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DeepTech JOURNAL

ADVANCED DIVING TECHNIQUES

Underwater Surveys

Methods and Techniques

Premier Issue

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DeepTech JOURNAL

Welcome

On behalf of the DeepTech staff I would like to welcome and congratulate you on being among the first to read this humble tome. It is a humbling experience producing a journal on technical diving—particularly since many of our readers are those same persons who first dared to bolt-together scuba tanks, regulators, lights and other gear in an attempt to explore beyond recreational dive profiles. We recognize these early adventurers as the forefathers of technical diving and honor them by dedicating this first issue to them.

This past weekend I and my lovely wife Linda were riding our bikes through our neighborhood here in Sarasota. We both have these big heavy bikes with only one speed, fat tires, and coaster brakes. You know, the kind that's good for riding on the beach because the tires don't sink into the sand. Well, today when I got to work, Kevin, one of the designers that works for us, was complaining because he also was riding his bike this weekend and had broken a rim on his bike. Kevin races in amateur bike races. He's one of those people you see riding on the road wearing a spandex racing suit and aerodynamic helmet. His bike weighs less that a box of corn flakes and is constructed from the same materials as the stealth bomber. The reason Kevin was complaining was that the rim he broke cost $700.

This struck me as somewhat humorous since I can have as much fun on my $79 beach bike as he can on his Italian racer with the expensive rims. But then I started thinking—Kevin just shakes his head when I tell him about my dives into sink holes in the Gulf of Mexico wearing my air filled doubles on my back, two singles filled with trimix clipped to my front, and staged nitrox and O2 at appropriate depths. "How much bottom time do you get?", he asks. "About 10-15 minutes.", I reply. Kevin just chuckles a little. The point of this anecdote is that all humans are different. There are those who are content, if not delighted, to dive Davis Reef (30fsw) in the Florida Keys to look at the eels—and there are those like you and I who are driven to explore the limits of scuba diving. The difference is passion. Most technical divers I've met share a passion for diving that goes far beyond the enjoyment of a sport.

This is not to say that there's anything wrong with diving Davis Reef. It is one of the prettiest I've seen. It gets four stars in my book as a night dive primarily due to the monster sized morays that emerge for a nocturnal bite to eat. Neither is there anything wrong with riding bikes with fat tires. I just don't happen to share Kevin's passion for racing. It is a poor man indeed who has nothing in his life to feel passion for.

Having acknowledged our passion for technical diving, we must also acknowledge the increased risk. This is an area that most technical divers would prefer to not discuss. But there are guidelines. Many cave divers paid with their lives before the five rules of cave diving were developed. As a result, cave diving incidents today are rare when all five rules are obeyed. Another example of increased risk is the belief that maintaining a partial pressure of oxygen (ppO2) less than 1.6ATA is acceptable. However, due to the dynamic physiology of oxygen toxicity divers have taken O2 hits with a ppO2 less than 1.6ATA. The point is that we should all be open to emergent philosophy and techniques, and be willing to modify our behavior accordingly. We here at DeepTech Journal plan to be leaders in technical diving safety.

My co-publisher, Curt Bowen, and I are delighted to have you as a reader on this, our premier issue. We are genuinely interested in what you think of DeepTech Journal, so drop us a line. We are accessible through the internet, snail mail (U.S. mail), and fax. See our masthead on page 2 for the details. Safe Diving!

Win Remley
Win Remley
Co-Publisher

DeepTech JOURNAL

ADVANCED DIVING TECHNIQUES

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Warning:

Diving is a potentially dangerous activity. Neither DeepTech Journal, nor it's contributors accept liability for diving injuries incurred by our readers. The materials contained within this journal are for informational purposes only and are not intended as a substitute for dive training.

Cover photo by Robin Gruters.

CONTENTS

Redundancy & Configuration

How many tanks do you need and where should you put them?

By analyzing diving accidents, evidence shows that many incidents could have been avoided if the diver had used sufficient and proper redundant equipment setup in a reliable configuration. At what point in our diving careers should we begin thinking about redundant equipment and stop relying on our dive partners for emergency gas supplies? Statistics prove that even in basic open water dives over half of the accidents involving gas-supply occurred when a buddy either did not know that a problem existed or was unable to help. There are even incidents where a buddy actually refused to give assistance. Emergency swimming ascents (ESAs) can be a valuable technique in these cases, but only if the ascent is controlled and constant exhalation is maintained. Most divers find ESAs possible only from shallower depths (60ft or less) and impossible in overhead environments. This is evidence enough that independent redundant back-up systems have a place in diving.

Should we all run out and bolt our tanks together? Not necessarily. One problem associated with redundant systems is the belief that the more gear a diver carries, the safer he will be. This problem is most commonly associated with beginning advanced divers, where the diver carries far to much equipment for the type of dive being conducted. When a diver carries too many cylinders, second stages, pressure gauges, reels, and lights, the possibility of equipment failure, equipment confusion, and equipment entanglement greatly increases. Divers must evaluate the type of dive being conducted and only carry the redundant equipment needed to provide an acceptable level of risk for each dive.

Because of the many variables and preferences that exist in setting up dive equipment, it should be noted that this article exists only to offer suggestions and give ideas for a basic blueprint on how equipment can be configured. Different geographic locations and dive profiles may mean that further modifications to equipment setup may be necessary to provide safety and reliability. The equipment configurations that follow are what many seasoned technical divers have successfully used many times on a variety of dives. Remember, in all cases, a failure on any gas-supply related equipment (i.e., tank valve, hose, or regulator assembly) will demand an immediate return to the surface or first decompression stop scheduled.

(continued page 4)

Cylinder and Regulator Configuration

Recreational Diving

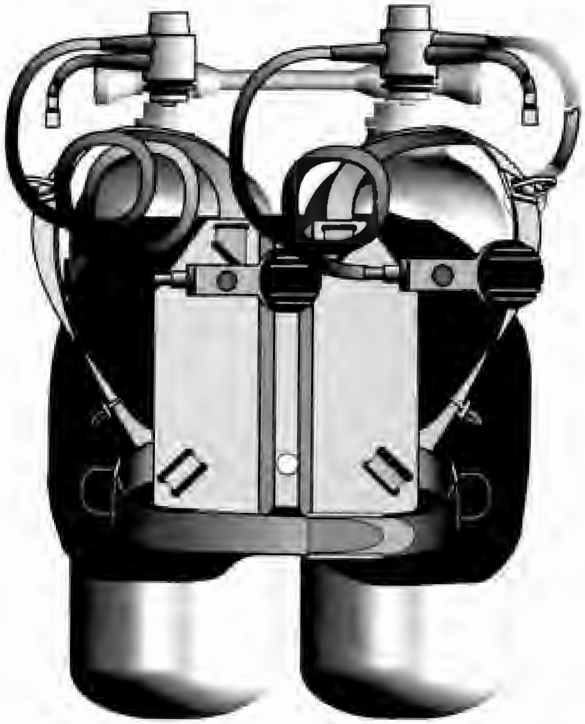
Single With Pony Tank

APPLICATIONS

Mainly used in deeper recreational diving at depths from 70-130 ft. This configuration provides an excellent fully redundant gas supply system for use in emergencies. The gas in the pony tank should not be planned for use at depth, nor should it be planned for use during decompression. This configuration provides solo divers or divers who loose track of their buddy with a safety net that they would not otherwise have. Follow appropriate gas management rules that apply to the type of diving being conducted.

