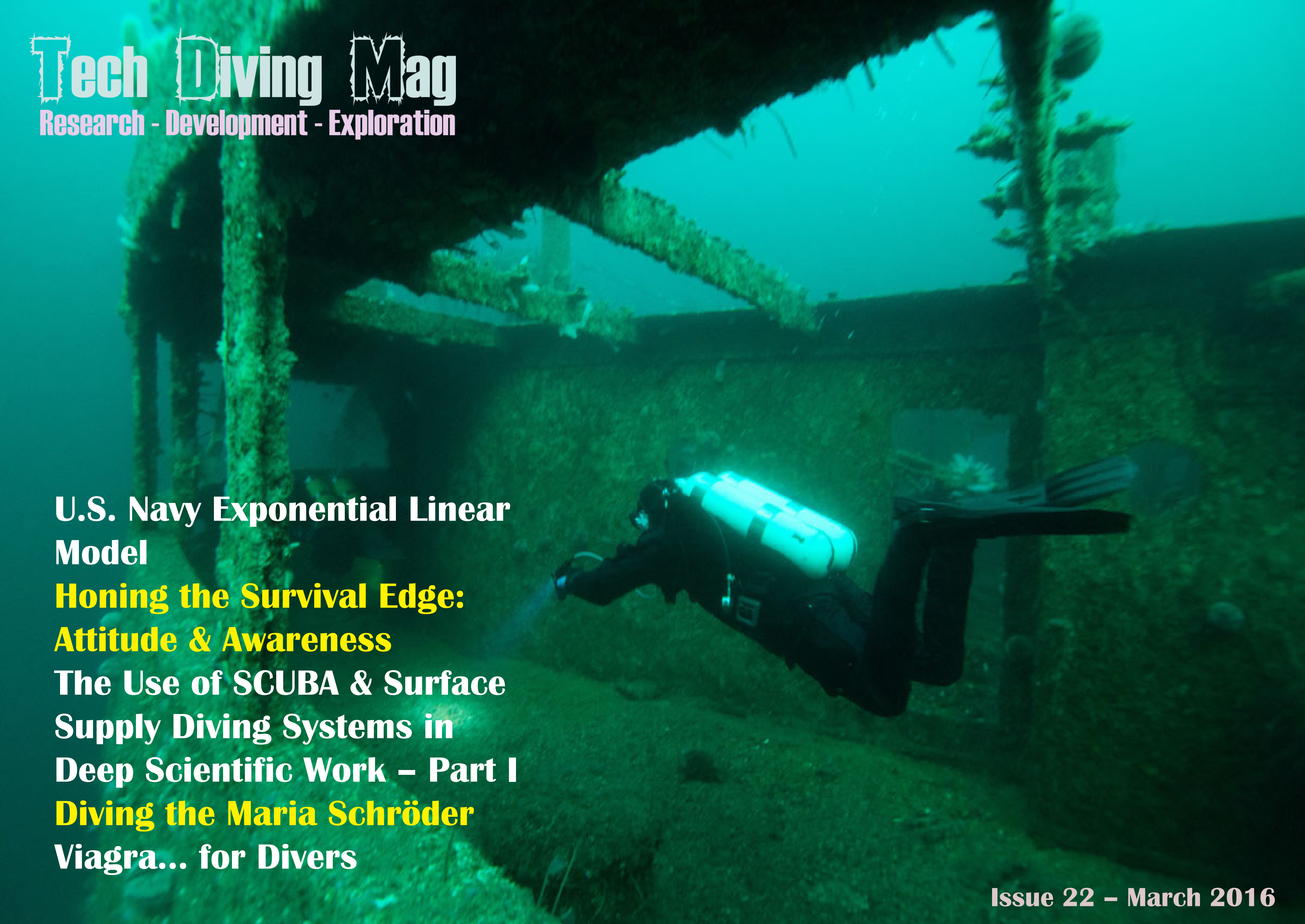

Tech Diving Mag

Research - Development - Exploration

U.S. Navy Exponential Linear Model

Honing the Survival Edge: Attitude & Awareness

The Use of SCUBA & Surface Supply Diving Systems in Deep Scientific Work – Part I

Diving the Maria Schröder

Viagra... for Divers

Issue 22 – March 2016

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Front cover image © René B. Andersen (www.uvgalleri.dk).

