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THE SCOPE OF NON-CONVENTIONAL RECREATIONAL DIVING

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Key Words

Deep diving, mixed gases, oxygen, recreational diving, safety, tables.

What is "recreational diving"?

Non-conventional recreational diving has to begin with a basic definition of recreational diving, which can be summarised as diving for fun. Recreational diving is well recognised as being scuba diving in the range to 40 msw (msw = metres of sea water; 1 msw ≈ 0.1 bar or 10 kPa), and further it is diving with air as the breathing gas and not involving decompression stops. Realistically, these are not the limits within which all recreational divers operate, but until recently they were the limits to which divers have been trained by the recreational diving training agencies, particularly in the U.S.A. The British Sub-Aqua Club (BSAC) trains divers to 50 msw and allows decompression stops. This zone defined above is also recognised by the U.S. Occupational Safety and Health Administration as being outside commercial diving. Thus instructors can teach diving within these limits without their employers having to comply with the Commercial Diving Standard. In Britain recreational diving instructors at work who breathe non-air mixtures are considered to be commercial divers.

As mentioned and as the name implies, recreational divers are doing it for fun. Implicit in this is that these divers are not employees and they are not at work. Other types of sport diving are "recreational" in not being work, but may involve considerable specialisation and skill. Some of these are cave diving, ice and other types of overheadenvironment diving, decompression diving with scuba, hookah diving, enriched air diving, rebreather diving, "technical diving," and combinations of these. Another "outside the limits" type of diving is deep air diving; this deserves special attention because it was to avoid deep air diving that technical diving was developed. Another category often considered to be "technical" and thus outside recreational limits is diving with oxygen-enriched air ("nitrox"). This has recently been rescued by PADI and BSAC and is now regarded by these agencies and others as being legitimate recreational diving.

One recurring question is, "What about instructors?" When they breathe exotic gas mixtures and perform decompression, are they within the limits of recreational diving? The answer to this one is still out in the U.S.; some discussion on this was done at the 1996 SPUMS meeting and will be reported in the Journal.

Deep recreational dives

Deep is a relative term which involves the diver's own skill and preparedness as much it does the water depth. Even within the mentioned limits special "deep" training is needed to go even as deep as 40 msw.

For some years now some scuba divers have exceeded the 40 msw limit in air scuba dives, using decompression stops when necessary, and under some conditions have even used oxygen for decompression. One clever method was to use the otherwise unreliable USN Exceptional Exposure air decompression tables with oxygen decompression. With oxygen in the last couple of stops the decompressions were not much of a problem, and the tables were "legal" and "in the book." However, these tables allowed divers to go well beyond the depth at which nitrogen narcosis can become seriously debilitating. As depth increases much beyond 60 msw the PO_2 (partial pressure of oxygen) in air also becomes a risk factor due to CNS (central nervous system) toxicity. It was clear to those who thought much about it that there was a need for something better than diving deep with air.

Relevant background experience

Mixed gas surface-supplied diving by navies and particularly commercial diving companies had been developed to a high level of sophistication but within rather narrow, experience-based limits. Air was not used beyond the depths where it is well tolerated, but for the tethered diver with a topside supervisor, narcosis was much less a threat that for the free-swimming scuba diver. The benefits of helium to prevent narcosis have been well established in this community, but in general the procedures were not easily adapted to scuba operations.

Although not generally dedicated to extending diving depth, another substantial experience base had developed in the application of technology to diving; this was the historical development of rebreather diving by navies, especially the clearance divers of the British Royal Navy during and after WW II. While properly thought of as "technical diving," this experience was not really tapped for the development of the initial wave of technical diving as we know it now.