Extended Range Diving

Standard Doubles



APPLICATIONS

Mainly used in overhead environments (i.e., caves, ice diving and wreck penetrations). This configuration typically provides enough gas volume for dives down to approximately 200 feet for 10-15 minutes, taking into account decompression requirements. The actual bottom time at depth will vary depending on air consumption, cylinder volume, and type of dive being conducted. This is also an excellent configuration for extended nitrox dives at shallower depths. Follow appropriate gas management rules that apply to the type of diving being conducted.

CYLINDER CONFIGURATION

Single—Use a 72 to 121 cubic foot cylinder. The main cylinder and pony can be banded together using one of several products made specifically for banding a pony to a larger cylinder (see your dive shop for details). These banding systems are easily removable for connecting the pony to several different cylinders during a multi-dive trip.

Pony—Use a 13 to 30 cubic foot cylinder for out of air emergencies only. Divers who accidently find themselves in obligated decompression can also use the pony for additional gas supply if needed (this is an emergency). The pony should not be planned for use in this manner since the main cylinder doesn't typically hold enough volume to carry the diver should the pony fail in some way. The pony is usually attached on the right side of the diver. The pony cylinder valve should be turned ON throughout the dive.

REGULATOR CONFIGURATION

Single—A standard two-stage, single-hose regulator with only one second stage is used on the main cylinder. This is your primary regulator. A high pressure hose with gauge console is attached and configured on the divers left side. A standard low pressure inflator hose is used for the buoyancy compensator.

Pony—The pony regulator is another standard two-stage, single-hose regulator with one first stage, one second stage, and a high pressure hose with pressure gauge only. No inflator hoses are attached to the pony. The pony's high pressure hose with pressure gauge is typically configured on the divers left side near the gauge console from the main cylinder. If the two gauges are similar in appearance they should be clearly marked with a high contrast label (i.e., black type on a white label) to minimize the possibility of confusion at depth.

CYLINDER CONFIGURATION

Matched cylinders are required for proper weight distribution. Use 72 to 121 cubic foot cylinders. Cylinders are banded together using steel bands and a standard valve manifold connects the gas supply between the tanks. An isolator valve manifold can also be used. Both valves on the manifold are turned on throughout the dive. In the event of a failure in any part of one of the regulators, such as a blown hose, the manifold valve connected to that regulator can be turned off preventing loss of gas. In this case all gas contained in both cylinders is still available through the remaining functional regulator. This event demands an immediate return to the surface or first scheduled decompression stop.

REGULATOR CONFIGURATION

Two independent regulators for full redundancy are used in this configuration. Regulator configuration can differ according to your training and type of diving. Two first stages are required for connection to each of the two valves on the manifold. A primary second stage with a longer hose (5-7 ft.) is typically connected to the valve closest to the divers right shoulder. The primary second stage can then be used in an emergency air sharing situation with two divers exiting single file in confined spaces. Another second stage and a high pressure hose with gauges is connected to the valve closest to the divers left shoulder. A low pressure inflator hose is connected to each first stage for BCD/Wings and drysuit inflation. All regulator second stages should be easily reachable, and all hoses should be streamlined to prevent entanglement.

(continued page 6)

Cylinder and Regulator Configuration (continued)

Cave Configuration

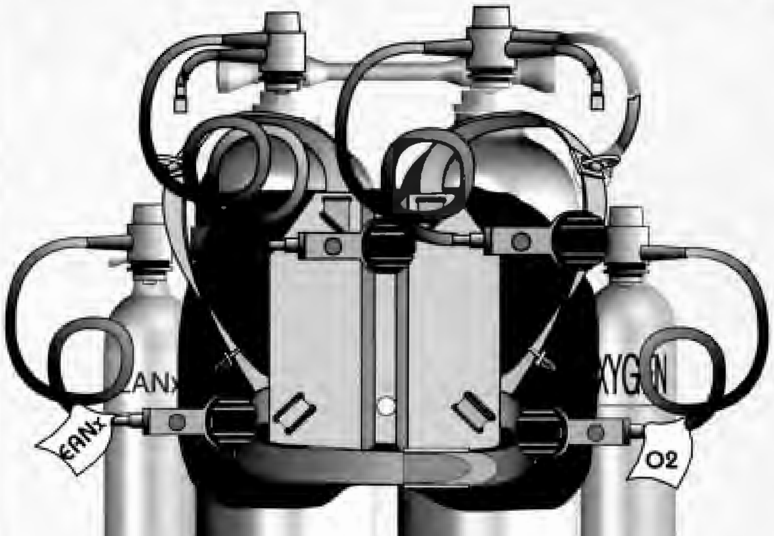
Doubles With Stage Tank

APPLICATIONS

Mainly used in deep, extended range, and overhead environments (i.e., caves) with heavier anticipated decompression requirements. The stage is sometimes used as a bailout bottle for emergencies. All cylinders should be clearly labeled with the exact gas mixture and operating depth. Follow appropriate gas management rules that apply to the type of diving being conducted.

Wreck and Ice Configuration

Doubles With Multiple Stage Tanks



APPLICATIONS

Mainly used in wreck and ice diving with heavier anticipated decompression requirements. The cylinders in this configuration are filled with a combination of travel gas, bottom mix, and decompression gases. The specific gas configuration varies depending on personal preference and the specific dive requirements. One stage cylinder is typically filled with 100% O_2 for shallow decompression ($ppO_2<1.6ATA$). All cylinders should be clearly labeled with the exact gas mixture and operating depth. Follow appropriate gas management rules that apply to the type of diving being conducted and the specific gases being used.

CYLINDER CONFIGURATION

Doubles—Matched cylinders are required for proper weight distribution. Use 72 to 121 cubic foot cylinders. Cylinders are banded together using steel bands and a standard valve manifold connects the gas supply between the tanks. An isolator valve manifold can also be used.

Stage—Use a 13 to 121 cubic foot cylinder for extended bottom times or decompression gases. The stage is usually clipped on the left side of the diver. In cave diving the stage cylinder is usually dropped and clipped to the guideline when one-third of the gas volume is used. It is picked up on the return and a second third is used on the exit (rule of thirds). Any dropped stage cylinders should be turned off to prevent loss of gas.

REGULATOR CONFIGURATION

Doubles—Doubles regulator configuration is the same as with the standard doubles (see page 5). Note that some cave divers prefer to configure the regulator with the longer hose as an octopus for emergencies, and some prefer to use it as their primary regulator, There is logic to support both approaches.

Stage—The stage regulator is a single independent regulator with one first stage, one second stage, and a high pressure hose with pressure gauge only. No inflator hoses are attached to the stage. Stage cylinder regulators should be clearly marked with a high contrast label (i.e., black type on a white label) to minimize the possibility of confusion at depth. Heavy rubber bands can be stretched around stage cylinders for stowing stage regulators and hoses to streamline the configuration.