Editorial

Welcome to the 22nd issue of Tech Diving Mag.

Best Publishing Co updated their web site and now all three forms (print book, eBook and package set) of *Deep Into Deco: The Diver's Decompression Textbook* could be reached from a single page. Those who already got the book from Amazon, please put your reviews there. How does it compare to other deco-related titles? It has all the basic topics covered, and is more into decompression simulation/modeling and up-to-date research.

The contributors for this issue are world renowned industry professional Bret Gilliam, commercial diving instructor Konstantinos Alexiou and technical diving enthusiast Ayman Khaled. Take a look at their brief bio at www.techdivingmag.com/contributors.html.

Tech Diving Mag is based on article contribution, so you're always welcome to volunteer a piece and/or some photos. The guidelines could be found at www.techdivingmag.com/guidelines.html.

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Asser Salama
Editor, Tech Diving Mag

U.S. Navy Exponential Linear Model

By Asser Salama

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Haldane presumed that if no symptoms of DCS were present post-decompression, then no bubbles were formed in the blood. He also assumed that the uptake and elimination of inert gas by the tissue compartments are symmetrical and that they take the exponential form.

When Doppler tests were incorporated into decompression research, they illustrated that bubbles could actually form in the blood even if no symptoms of DCS were present post-decompression. The presence of these bubbles would affect the off-gassing efficiency, meaning that it would slow the off-gassing rate, which in turn would cause more bubbles to form.

To compensate for the anticipated decrease in off-gassing rates caused by the presence of these bubbles, Dr. Edward Thalmann (1945-2004) published in 1984 an algorithm based on the asymmetric gas kinetics concept, meaning that the uptake and elimination of inert gas by the tissue compartments are not symmetrical.[1] Called the USN E-L (also known as VVal-18 Thalmann) algorithm, it assumes that the inert gas is absorbed by tissues at an exponential rate (as in other neo-Haldanean models) but is discharged at a slower linear rate (hence the name E-L). This not only results in longer decompression stops but also affects the off-gassing rate during the surface interval, causing it to slow down.

In conclusion, the schedule generated for the first dive would be more conservative, and the schedules generated for repetitive dives would be much more conservative.

In 2001 some U.S. Navy divers made the first official computerized decompression dives in U.S. military history, using dive computers made by Cochran Undersea Technology and incorporating the USN E-L algorithm. In 2012 the Navy dive computers were validated by faithful replication of "gold standard" software implementations of the E-L algorithm maintained by the U.S. Navy.[2]

Continuous research by the Navy Experimental Diving Unit (NEDU) on the E-L algorithm resulted in a set of tables based on Thalmann's work and produced by Gerth and Doolette in 2007.[3]

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Excerpted from *Deep Into Deco: The Diver's Decompression Textbook*. The title is available at:

https://www.bestpub.com/books/scientific-diving/product/428-deep-into-deco-the-diver-s-decompression-textbook/category_pathway-42.html

http://www.amazon.com/Deep-Into-Deco-Decompression-Textbook/dp/1930536798

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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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Honing the Survival Edge: Attitude & Awareness

By Bret Gilliam

Rarely does everything go exactly the way we want it to: in life, business, diving, and especially take-out food. And that's okay, since the serendipitous events of the unexpected can sometimes be a great learning experience. Or they can be yet another episode in natural selection. Hey, Darwin never worked at Burger King!

Anticipation is, of course, a first line of awareness that conditions the diver to expect things to go wrong and to be constantly adjusting a mental protocol of things to do when circumstances find yourself "circling the drain" in some situation or another.

Mental preparation and skills conditioning are the first element of survival. But it helps to have the extra edge of knowing that you can beat the situation simply on will and attitude. Remarkably, the only difference between some survivors and those who perished was the attitude of each individual.