However, rebreathers were involved in the early development of technical diving. In the middle 1980s Stuart Clough of Carmellan Research began using Rexnord CCR-155 rebreathers (now Carleton), focussing on photogrammetry, exploration, and treasure hunting. This was supported by lab trials at Dr. Maurice Cross' Diving Diseases Research Centre (DDRC) at Plymouth in the UK and included dives to 150 msw and also work with neon.[1] This group found that using a PO_2 of 1.4 bar(140 kPa) gave an efficient decompression. The idea had been mentioned by Vann some years earlier,[2] but the US Navy used only 0.7 bar PO_2 in the military versions of these rebreathers, for reasons other than decompression. This level, 1.4 bar, is just below the level of central nervous system toxicity and because of the high oxygen it gives a nearly optimal exposure to inert gas at bottom pressure (that is, it makes the inert component as low as it can safely get). An expedition in 1987 by Rob Palmer to study blue holes on Andros Island in the Bahamas involved Stuart Clough, Bill Stone, Rob Parker and myself, among others; successful dives to nearly 90 msw were done with the rebreathers.[3]

As a direct follow-on to the Andros operation, a group of cave divers making deep penetrations began to add some helium to their bottom mixtures. Cave exploration in North Florida by Parker Turner, Bill Gavin, and others called for long times (over 1 hr) at depths in the 70-80 m range; these divers (quite correctly) regarded such dives as being too dangerous with air, primarily because of the narcosis. The use of special mixes also allowed the oxygen fraction to be reduced, allowing a lower PO_2 to be used at bottom depth and thus making longer bottom times feasible without incurring oxygen toxicity.[4] The use of special mixtures made special decompression tables necessary, and these were developed.[5] Cave divers had already developed highly specialised techniques and equipment, a high level of discipline and a special category of training, so were a good place for this to start. This technology quickly spread to deep wreck divers, who learned to do this same pattern with diver-carried gas.[6,7] This is the technology that became known as "technical diving." It is correct to say that technical diving was invented to avoid having to dive deep with air.

The pattern from the beginning was to use an oxygen-helium-nitrogen trimix with both oxygen and nitrogen appropriate to the depth, then switch to an intermediate enriched air mixture until oxygen could be breathed (at first at 9 msw, but this was reduced to no deeper than 6 msw as experience built).

Boyle's Law expansion

Like a rising bubble, the concept began to grow. Jim King, who could afford it, began serious deep diving operations, working with Billy Deans of Key West, who became, and still is, the leading technical diving guru. Others learned to do the decompression calculations, based on the published algorithm of Prof. Bühlmann.[8] In due course commercially available do-it-yourself decompression software became available.

Early interest was in cave exploration, but soon open-sea wreck divers began to develop techniques. Early development focussed mainly on gas logistics. At first tanks were over-pressurised, later bigger tanks became available. Cave divers stage their extra gas, but open sea divers have to be self-sufficient, even to the extent of completing their decompression while drifting, possibly having no contact with the boat. Drs Zannini and Magno[8] had earlier helped Italian coral divers develop similar techniques, but this was not known to the American cave divers. There had been other deep open-circuit scuba dives by specialists, not all successful (some of these were real explorers), and the impression was that this was risky (rightly so!), highly specialised, proprietary, and the techniques were not available to others. Some significant explorations have used technical diving techniques.

aquaCorps takes it "out of the closet"

The final step in making technical diving a reality was spreading the information to other divers. This began with the publication of a journal dedicated to it. Michael Menduno was so intrigued by this new development in recreational diving that in 1990 he founded aquaCorps, a "journal" (really a magazine) dedicated to this concept. It not only disseminated technology, but it got people talking about it. Menduno coined the term "technical diving." He also had the idea of running a conference dedicated to technical diving, and "tek" conferences were held just before the DEMA show from 1992 to 1996. aquaCorps ceased publication after a total of 12 issues, closing down after the 1996 tek show and is now out of business. Several other magazines now address technical diving issues.

As the interest in this extended-range diving increased, manufacturers began to provide big tanks, special components of the technical rigs, gas mixing facilities, scooters, etc. Decompression software became available, and enriched air computers. Training courses have proliferated, most of them spun off from enriched air training; several are offered by companies that pretend to be "associations" of technical divers. On the down side, a dozen or so fatalities in 1992 showed the hazards of not doing it right.