CYLINDER CONFIGURATION

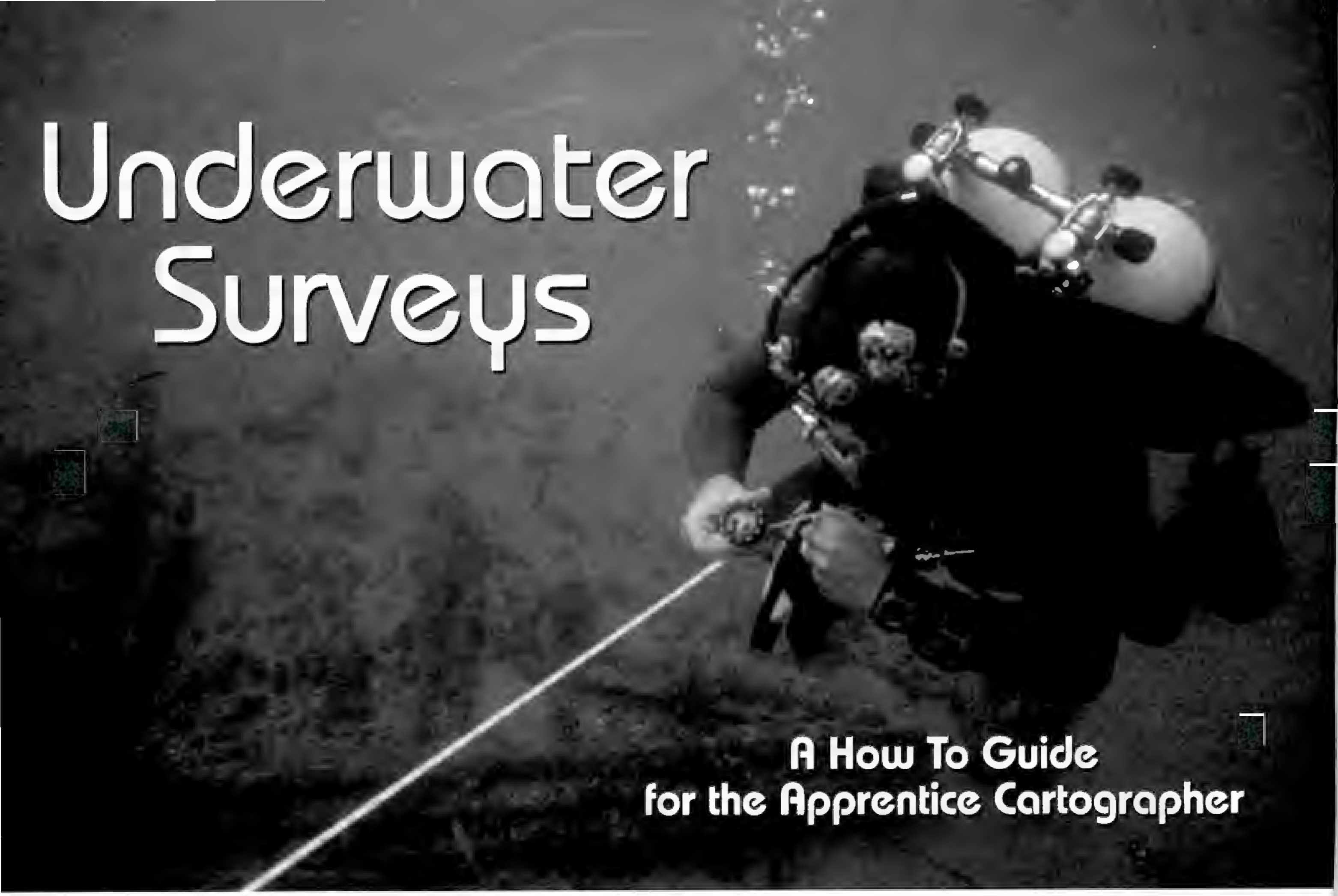
Doubles—Matched cylinders are required for proper weight distribution. Use 72 to 121 cubic foot cylinders. Cylinders are banded together using steel bands and a standard valve manifold connects the gas supply between the tanks. An isolator valve manifold can also be used.

Stage—Use 13 to 121 cubic foot cylinders for extended bottom times or decompression gases. The stages are commonly banded in a balanced symmetrical configuration. Stage tanks are carried by the diver throughout the entire dive because of the risk of becoming separated from the decompression line due to strong currents or becoming lost.

REGULATOR CONFIGURATION

Doubles—Doubles regulator configuration for wreck and ice diving is the same as with the standard doubles (see page 5). Note that some wreck and ice divers prefer to configure the regulator with the longer hose as an octopus for emergencies, and some prefer to use it as their primary regulator, There is logic to support both approaches.

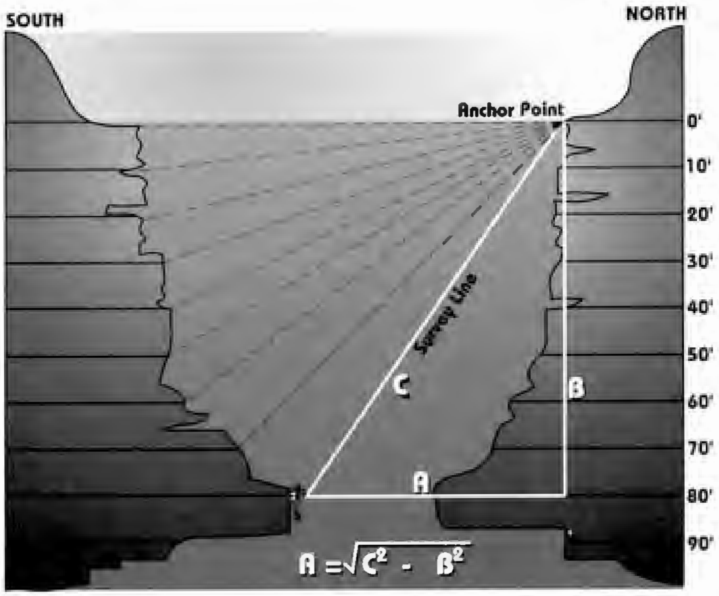
Stage—The stage regulator is a single independent regulator with one first stage, one second stage, and a high pressure hose with pressure gauge only. No inflator hoses are attached to the stage. All cylinder regulators (doubles and stage) should be clearly marked with a high contrast label (i.e., black type on a white label) to minimize the possibility of confusion at depth.



Underwater Surveys

A How To Guide for the Apprentice Cartographer

You have probably seen drawings of ship wrecks or cave systems hanging on the wall in your dive shop and may have wondered how they were created. Did someone with a photographic memory and a high tolerance to nitrogen narcosis simply draw a sketch after a dive? Probably not. Those drawings are created by divers who have surveyed the wreck or cave and taken many detailed measurements, depth readings, and compass headings. This data is then analyzed, processed and a drawing is created either by hand or, more commonly, by computer.



◀ **Triangulation from a fixed anchor point is an excellent method for surveying sinks. The length of the survey line and the depth, read from the divers depth gauge are used to calculate wall contours using simple trigonometry.**

Some underwater surveys can be relatively simple taking only one dive to complete the data collection. Others can be very complex requiring many dives and coordination of many divers with lots of equipment. The difference lies mainly in what is being surveyed. There are many factors that contribute to survey complexity including size, depth, visibility, currents, and site access.

Each site is unique and requires ingenuity and planning to efficiently collect survey data. Deep surveys (130ft+) and long penetration cave surveys (2,500ft+) require the most planning and the greatest level of training.

Survey equipment usually consist of measured survey lines, compass, slates, and video equipment. Survey reels commonly hold over 400 feet of #24 nylon line. This line is knotted every 10 feet for accurate measurements.

A cave survey is typically begun by running a pre-measured survey line through the cave system and recording information at various stations. Stations are the locations where the survey line makes a direction change such as turning a corner in the cave. These stations are numbered on a slate and data such as distance from previous station, depth, and compass heading are recorded. Other information including the distance from floor to ceiling, wall to wall, breakdowns (rock piles), pits, wall contours, silt conditions, floor composition, etc. are also recorded.