In diving, preparation for contingencies can ease their eventual encounter. But almost as important is developing an "attitude" of confidence that allows you the edge in dealing with stressful and dangerous scenarios. My first dive was in the late 1950s and along the way since then I've managed to step into the world of contingencies with both feet on more than a few occasions. Several brushes with mortality were thwarted, perhaps as much as anything, by simply refusing to accept that my number was up. And although scared and stressed, still running through the check list of options instead of giving up.

Consider this quotation from How to Survive on Land and Sea originally published in a U.S. Navy publication in 1943:

Life's battles do not always go
To the stronger or faster man
But sooner or later the man who wins
Is the man who thinks he can

There are accounts of seamen who managed to escape death in convoy vessels sunk in World War II only to lose hope in lifeboats and simply decide to die. Their shipmates who marshalled courage to cope with the fear that everyone must eventually face were able to "decide to live" as an alternative in exactly the same circumstance and were rescued.

There are similar accounts in diving. Consider the oft told story of the individual who became lost in a cave system and spent the final 20 minutes or so of his life writing a lengthy message to his family on his dive slate. When his body was found several days later he was within 100 feet of the exit. I don't know about you, but I've got to think he might have better used that time and the remaining air supply to take a more pro-active role in seeking a way out.

About ten years ago, three divers got separated from their dive boat and drifted away in the dark Gulf Stream. In spite of being similarly equipped and in warm water, two died and one survived. The survivor later recounted discussions between his two partners as to the utter hopelessness of their situation.

"Will we drown, die of thirst, or be eaten by sharks?"

Not exactly the power of positive thinking.

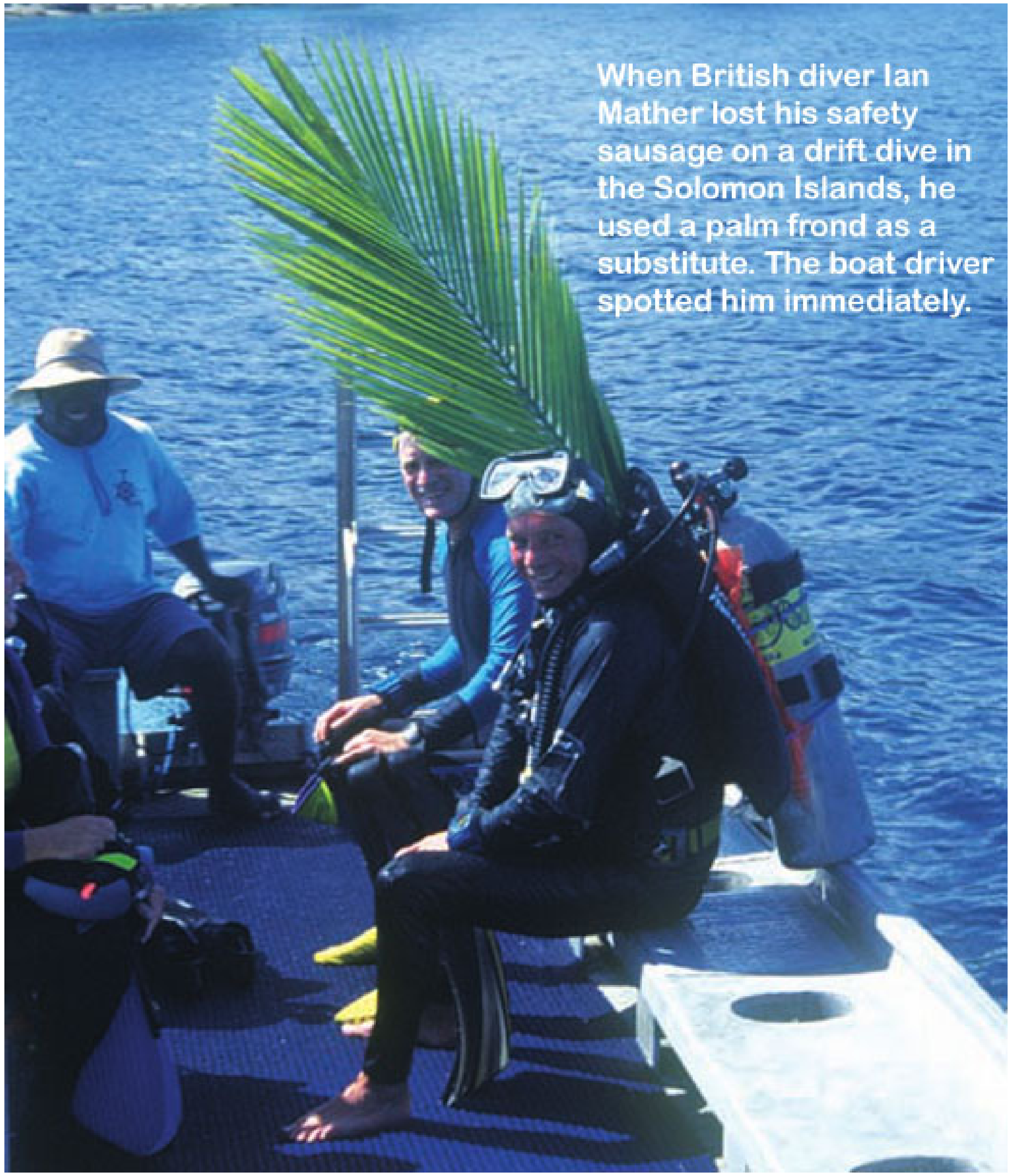
"The hell with Door Number Three, Monty, I'll take what Carol's got on her table" pretty much summed up the survivor's attitude and he finally swam away rather than listen to more of the grim dialogue that seemed to be measuring him for a coffin already. He was retrieved on the third day.

