Application of Non-traditional Advanced Scuba Technologies to the Pursuit of Scientific Objectives: A Case Study in the Gulf of Mexico

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INTRODUCTION

With the development of the demand regulator an amazing new tool for the exploration of underwater habitats and ecosystems became available to the scientific community. This technology has had profound impact upon the explorations of underwater frontiers that before could only be sampled with remote sampling tools such as grab samplers or from expensive and unwieldy one atmosphere underwater vessels. SCUBA technology provided scientists an inexpensive, flexible, and effective tool to advance exploration of the aquatic realm. In effect, SCUBA technology put the scientists into the water to explore, observe, and collect data firsthand.

In recent years significant advancements in SCUBA technology have been made. Decompression computers have drastically altered dive planning and implementation. Full face masks with wireless communications have been adapted to SCUBA systems and rebreather technology is advancing rapidly. The utilization of altered breathing gas mixtures (e.g. nitrox, trimix, and oxygen) in SCUBA delivery systems is common. But, interestingly and surprisingly, few of these advancements have come from the scientific diving community. Decompression computers were developed to support the recreational diving community. Hard hat and underwater communication technology was advanced to support commercial oil and gas and military activities, and rebreathers and trimix breathing gas mixtures were advanced by a fringe element of the recreational diving community to support extended time and depth exploration of submerged caves. Rebreathers have also been a military tool since WWII. Modified decompression tables have been developed to support cave and wreck diving enthusiasts using multiple breathing gas mixtures to greater depths and duration.

Scientific diving administrators, officers, and divers have not always been receptive to technological advancements. For example, up to the preparation of this paper, September 1997, divers for the National Oceanic and Atmospheric Administration (NOAA) have been prohibited from using decompression computers although decompression computers have been considered standard equipment in the recreational and academic scientific diving communities for a number of years. Altered breathing gas mixtures have been viewed with suspicion in some quarters although the commercial diving industry has been using heliox for deep and extended diving and oxygen for decompression for at least three decades.

It is the opinion of the author that some of the advancing technology and diving protocols that exist in the recreational and commercial dive industries should more aggressively be integrated by the scientific diving community into the pursuit of scientific objectives. Following is a description of some activities of scientific divers of Texas A&M University-Corpus Christi (TAMUCC) that include utilization of technical (i.e. "non-traditional") diving technology that increase safety of deeper and longer duration dives.

TEXAS A&M UNIVERSITY-CORPUS CHRISTI DIVING ACTIVITIES

The Texas A&M University-Corpus Christi *Manual of Scientific Diving Guidelines* was adopted February 10, 1995 after close scrutiny by the Office of Risk Management of the Texas A&M System. The guidelines stipulated in this management document, by design, allow for the application of advancing dive technology and protocols including trimix breathing gas mixtures and dives deeper than 198 fsw with sufficient training, experience, project management, and project specific approval. Diving projects are initiated with the admonishment that nothing we can possibly learn on any given dive is worth injury or death. At the start of each project, divers are counseled both verbally and in writing about resisting peer pressure relating to diving activities, and to dive within individual boundaries of physical and mental capability and training.

Since the development of a scientific diving program at TAMUCC in 1993, 2218 air dives have been logged. Of the air dives 337 have been to depths $\geq$130 fsw. Of these deep air dives, 181 have been made between 150 and 198 fsw. Two hundred thirty-five dives have been made on enriched air (i.e. nitrox) and 41 dives have been made on trimix to depths ranging from 200 and 250 fsw.

Through the TAMUCC *Manual of Scientific Diving Guidelines,* and consistent with AAUS diving guidelines, depth limitations for air based dives is established for each diver through a progression of dives to increasing depths. Dives involving altered air mixtures (i.e. nitrox and trimix) require specific gas certifications through a recognized SCUBA training program such as International Association of Nitrox and Technical Divers (IANTD) or Professional Association of Diving Instructors (PADI) followed by a closely supervised program of experience development.