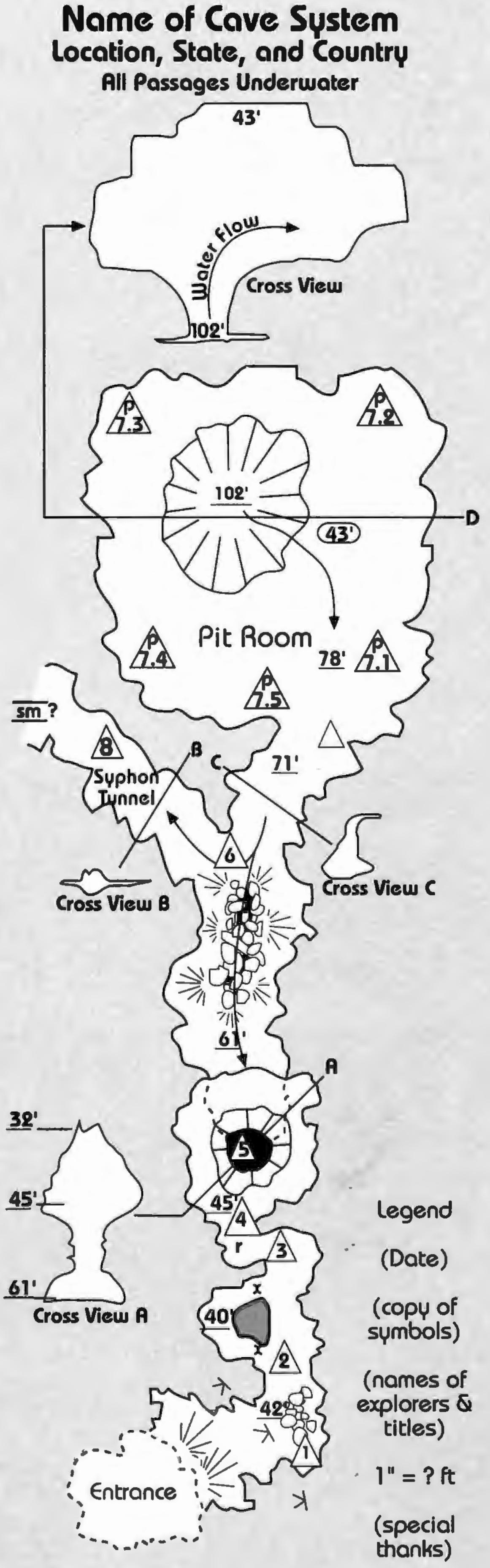
In cave systems with extremely large rooms, perimeter survey lines must be installed. A perimeter line is a pre-measured survey line that follows the outer walls until it returns to the starting point, completely encircling the room. Station data is collected at each station and recorded on a slate. This process accurately represents the size and shape of the room.

Common map symbols and terminology are shown on page 10. These symbols have been illustrated in the sample cave map to the right.

Side view cutouts are used at important or interesting places to give a more three dimensional understanding of the cave. Example, cross view D illustrates what the Pit Room looks like from top to bottom.

Survey maps should also include information such as the name of the system, location, a legend (all symbols used in the map), date, names of the explorers, scale, and special thanks.

(continued page 10)



Sample cave map showing a variety of ▶ geologic constructions. The symbols are critical to giving the reader a proper understanding of the three dimensional nature of the system. See index of symbols on page 10.

DeepTech JOURNAL

ADVANCED DIVING TECHNIQUES

Next Issue:

Decompression Setup and Safety

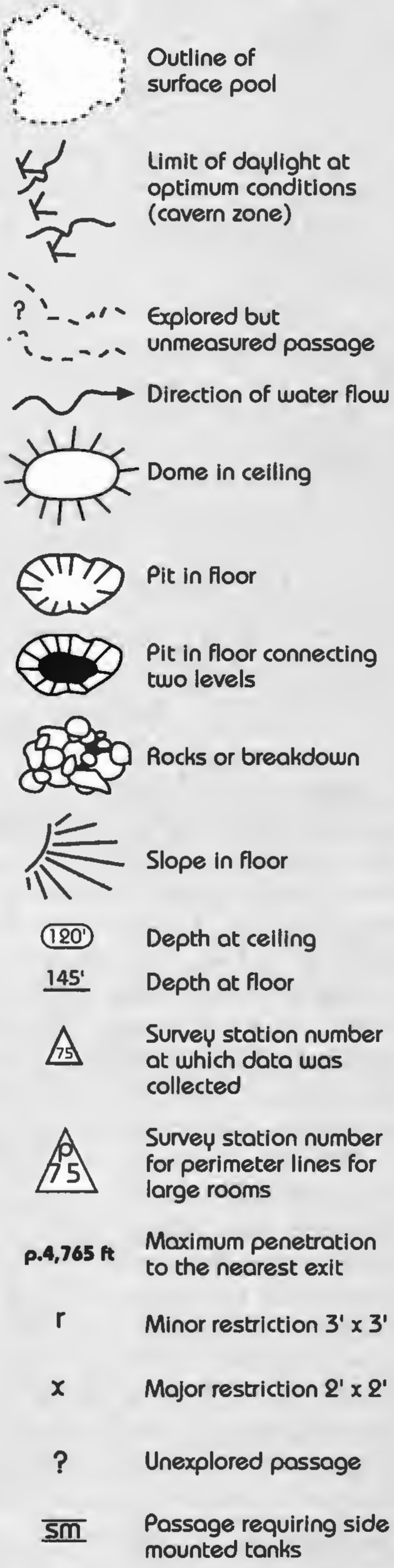
Women in Technical Diving

Been There—The Monitor

Guru Diver—Billy Deans

And More...

Cave Mapping Symbols and Terminology

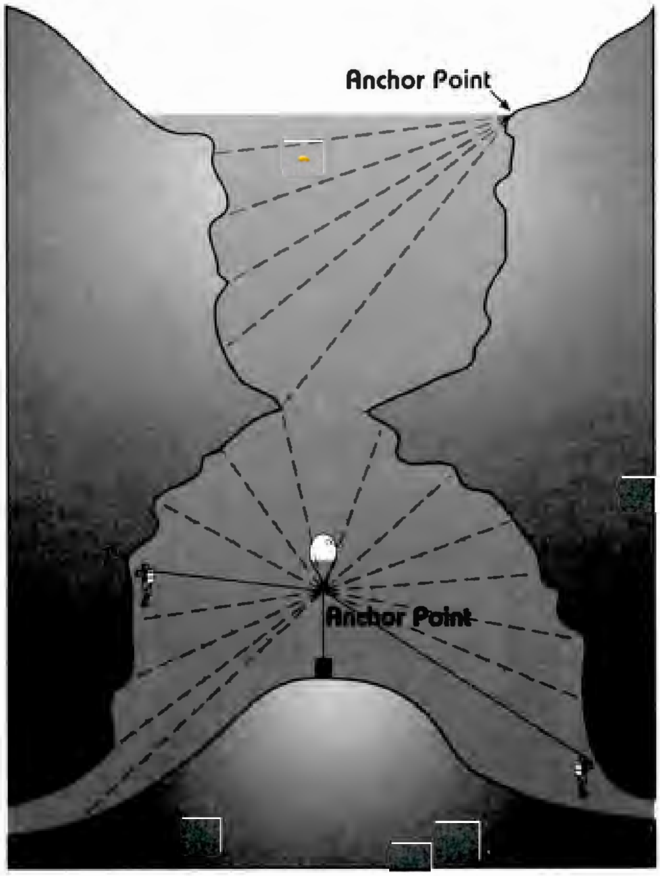


	Outline of surface pool
	Limit of daylight at optimum conditions (cavern zone)
?	Explored but unmeasured passage
	Direction of water flow
	Dome in ceiling
	Pit in floor
	Pit in floor connecting two levels
	Rocks or breakdown
	Slope in floor
(120')	Depth at ceiling
145'	Depth at floor
75	Survey station number at which data was collected
P 75	Survey station number for perimeter lines for large rooms
p.4,765 ft	Maximum penetration to the nearest exit
r	Minor restriction 3' x 3'
x	Major restriction 2' x 2'
?	Unexplored passage
sm	Passage requiring side mounted tanks

▲ **Standard cartography symbols used in cave maps. Measurements taken at survey stations plus video or slate sketches are used to develop the cave maps.**

Triangulation Method

Several methods can be used to take station measurements for underwater surveys. The triangulation method is ideal for large rooms, sinks, and open-water wrecks, especially those wrecks with large debris fields. The only two requirements are a stationary anchor point and a straight line between the anchor point and the area being surveyed. No bends in the survey line are allowed or the survey data will be incorrect. A minimal amount of equipment can be used for this method. A survey reel with marked distances, compass, slates, and a digital depth gauge. A 200 ft. cloth measuring tape works well.