Underwater our most serious contingencies sooner or later come down to a question of air supply. When that's gone, in most cases, so are you. There is an endless list of ways to avoid running out of air and with modern submersible pressure gauges, no diver should face that situation unless he has become unexpectedly trapped without an egress to the surface. This happens in caves, wrecks, ice and other overhead environments. But even then, if you keep your cool there is every fighting chance that the situation can be overcome with a bit of luck and some creative thinking.

I'm sure everyone who read about the divers lost in Palau on a drift dive in 1994 had to shudder. A combination of mistakes led to their marooning but the biggest problem ultimately was that they could not be seen by rescuers looking for them.

There have been millions of words written on how to survive the "unexpected underwater." But little devoted to surviving a bad situation once the diver makes it back to the surface. And that's where we should be able to muster a fairly strong argument that it's not our week to be fish food if some common sense is applied to supplementing our gear packages.

Surface signaling apparatus should be a part of every diver's standard equipment for every dive. We have the economical tools to provide at least a fighting chance for rescue if an inflatable "sausage" and a Dive Alert are carried. These items are small enough to be carried without intrusion and cheap enough to remove a financial obstacle.



I have spent far too many occasions in my career abandoned by Third World boat drivers (through a variety of scenarios). If you have not experienced the singular pleasures of watching the sun set over the Yucatan as you drift north at five knots past Cozumel while your boat steams anxiously in the opposite direction... well, you really haven't seen the island with the same appreciation as one who watches the lights of Carlos & Charlie's fade between wave crests.

After my last thrill-packed drift into oblivion in 1989 that lasted nearly four hours, I went out and bought a carton of "safety sausage" floats and gave them out like cigars from a proud dad. Now I also carry the Helix strobe for possible night situations and some orange smoke flares for the day whenever my schedule has me in real or potential drift situations. Especially if I don't know the boat operator. And I've used them every year when Mr. Murphy inevitably strikes.

I'm also a firm believer in borrowing money from the captain at the beginning of the trip. Funny how that bond seems to keep them alert.

"There's a diver missing? Yeah, call me if you don't find him in an hour or so. Oh Christ, it may be Gilliam and he owes me fifty bucks!"

Now the choppers are scrambled.

But all kidding aside, there are a variety of excellent products that can dramatically increase your odds of being detected in a dark, rough ocean. And the investment is probably less than a dinner out.

