. Those exhausted, I turned to the Internet.

During my Open Water course, I remember my instructor mentioning nitrox. I can't remember exactly what he said, but it left me with the impression it was something for people who were very serious about their diving, who were going beyond the limits I had been told would apply to me as a recreational diver.

So I was surprised to find nitrox all over the place. It quickly became

apparent why – the benefits were obvious, the risks manageable. And I was interested by the history of its rise as a recreational diving gas.

At the same time I discovered ‘technical diving’. I came to understand it basically means diving deeper and/or longer. It means the ability to make a direct ascent to the surface is removed, either literally in the case of caves and wrecks, or virtually in the case of dives requiring decompression stops.

Whilst I didn’t set out on the path to technical diving – and still haven’t – there was something about it that really appealed: it was all about maximising safety by reducing risk.

Minimising and mitigating risk just make sense to me. The suggestion that accident prevention measures take the fun out of things is simply wrong. They make sure things stay fun.

So over the past couple of years I’ve soaked up writing, tuition and the knowledge and experience of technical divers. In particular, Steve Lewis’ *The six skills and other discussions*, *Staying alive* and his blog contain great advice in an accessible format.

Equipment

I understand the technical approach to equipment to be ‘streamlining’ in its widest sense. Understand what you need, only take what you need, keep it tidy, make sure you know how to use it and check it works before you dive.

Backplate and wing

It should also be fit for purpose. One thing that had annoyed me about diving was the BCD. I don’t say ‘jacket style BCD’ because, at that time, I had no idea there was an alternative.



But now I have and love my backplate and wing. The first time I dived with it I didn't even sense it was there until I needed to. It was a welcome contrast to a jacket which constantly rode up, restricted my movement and provided lift where I didn't need it.

Long hose

Of course, I discovered the fun of the 'long hose debate'. It took little to convince me. I immediately grasped the psychological benefit of donating a working regulator. Once you add to that streamlining of hoses and always knowing where your backup is, I simply don't understand why anyone would do differently.

I was guilty of doing it wrong though. I put together a long hose setup without training. I only used it twice, both times at an inland UK site, once on a dry suit course and once with a buddy.

But I quickly realised my mistake and went back to what I had been trained to use. I also joined a BSAC branch and began my Sports Diver training, so I would have had to put the long hose to one side anyway.

Sports Diver training completed, I did the TDI Intro to Tech course with Mark Powell. As well as my first taste of doubles, it provided the skills and confidence I needed – and my buddies can rely on – to use the long hose.

Delayed surface marker buoy

The other item I'm glad I now know how to use is the DSMB, a result of my decision to join a BSAC branch and dive in UK waters. I had seen instructors and guides use them and had the impression it was an advanced skill I didn't need.

But, like most things, all it took was some good tuition and (ongoing) practice to develop a skill I now understand all divers should have. Its modest size and range of benefits – for performing stops, being seen, drift diving and emergency surface buoyancy – counters any argument against carrying one.

Redundancy

The importance of redundant equipment also quickly became apparent. I recently read a forum thread debating whether or not you should carry a spare mask. In my opinion, there is no good reason not to. Unless, of course, you need the space for that all-important 12 inch Bowie knife.

My aim for this season is to train in the use of a 7 litre slung pony. I've decided against doubles as it represents an additional financial cost that's unnecessary for the diving I want to do. But, again, why wouldn't I want to carry extra gas for my buddy and me when it's relatively easy to do so?

Planning

Dive planning always appealed to the bureaucrat in me, so the enhanced focus on it for technical diving made welcome sense. And it reinforced my belief recreational divers need to keep doing it too.

Computers are undeniably great, but electronics break and I'm paranoid. Plus, dive planning is so easy for recreational diving. Even if slates didn't exist, it isn't difficult for most of us to memorise a few no-stop times. Especially when you're not going deeper than 35m and the amount of gas you're carrying limits shallow dive times.

So as well as my computer I dive with a laminated card and numbers in my head. Oh, and a dive timer so I can practice with that too. So far the computer has held up, as you'd expect, but it's all there for the day it doesn't.

Technique

As someone who is not particularly gainly on land, I've always enjoyed the physical freedom of being in the water. As a confident swimmer I never hesitated to jump in with dive gear, remove and replace my mask, and swap regulators.

But I found out this wasn't enough. I knew control of my position in the water was important, but I didn't even know 'trim' was a thing. And helicopter turns?

The benefits in terms of safety and comfort were clear. After watching myriad videos of technical divers moving about and remaining in one spot with apparently little effort, I turned to the BSAC buoyancy and trim workshop. My desire to improve these skills was another reason for my decision to do the Intro to Tech course.

Improving buoyancy, trim and finning are, and will remain, my focus on all dives. Because who doesn't start diving with the desire to be as at home in the water as a fish?

Self sufficiency

Another debate I've explored with interest is that about diving alone. As with most discussions, good and bad points have been made on both sides, and there's no need to rehearse them here. If you're interested I recommend '*Solo diving*' by Robert von Maier.

But I've noticed a potentially misleading argument against it that also applies to diving with more than one buddy. Some people use accident data to support their claim that solo or team diving is more dangerous than diving with one buddy. However, the data usually doesn't tell us if the dead or injured had trained for solo or team diving. As with the figures for cave diving, take out those who didn't bother to train and I bet the figures shrink massively.

That said, when I do the SDI Solo Diver course it won't be because I want to dive alone. It will be because I want to be as safe as possible and the best buddy I can be. Self sufficiency is something else that makes total sense, because I can imagine many ways I might end up alone, in a practical sense, underwater.



In conclusion

Although I haven't done any technical diving training, it should be clear I've learnt much from the principles that underpin it. In particular, that what I choose to do is dangerous, but the danger is eminently manageable.

I hope my account will encourage other recreational divers to develop their approach to diving by exploring and applying the principles of technical diving. They represent many years of experience that is still being refined and built upon.

You might be thinking, "That's not for me, I don't need to think about all that, I just love diving". That's like saying you love cooking but have no time for recipes, ingredients and utensils. With more knowledge and understanding you'll not only be a better diver, you'll have more fun.

I also recommend joining and training with a BSAC branch. The courses are well developed and focused on key safety skills. And the club environment is an opportunity to reflect on your learning with fellow trainees, discuss the finer points with instructors and benefit from the experiences of a diverse range of divers. It has helped me improve my skills and confidence hugely in a short space of time.

But I know I still have lots to learn. Even though I don't think I'll ever become a technical diver, I know I'll do all I can to be a safer diver.



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