Sink and Cave Surveys

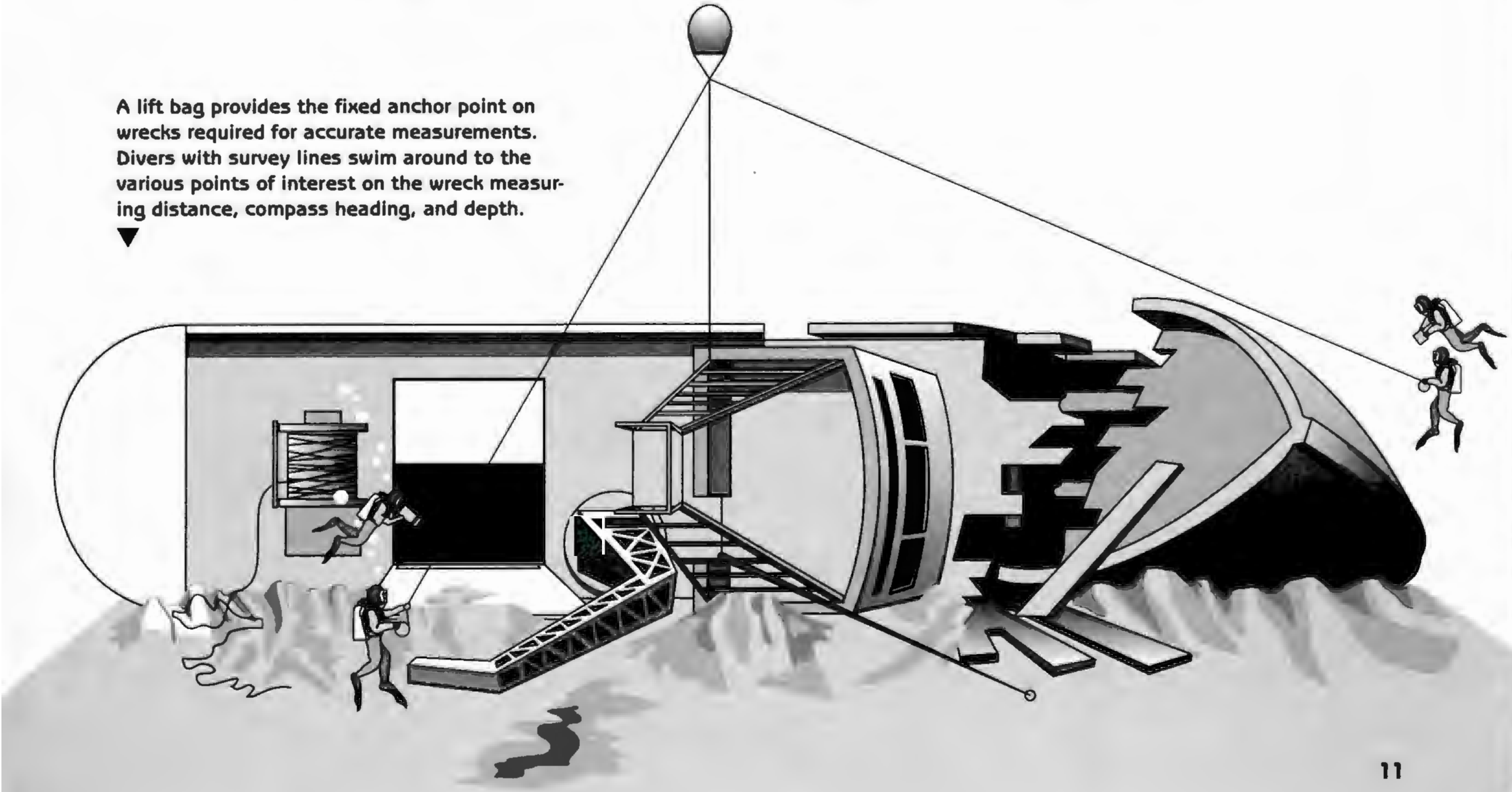
An anchor point must first be determined. Usually the best location for cave surveys is the center of the area being surveyed or on an outer wall. The diver should first circle the room taking compass, depth, and distance readings on the east, west, north and south walls as well as points of special interest (i.e., pits, breakdowns, artifacts, etc.). When surveying deep sinks only one or two walls may be surveyed per dive due to dive time restrictions.

Wreck Surveys

When surveying wrecks, first locate a recognizable structure as close to the center of the wreck as possible, tie off a 25 foot piece of rope with a 50+ pound lift bag. Inflate the lift bag so that it rises above the wreck. Tie the survey reel off just below the bag. This will keep your survey line from becoming tangled in wreckage. Swim around the wreck taking line distances, depths, and azimuth readings. Slate sketches and video will help when piecing the information together afterwards. When drawing wreck maps, all significant items of interest can be labeled either by numbering the sites and creating a legend, or by labeling each component individually on the map.

A lift bag provides the fixed anchor point on wrecks required for accurate measurements. Divers with survey lines swim around to the various points of interest on the wreck measuring distance, compass heading, and depth.

▼



The Predator

Dive Deeper • Penetrate Further • Fly Faster

In 1979, Arnold Jackson started cave diving in the Florida panhandle. Much of the cave diving equipment being used at that time was just being invented, designed, and constructed by the divers themselves in their garage. As the sport matured, many divers, including Arnold, began penetrating farther and deeper into caves. Due to the increased risk and requirements of these more technical dives, it became evident that higher performance, more reliable equipment was needed. These are the conditions that eventually gave birth to several technical dive equipment manufacturers including American Underwater Lighting.

Arnold initially went into business repairing Tekna scooters in a small shop in his back yard. As the demand for more durable, advanced cave gear increased, Arnold began producing underwater, high performance lights. His light designs became hot sellers almost immediately. Arnold decided to design and build a deep scooter due to the lack of scooters available for deep diving. After hiring Terry Phelps, a professional engineer, they both went to work to design a scooter able to dive deeper, burn longer, and still have a fast pace. After two years of research, development, and testing, the Predator Scooter was released.

Testing of the Predator consisted of flow water prop testing conducted by the Swedish Design Corporation. In addition, depth tests consisted of an actual in-water dive to over 500 feet by Berry Miller, 1000 foot depth test in a chamber, one scooter was left at 330 feet for 10 days for a leak test, and several other distance, depth, and time tests have been conducted prior to release.

This year American Underwater Lighting plans to release smaller scooters with available residual battery pods that can be connected and disconnected while underwater for longer burn times. This will provide those who have the smaller scooters longer burn times without having to purchase the longer units. These battery pods also provide the capability of carrying redundant battery packs thereby increasing diver safety.

Other Products from AUL

In addition to the Predator, American Underwater Lighting is currently producing reels (many sizes), backplates, harnesses, side mount harnesses, lights, video lights, video housings, surface supplied video, custom video housings, and

many items for larger dive manufacturing and commercial companies. Sometime this year, American Underwater Lighting plans to release a new 300 watt super video light. The light consists of a 6 inch diameter by 13 inch long tube. The light is powered by two 12 volt, 12 amp batteries, allowing the diver a 40 minute burn time. For long duration dives, the bulb can be replaced with a 50 watt bulb allowing a burn time of over 5 hours.