Consider the following:
1. some variety of inflatable "safety sausage"
2. a long life battery powered flasher or strobe
3. a small signaling mirror
4. smoke for day and flares for night
5. a folding compact radar reflector
6. a Dive Alert sonic L.P. "shrieker" (This should get an Oscar for how many people it's helped or saved.)
7. a modern submersible EPRIB device
8. a water-compatible loud whistle

All these items can be stored in a BC pocket or in a tank mounted fanny pack. They can be the difference between being found and rescued or a long wait with the "Donner party". After all, it would really be a bummer to manage a magnificent free ascent from 200 feet or some other life threatening scenario only to expire because you drifted away in the fog and no one could find you.

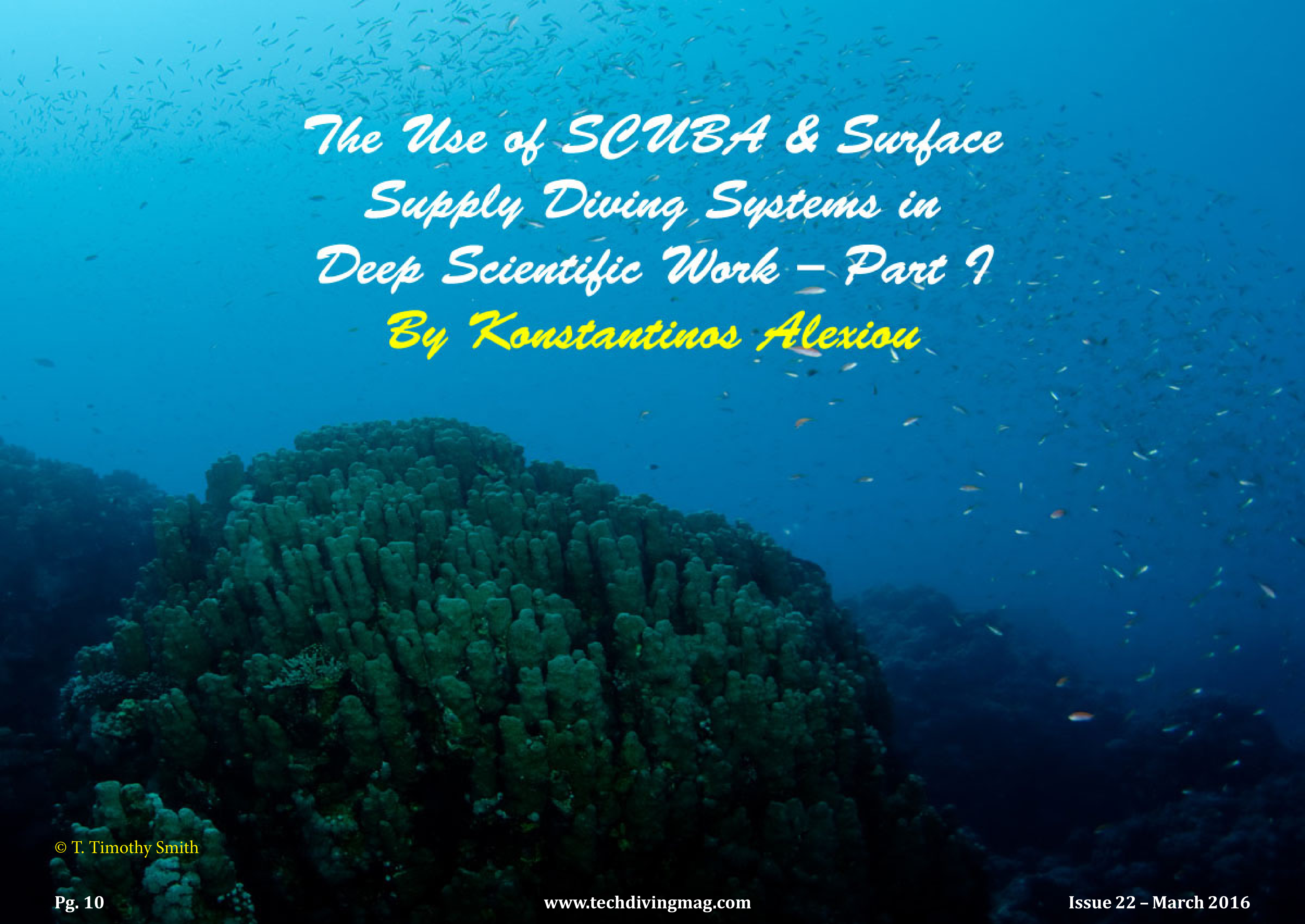
Regardless of the circumstance, remember that your will to survive may well be the only edge you have on others who toss their chips in early. Fear is a potent adversary. But the human species has a remarkable ability to endure what might seem impossible. It all comes down to confidence. And attitude.