Most of the scientific diving activities at TAMUCC are conducted in support of research into natural and artificial reef dynamics. The majority of the dives $\geq$150 fsw were conducted at oil and gas production platforms (i.e. artificial reefs). A limited number of dives to 150 fsw were conducted at Stetson Bank and at the Flower Garden Banks coral reefs in the northwest Gulf of Mexico. All deep dives were in an open ocean environment. Dives to depths $\geq$200 fsw involving trimix gas included the use of an enriched travel gas (i.e. 36% O_2) and 100 % O_2 during decompression. All dives with mandatory decompression were accomplished with surface supplied 100 % O_2 at decompression stops $\leq$20 fsw.

DEEP DIVING PROTOCOL

Diving to extended depths and time duration is a serious consideration and must be planned for accordingly. Certifications from sport diving organizations are not considered absolute evidence of qualification or competency for extended depth and duration diving. Regardless of certifications and individual dive log information, divers new to the program are closely observed and instructed at progressively deeper depths beginning at less than 100 fsw until the project Dive Supervisor and/or the Diving Health and Safety Officer are satisfied that their skills, experience, and competency are adequate to participate in extended depth and duration diving.

Surface supplied 100% O_2 is required for decompression stops $\leq$20 fsw (within CNS O_2 toxicity safety limits). A safety diver is stationed at the site of decompression. For dives using trimix gas to depths $\geq$200 fsw, a safety diver is on station in the water with a full face mask and wireless communication system with a surface unit. The safety diver intercepts the trimix divers on ascent at 80 fsw and stays with them through the decompression period to monitor their condition. This person is in position to assist any diver that is in distress and to communicate needs to the surface crew. When possible, a hyperbaric chamber is maintained on site with certified operators. And, when available, a diving physician with training in hyperbaric treatment is included in the field team.

For air and nitrox based dives, electronic decompression computers are accepted to manage decompression obligations. Computers with a moderate level of conservatism such as the U.S. Divers Pro Monitor II and the Dive Rite Bridge are specified. In the event of a non-computer dive, the U.S. Navy Dive Tables are used to manage decompression with the stipulation that a five minute safety stop 100%

O_2 (within CNS O_2 toxicity safety limits) is added to the time requirements. For trimix dives, tables produced by International Association of Nitrox and Technical Divers are used.

Through a program that allows access to offshore oil and gas production platforms for scientific purposes, the Flower Gardens Ocean Research Project (FGORP), Texas A&M University-Corpus Christi (TAMUCC) in collaboration with other universities, most notably Florida State University, has been able to utilize offshore platforms as training sites for non-traditional diving technology (i.e. extended depth and duration, trimix breathing gas, and hyperbaric chamber operations). Working from platforms 110 miles offshore in the tropical waters at the edge of the continental shelf, the training site is an open ocean environment with warm clear waters. Depending on the location, water depths range from 400 to 900 fsw. And, when linked with the artificial reef research program of TAMUCC the trainees can actively engaged in a research project while meeting dive training requirements.

These platforms provide a stable and relatively safe structure and environment from which to conduct training exercises. In the water, the platform structures provide a physical presence and boundaries in which to operate. Staging equipment both on the deck and underwater is simplified. At the end of the diving day, trainers and trainees have access to all the comforts of home in which to study and rest.

DISCUSSION

Application of new technologies for extended depth and duration diving has allowed productive and cost-effective exploration into areas heretofore only sampled remotely. It is the author's experience that divers trained in scientific observation can more effectively collect information than remote sensing techniques. Extended depth and duration diving has limits, and must be approached with evaluation of benefit versus risk. When justified, and when the resources and expertise exist to utilize this tool, it can be an effective and relatively safe means to advance scientific exploration.

Extended depth and duration diving has been developed and field tested adequately to demonstrate its utility for scientific exploration. The primary challenge to employing this technology is training and assessment protocols and facilities. Organizations such as the International Association of Nitrox and Technical Divers have established rigorous training criteria to initiate divers into the realm of extended depth and duration diving. But, as with any physically and mentally challenging activity, competency is developed through repetition and diversity of experience. It is critical that guidelines and resources for training are established to ensure that opportunities for repetition and diversity of experience exist and are utilized.

TAMUCC will continue to utilize offshore platforms for training purposes, but we are only a small part of the scientific diving community. Strategies need to be developed to expand training opportunities to the scientific diving community as a whole. We can safely and effectively expand the horizons of scientific diving and should do so. This will require a concerted vision and effort, and the American Academy of Underwater Sciences should be in the forefront.