By the time you read this issue of DeepTech Journal, a new computer chip produced by American Underwater Lighting, will be available that enables the diver to electronically control several brand name video cameras. This eliminates the need to manually control knobs and switches that now exist on most underwater video housings.

DeepTech also conducted several dive tests on AUL's Meteor 4 cave light. Several cave dives were done with depths ranging from 100 feet to 270 feet along with tight restrictions, strong currents, and low visibility. The light was intentionally subjected to demanding conditions to test reliability and durability. We found the light canister to be extremely durable, the electric cable held up with only small markings, and the goodman style handle made pull and glides a breeze.

Cave and Wreck Lights

Model	Voltage DC Volts	Current Amps	Bulb watts	Length inches	Diameter inches	Burn Time minutes/watts
Spectrum 14	12	14	50	14	5	180/50
Spectrum 10	12	10	50	14	4-3/4	150/50
Spectrum 7	12	7	50	8	5	90/50
Meteor 3	12	3	20	12	3-1/2	95/20
Meteor 4	12	4	20	10	3-3/4	140/20
Comet 250	24	7	250	14	5	30/250
Comet 400	36	14	400	20	5-1/4	20/400

◀ The Meteor 4 cave light provides 50 watts of light for 25-35 minutes or 20 watts for 95 minutes. DeepTech found it to be both durable and reliable at depths to 270 feet.

Custom underwater video housings ▲ by AUL are designed specially for each make of video camera. Optional twin 250 watt lights are shown.

	Predator 2000	Predator 3000	Predator 4000
Length	46 inches	56 inches	64 inches
Weight	65 lbs	88 lbs	110 lbs
Speed	200-250 ft. min	200-250 ft. min	200-250 ft. min
Running Time	40-100 min	60-120 min	120-180 min
Static Thrust	75-80 lbs	80 lbs	75-80 lbs
Batteries *	2-12V, 18 AH	3-12V, 18AH	4-12V,18AH
Range	1-3 miles	2-5 miles	3-9 miles
Rated Max Depth	1000 fsw	800 fsw	600 fsw

*All batteries are sealed rechargeable
All Units made from 6061-T6 511 aluminum
Based on an average open water single tank diver with no extra drag. Speed and distance are dependent on amount of equipment, drag, and riding style of the diver. Distance can be increased or decreased on diver's gear configuration and riding style.

The Green Banana

The Green Banana is one of many sink holes that dot the gulf floor. In fact, if it were possible to drain the Gulf of Mexico it would probably look like Swiss cheese with all the sinks scattered about. The Green Banana was rumored to be very deep. Exactly how deep was unknown. Other divers had penetrated to a depth of about 320fsw. Reports indicated that it just kept going.

An expedition was planned to, hopefully, find the bottom of the Green Banana. The expedition was lead by Curt Bowen, a veteran explorer originally trained by Sheck Exley. Other team members included Frank Richardson, David Miner, Jim Cutway, Larry Borden, and Win Remley. The team set out loaded with eight sets of doubles and 32 singles filled with various mixtures of nitrox, trimix, air, and oxygen. Several exploratory penetrations plus two deep penetrations were planned over a four day period.

The Green Banana Sink is located in the Gulf of Mexico 42.3 miles west of Sarasota, Florida. Several stories exist that tell how the Green Banana got its name. The most credible seems to be that it was discovered by a fisherman (as most sinks in the Gulf are) who got an awesome catch while trolling around the sink. As he was pulling in his nets he noticed a case of green bananas floating by—hence the name Green Banana.

This particular trip to the Green Banana was planned after an exploratory survey dive the previous year by Curt Bowen. Not knowing the maximum depth of the sink, the team pre-calculated decompression tables for depths from 300fsw to 500fsw in 10 foot increments, each with a 15 minute bottom time. Both Dr. X and DPA decompression software was used to plan the dives and decompression schedules.

Two setup divers initially set up the site by anchoring two ascent lines to the Gulf floor (154fsw) next to the mouth of the sink. The ascent lines were held taunt with large orange surface floats. This also minimized ascent line motion due to surface waves. The mouth was measured to be 134 feet wide. A guideline with direction markers was laid across the diameter of the mouth and attached to the anchored ascent line to provide directional guidance should the divers ascend in the center of the hole and lack the visibility to see the ascent lines. After the site preparation was complete, the deep penetration team prepared for their descent.

Air was planned for the decent to a depth of 200fsw. At 200fsw the switch was made to their bottom gas, trimix 10/50 (10% Oxygen, 50% Helium, 40% Nitrogen). This mixture provided the divers with a partial pressure of oxygen (ppO2) of 1.66ATA at the maximum planned depth of 500fsw. The bottom gas also provided the deep team with an Equivalent Narcotic Depth (END) of 236fsw.

The deep team consisted of Frank Richardson and Curt Bowen. They each wore double 121s filled with air on their back and two single 80s filled with trimix clipped to their sides in a cave configuration. Nitrox 40 was staged at 100fsw and 100% O2 was staged at 20fsw. Safety divers were placed at 300 fsw, 170fsw, 50fsw, and surface to ensure the safety of the deep team.

On the first of the two deep penetrations the divers descended to the lip of the sink where they attached a guideline and reel for entry into the sink. They descended at a rate of 50 feet per minute. The divers found the silt mound located at a depth of 394fsw. They explored briefly reaching a maximum depth of 405fsw. The silt mound sloped very gently outward so they speculated that the bottom was probably not too much deeper.

During the ascent, survey measurements and drawings were made for cartography purposes. The ascent rate of 33 feet per minute provided ample time for these measurements to be taken. The total ascent, with decompression, lasted 175 minutes. The first decompression stop was made at a depth of 220 fsw where the OK sign was made to the deep safety.

Decompression on ascent was accomplished on trimix to 200fsw where the divers switched to air. Air was used from 200fsw to 100fsw and then exchanged for the staged Nitrox 40. Oxygen was used at the 20fsw and 10fsw stops.

After the dive, the team met to discuss the dive and plan for the second penetration. The next day the same dive profiles were used with Curt and Frank descending to the bottom. On this dive a quick survey of one wall was made that confirmed their suspicions about the maximum depth. The deep team found 435fsw to be the deepest spot in the sink. The mystery of the Green Banana depth having been exposed, the team set off for port.

▲ The Green Banana sink is located 42.3 miles west of Sarasota, Florida in the Gulf of Mexico. The sink begins at the Gulf floor (154fsw). The bottom was found at 435fsw.

The Truth About Enriched Air Nitrox

by Dick Rutkowski

The various myths and misconceptions of oxygen and nitrox use in scuba diving unfortunately originate from many sources. Due to the nature of the errors that are being made, it appears that some people have apparently read some materials about one type of oxygen use and have applied that information to other types of use.

Enriched air mixtures up to 40% have been used successfully for over 50 years by many organizations including commercial industry, the military, and NOAA, and for recompression therapy using standard non-oxygen cleaned equipment.

Nitrox is used in many types of diving including commercial, saturation, rebreathers, recompression therapy, deep diving on air or trimix, in-water decompression, and of course, recreational diving. However, since the introduction of nitrox into the recreational diving arena, some people have assumed that what they read about one use of nitrox applied to other uses. In other words, they wanted to play in the game, but didn't come with the right ball.