You can start by wearing your ball cap backwards and an old Raiders football tee shirt under your wet suit. Al Davis was right: "Just win, baby!"

Bret Gilliam was the founder of TDI and the other agencies in the ITI conglomerate. He began diving in 1958 and his professional diving career in 1971 with the Navy project. Since then he has been involved in every segment of the diving industry including retail and resorts, military and commercial operations, filmmaking, publishing, manufacturing, diving ship and liveaboard design and operations, as well as legal consulting in litigation procedures. Along the way he has logged over 18,000 dives. He was inducted into Diving's Hall of Fame in 2012 by the AUAS as the Recipient of their NOGI Award for Diving Sports/Education. After nearly 25 years of living in the Caribbean and equatorial regions of the world, he now makes his home in Maine and travels internationally on diving projects.

The Use of SCUBA & Surface Supply Diving Systems in Deep Scientific Work – Part I

By Konstantinos Alexiou



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Introduction

Science is defined as the knowledge of the physical or material world gained by systematic study, through an organised approach, which consists of observation and experimentation.Regardless of the environment where the scientific work is performed, the scientist relies on specific training, tools, methods, and techniques in order to carry out all the required tasks in a scientifically approved manner. The productive potential of the scientist depends upon the above four interconnected factors. No doubt, thespeed at which the technological innovation occurs and how efficiently is used by the individuals have a strong impact on the above interaction [2]. Scientific diving is a valuable tool that has allowed us to enter and examine the underwater environment, supporting research operations related to a broad range of marine sciencesand disciplines. Starting from the 1950s, there have been significant underwater operations linked to a scientific purpose, where often the divers had to patent different SCUBA systems in order to venture in the deep water [4].

Deeper scientific diving needs

Scientists have been performing deep dives to 50-60 metres for quite a long time in Europe and the United States.The last decades the scientific diving community examines the capability for the scientific divers to work safely and efficiently, as well as cost-effectively up to depths of 100 metres. Technologies used primarily in the offshore oil and gas industry, such as acoustic mapping, ROVs (Remoted Operated Vehicles), and AUVs (Autonomous Underwater Vehicles) have been successfully used for scientific work, but there is the strong belief that a properly trained scientist can offer research value and flexibility that unmanned underwater systems cannot [3]. Let's see the current modes of deep scientific diving that the research community uses for deep scientific work.

Technical SCUBA diving systems

Michael Menduno coined the term "technical diving" in 1991 as diving that consists of dives beyond recreational limits (40m). It is further defined as, and includes one or more of the following: diving operation that required stage decompression, diving in an overhead environment beyond 40 linear metres from the surface, diving with accelerated decompression and/or the use of variable gas mixtures. He got the idea from "technical" climbing, and this term is used until today in the diving community [7]. The last decades technical diving is steadily increasing in popularity and the advancements in open- and closed-SCUBA systems have extended the underwater productivity and the range within the scientific diving community. The technical diver's equipment differs considerably from that used by recreational divers. Open SCUBA systems consisting of twin independent tanks of different volumes, such as 12 litres, 15 litres, 18 litres, 20 litres, filled with the appropriate breathing gas/mix, two regulators, a wing type BCD attached on a backplate,and a diver harness are widely used by the scientists. The diver carries on his/her side additional tanks and regulators, depending on the dive profile. In addition, the scientific diver can carry a closed SCUBA system, a closed circuit rebreather (CCR). The use of CCR systems is not new to scientific diving, but still not as common as this of open SCUBA gear. The rise of CCR diving in technical diving and the experience gained in the last 20 years, open new horizons with respect to improved deep scientific diving capabilities. The first advantage of CCRs compared to the conventional open SCUBA equipment – or semi-closed apparatuses – is their gas efficiency. Secondly, via electronics and sensors the CCR optimizes decompression by allowing the maximum partial pressure of oxygen in the loop at each stop level, based on the exposure limits. These result in extended depth capability, redundancy, and safety through the manual override options in the unlikely event of system failure.