Enriched air for the masses

In a somewhat parallel development, the use of oxygen-enriched air (OEA) in recreational diving has reached a high level of refinement. This is the practice of improving the decompression situation by replacing some of the nitrogen in air with oxygen. It was started in the 1970s within the diving program of the US National Oceanic and Atmospheric Administration (NOAA) by Dr Morgan Wells and was picked up by his colleague Dick Rutkowski who began promoting and popularising it (they called it "nitrox") among recreational divers. Promotion of OEA created considerable controversy, largely because of the NIH (not invented here) factor, gross and somewhat unsophisticated over promotion (mainly by Rutkowski), and a general lack of understanding of the practice. Australia was not spared this controversy. Those uncomfortable with the practice stretched their imaginations in finding reasons not to do it as much as its supporters did to promote it. NASA spent these early years finding reasons not to use OEA in their neutral buoyancy training tanks, but when the Hubble telescope repair called for a long mission, and training for it could be done most efficiently with enriched air, NASA jumped right in. The final stroke of acceptance has been with PADI's entry into this practice (see paper by Drew Richardson).

Those inside the technical diving community regard diving with enriched air as not being technical diving (with the exception of technical training organisations, who keep this issue totally muddled with the multiplicity of courses offered). Those outside see OEA as exotic and highly technical, so find it easy to lump it with technical diving.

Although not really "technical" diving, use of enriched air called attention to alternative breathing mixtures. Interestingly, technical diving practice itself did not cause such controversy, perhaps because it did not threaten to invade the recreational diving domain. Some "nitrox" related myths were that it would corrode your tanks and buoyancy compensator (inconsequential), that you could not treat a diver with DCS from "nitrox" diving (standard treatments work the same way they do for air dives), that gases have to be used within two weeks (if they change it is because they were not properly analysed to begin with), that you should use two analysers (if you need think you need two of them, then chances are you do not know how to use either one of them correctly). Other myths from the promoters were that there were some half dozen benefits (there is only one, it improves decompression); that it reduced narcosis (it does not, since oxygen is as narcotic as nitrogen); and that one could benefit from using OEA at 50 msw (this is not at all worth the effort because of oxygen toxicity limitations).

What is "Technical diving"?

Given all this, perhaps it is now possible to define technical diving. At the outset it should be pointed out that the term "technical diving" comprises so many different aspects of diving practice that SPUMS policy does not address this as a single entity.

Technical diving

is recreational;
it has been developed entirely by recreational divers who do it voluntarily, at their own expense and risk;
it does not meet occupational safety standards;
the term is an analogy with technical mountain climbing;
is self-contained recreational diving which may extend beyond the range of traditional recreational diving;
necessarily involves special training, discipline, experience, and commitment beyond ordinary diving;
uses special techniques and equipment, including breathing mixtures, gas management, decompression procedures, decompression stations, thermal protection, buoyancy and ascent control, propulsion, and redundancy;
requires detailed operational preparation and planning.

A technical dive involves a change in breathing mix or use of a rebreather.

The definition excludes some things. Technical diving is not;
diving with oxygen-enriched air ("nitrox");
using rebreathers in the recreational envelope (40 msw, no-stop);
and of course deep air diving.

Operational organization is imperative for all but the mildest technical dive; some good examples of how to do this are now available.[10]

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NITROX

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Key Words
Accidents, deaths, injuries, mixed gas, nitrogen, nitrox, oxygen, safety.

"Nitrox" is an easy word to use for the range of oxy-nitrogen mixtures but there are several other terms also in use. For those mixtures in which the oxygen content is greater than 21%, "Enriched Air Nitrox" (EANx) is a common term and "Oxygen-enriched air" (OEA) is another, while others (such as the one which suggests that nitrox is a "safe" version of air) are proprietary. Nitrox has also been a term used in saturation diving procedures by NOAA for mixtures in which the oxygen content is *less than* 21% and it has been suggested that the term nitrox for oxygen-rich mixtures could be ambiguous and that nitrox should be reserved for oxygen-lean mixtures.

But there is a precedent: "heliox" is also an easy word to use. The heliox mixtures used in deep diving are