Recreational divers using nitrox within all operational and physical limits of basic scuba certification dive profiles can only have an enhanced physiological advantage, i.e., helping to prevent decompression sickness. Maximum no-decompression dive times can be increased without approaching central nervous system or pulmonary oxygen toxicity limits. Recreational divers, however, should not, under any circumstances, get involved with the mixing or blending aspects of nitrox. Neither should recreational divers use more than a 40% mixture of nitrox. If recreational divers observe the operational and physical limitations of recreational diving on air, and never use a breathing mixture greater than 40% oxygen, the same diving equipment can be used as if the mixture is air, and is not required to be oxygen cleaned.

In January 1992, the Diving Equipment Manufactures Association (DEMA) hastily issued a warning to all dive shops that nitrox mixtures greater than 23% could not be used with standard diving equipment because it could cause the rubber, teflon, brass or chrome valves, and inflator hose parts to deteriorate faster. This statement is erroneous. Enriched air mixtures up to 40% have been used successfully for over 50 years by many organizations including commercial industry, the military, and NOAA, and for recompression therapy using standard non-oxygen cleaned equipment. The precedence for this follows:

- Code of Federal Regulations, Part 1910.430(i) (Commercial Diving Operations)
- OSHA Oxygen Specifications 1910.420 (i)

These standards contain requirements for the safe use of oxygen which apply to all components connected into the oxygen system. Equipment used with pure oxygen or with mixtures containing over 40% oxygen by volume must be properly designed for oxygen use. All components (except umbilical) used with mixtures over 40% oxygen by volume must be cleaned of flammable materials before use. Finally, oxygen systems carrying over 125 psig, and compressed air systems carrying over 500 psig must have slow opening shut-off valves in order to prevent the rapid buildup of pressure and temperature in the system. All of these requirements are meant to reduce the hazards of ignition and combustion present within oxygen systems. These recommended practices for oxygen cleaning of scuba equipment is also supported by both NOAA and the U.S. Navy indicated by their respective specifications below:

- NOAA Oxygen Specifications—Appendix "D" NOAA Nitrox I Diving and Decompression Tables. High pressure storage cylinders, SCUBA tanks, regulators, and all high pressure transfer equipment used with pure oxygen or with nitrox mixtures containing more than 40%, must be cleaned and maintained for oxygen use.
- United States Navy Oxygen Specifications—U.S. MIL-STD-777E (SH) Note K-6-4, Cat. K.6. Mixed Gas, 4500 PSI Service, 150 F Max. For systems with oxygen content greater than 40% by volume, oxygen system components shall be cleaned in accordance with the requirements of MIL-STD-1330.

Some diving manufacturers have insisted that diving equipment using oxygen mixtures over 22 percent must be oxygen cleaned. If these manufacturers would have performed some research, they would have discovered that this requirement is needless. All medical and welding cylinders, valves, and regulators are made from the same brass and chrome materials as scuba equipment. Luxfer, one of the main cylinder manufacturers, stated openly that they have no problem with nitrox mixtures in their tanks.

As for the recreational diving community, as long as they never use more than 40% oxygen, they can use their equipment safely. Divers who are using more than 40% oxygen in their tanks or regulators must have all components of the oxygen system cleaned for pure oxygen service. The 40% oxygen clean regulation study was conducted by the American Society for Testing and Materials in the 1960's for NASA at the White Sands Proving Grounds.

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When partial pressure filling, however, using 100% oxygen and then topping off with air, all cylinders, valves, O-rings, transfer hoses, and gauges must be oxygen cleaned.

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Additionally, certain diving equipment manufactures are trying to convince the Compressed Gas Association (CGA) that it is necessary to have special scuba regulators and tank valves for nitrox mixtures over 23%. This is erroneous as pointed out earlier. U.S. Navy rules regarding 23-25% oxygen containing equipment for recompression chambers is in no way related to breathing gases in high pressure cylinders. Rules for compressed gas cylinders are not related to rules for recompression chambers. Assumptions of this nature are inherently flawed. An FO2 less than 25% is for living in chambers, mechanical ignition, greater than 40% is for chemical ignition.

Because of DEMA's erroneous warning, a two day nitrox workshop was conducted with major experts representing gas physiology, medical, engineering, equipment, compressor, oxygen and oxygen lubricant field representatives. The workshop was called "Evaluating Enriched Air (Nitrox) Diving Technology" and was held January 13th-14th, 1992 at the Hyatt Regency, Houston, Texas. The Minutes of the workshop are available from SDRG, P.O. Box 3229, Boulder, CO 80307 for $12.00.

When partial pressure filling, however, using 100% oxygen and then topping off with air, all cylinders, valves, O-rings, transfer hoses, and gauges must be oxygen cleaned. The cylinder must be labeled as a nitrox cylinder and only be filled at a proper nitrox facility. In this case, as long as the mixture is below 40% oxygen the regulator (first stage, second stages, inflator hose, high pressure hose, and pressure gauge) are not required to be oxygen cleaned.

Dick Rutkowski retired as the Deputy NOAA Diving Coordinator with 35 years of service and is the past director of the NOAA Hyperbaric Facility, founder of Hyperbaric's International, Inc., IANTD (1985), and cofounder of ANDI (1989).