A SCUBA diver in typical back-mounted doubles

However, the CCRs have their downsides. This kind of system requires a special mindset comprising of proper training and discipline. CCR diving introduces forms of risk not experienced by open SCUBA divers, therefore not immediately obvious if the diver fails to recognise them through the instrumentation, his/her training, and experience. The closed system requires a great deal of training and discipline. Dedication to equipment maintenance, pre- and post-dive procedures is of essential importance. The open SCUBA apparatus is very robust compared to CCRs. The dive community has an experience of more than 50 years of constant use of open SCUBA systems, which has made them safe and reliable. CCRs are also evolving, but at a slower pace. The cost of a CCR system is much higher than of an open-circuit. However, after the initial purchase, the operational cost is low. Especially when TRIMIX is used for scientific dives, the CCRs are most cost effective than open circuit diving or surface supply diving systems [5, 8].

Surface Supply Diving (SSD) systems

Surface supply diving is the mode of choice for most commercial and military diving operations to depths of up to 100 metres. The specific type of diving has solid advantages over any diving operation performed on SCUBA gear. To mention some: a) increased safety and high sense of comfort, established by the existence of the lifeline (umbilical), which constantly supplies with breathing gas, communications and light systems, as well as hot water for the diver's hot-water diving suit, b) ability to carry out surface decompression procedures on oxygen (sur-D-O_2), that decreases the in-water decompression procedures which are completed in the sheltered and controlled environment of the chamber, c) the use of saturation diving when required, which has many benefits, such as unlimited bottom time and efficiency. During SSD operations, there is an entire team on the surface with designated duties, which makes the diving operations very safe and productive. The surface crew, and specifically the Dive Supervisor, can offer significant practical, mental, and psychological support to the diver. The dive is managed exclusively by the Dive Supervisor who relieves the diver of tasks, such as dive calculations, gas management, gas switching, and arrangement of decompression procedures. This support is of high value to the working diver who operates at depths of 90-100 metres. Saturation diving systems are also used, but due to their heavy logistical envelope are not the preferred choice. The same applies to the atmospheric diving suits (ADS), which can offer long bottom timesin a protective atmospheric environment with no decompression requirements. SSD systems offer unique deep scientific diving capabilities, but also present with limitations. The surface supply diving and its manifestations when conducted in open water require a heavy and complicated resource commitment. The existence of a large and redundant diving platform, usually a dive vessel, able to accommodate the needs of such operations is critical for this kind of diving operations. Overall, the above systems are cost prohibitive to the average scientific diving programs. The high costs and inflexibility surrounding this kind of operations are the principal reasons that this diving is not the preferred method in scientific diving, even though theirsafety standards, reliability, and efficiency are proven. As previously mentioned, the research community operates with conventional SCUBA equipment and systems, with CCR being preferred for deep dives in the zone of 60-100 metres. The SCUBA gear is relatively inexpensive and highly mobile, is being constantly improving, requires minimal logistical support and maintenance, easily accessible, and familiar to the divers from their initial dive training, especially while transitioning to the redundant technical diving configuration. However, for specific underwater tasks, the use of SSD system rules out any potential advantage of the SCUBA gear [6].

Epilogue

There are human, economic, and logistic limitations in both SCUBA diving and surface supply diving systems. Any type of deep diving is associated with exposure to risks. Maybe the shift of the scientific diver towards the use of CCR diving in order to conduct deep underwater research is more “natural” and logical, since the SCUBA setting is the core training method for any type of initial and advanced dive training. However, the scientific diving community needs to realise the potential of SSD systems for deep scientific diving. This will probably take time, because an adequate operational and legislation framework, in which this mode of diving will function, needs to be first established. In the next article, we will look further into the use of SCUBA and surface supply diving systems as a tool to perform deep scientific work.

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Diving the Maria Schröder

By Ayman Khaled

The *Maria Schröder* was an 81 meter length, 12.8 meter beam, 7 meter draught steam-powered cargo vessel. With a total volume of 1,917 gross tonnes, her triple-expansion steam engine was able to propel her at a speed of 11.5 knots. The ship was built at Trondhjems Mekaniske Værksted (Yard No. 174), Trondheim, Norway, for Det Nordenfjeldske Dampskibsselskab.

From 1920 till 1940, she sailed the Mediterranean service route as the *Rolf Jarl*. Although she was in Norway when Germany invaded Norway, she was able to escape and sail to France. She was placed in Allied service. After WWII she was sold to Reederei Richard Schröder, Hamburg, Germany, and renamed the *Maria Schröder*.

On 11 April 1956, on a trip from Aqaba, Jordan to West Germany, the *Maria Schröder* ran aground on a reef at Nabq north of Sharm El Sheikh at position 28.10N/34.30E. Attempts to refloat the ship were unsuccessful and she was declared a total loss.

Diving the wreck

Today the *Maria Schröder* lies atop the reef approximately 120 meters offshore. The easiest way to dive her is by boat. Since that was no avail option some 10 years ago, we entered the Nabq State Park from Sharm El Sheikh's gate by car with our Bedouin driver/ guide, loaded with tanks, gear and O2/first aid kit. Nabq is a very nice place for desert lovers, bird watchers and wild life photographers. It also includes the most northern mangrove forest in the world. As for the location of the wreck, just follow the seaside track. You can't miss her out.

We went for the 120 meter reef table walk. With gear on, this is a long distance. We finally reached water deep enough to swim through, just to discover that we're in a closed lagoon. Climbing the edge of the lagoon to continue our walk was even more tiresome.

At the beginning of the dive we saw an eagle ray at 7 msw, not an unusual sighting in this part of the Gulf of Aqaba known for strong currents. Most of the wreck is still above water. As the ship collided with the reef (again not something unusual in the Gulf of Aqaba!), she was cut into two big sections.These two sections are very unstable so stay away from the rusty, collapsing main structure. Scattered debris is found down to about 22 msw, where parts of the keel's I-beam could be located. Most of the debris is covered in pristine hard corals teaming with marine life. The reef table is a sloppy wall reaching down to about 61 msw.

It was May, not so hot in this part of the world. Water temperature was about 26 °C. After the dive, we enjoyed a cup of Bedouin tea followed by a fresh meal. It's somewhat weird to enjoy watching the fish underwater just before re-enjoying them as food!

Viagra... for Divers

By Asser Salama

A recent study by Duke Health suggests swimmers and divers who are prone to a sudden and potentially life-threatening form of pulmonary edema in cold water could benefit from a dose of Sildenafil (Viagra™). The research was published in *Circulation: Journal of the American Heart Association* (February 16, 2016 issue).

Although used mainly for treating male impotence, it could also be used for pulmonary arterial hypertension. Viagra dilates blood vessels, giving it the potential to ease an unexpectedly sudden cold water-induced constriction of blood vessels in the limbs that can lead to blood pooling in the heart and lungs, a condition called Swimming Induced Pulmonary Edema (SIPE). SIPE symptoms include coughing up blood, elevated work to breathe and low blood oxygen.[1]

But what about deco? As per our current understanding, gas-exchange kinetics are accelerated by vasodilation. Accelerated gas-exchange kinetics means more on/off gassing rates.

Viagra takes effect in about 30 minutes. The effects last for about 4 hours.[2] This means that taking the drug should be "synchronized" with the dive plan, otherwise you might end up with accelerated gas-exchange kinetics at the descent/bottom phase and normal gas-exchange kinetics at the accent phase, not something a diver would be looking for.

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