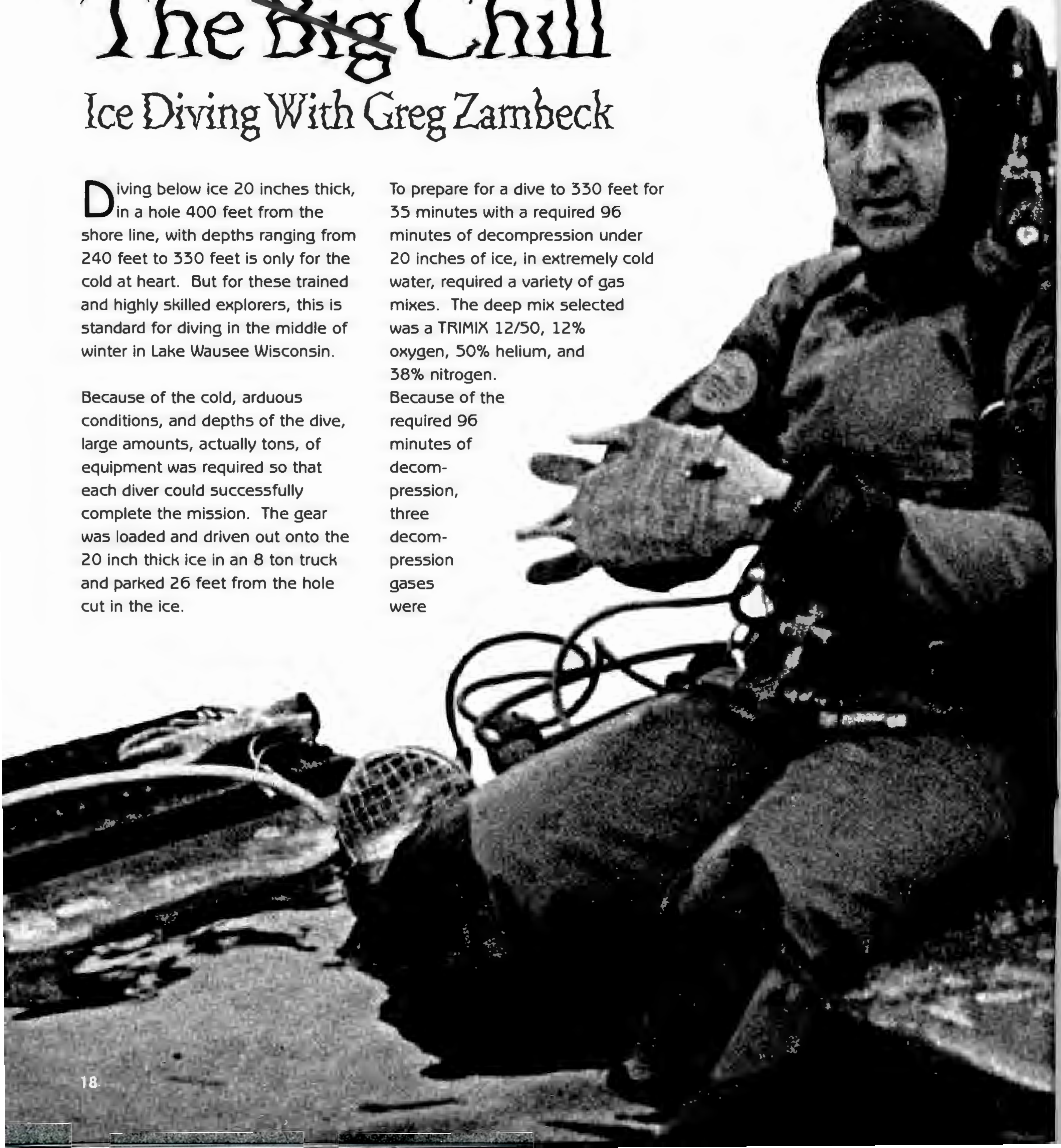
The ~~Big~~ Deep Chill

Ice Diving With Greg Zambeck

Diving below ice 20 inches thick, in a hole 400 feet from the shore line, with depths ranging from 240 feet to 330 feet is only for the cold at heart. But for these trained and highly skilled explorers, this is standard for diving in the middle of winter in Lake Wausee Wisconsin.

Because of the cold, arduous conditions, and depths of the dive, large amounts, actually tons, of equipment was required so that each diver could successfully complete the mission. The gear was loaded and driven out onto the 20 inch thick ice in an 8 ton truck and parked 26 feet from the hole cut in the ice.

To prepare for a dive to 330 feet for 35 minutes with a required 96 minutes of decompression under 20 inches of ice, in extremely cold water, required a variety of gas mixes. The deep mix selected was a TRIMIX 12/50, 12% oxygen, 50% helium, and 38% nitrogen. Because of the required 96 minutes of decompression, three decompression gases were

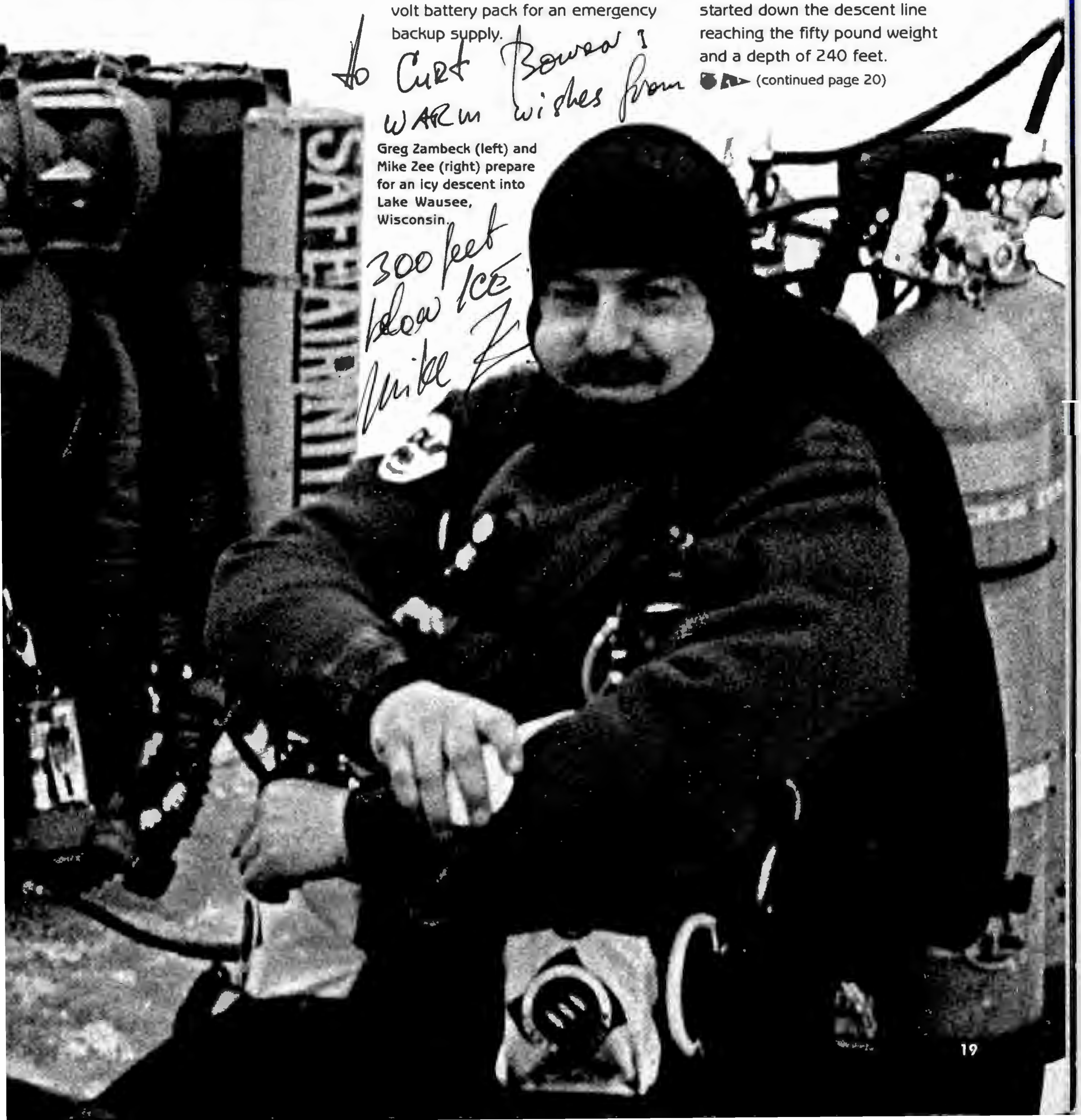


used, NITROX 40/60, NITROX 80/20, and 100% oxygen. All decompression gases, except the AIR at 200 feet, were supplied to the divers from surface supply hoses with low pressure regulators connected to 312 cubic foot supply cylinders. The AIR was supplied from a 2750 psi high pressure hose. The supply lines were placed at 200 feet, 100 feet, 30 feet, and 10 feet.

Because of the extreme cold, twin car batteries powered a 100 foot electrical cable with four, 12 foot extension cables to provide energy for electric socks, gloves, and pads to keep the divers warm. In addition, each diver carried a 24 volt battery pack for an emergency backup supply.

With all the gear in place and each diver waiting excitedly to descend into the deep chill, the dive plan was rehearsed once more. The planned profile was to descend down the drop line to 240 feet, attach an exploration reel, and follow the lake floor down to 330 feet. The plan was set and each diver entered the water. The team started down the descent line reaching the fifty pound weight and a depth of 240 feet.

(continued page 20)



Greg Zambeck (left) and Mike Zee (right) prepare for an icy descent into Lake Wausee, Wisconsin.

to Curt Bowen !
WARM wishes from
300 feet
below ICE
Mike Z

At this point, one diver took the drop camera already in place and another pulled the cable as they followed the slope of the lake. The camera recorded the descent down to 330 feet grabbing images of large orange colored rocks, among others. With time running out, the divers made it to the desired depth of 330 feet, turned and started heading back to the decompression lines.

While the divers performed their scheduled decompression, the surface crew pulled up the camera. Each diver was now concentrating on being warm at the 100 foot decompression stop. Here, the divers had access to the hot water system. The system is a 250,000 BTU unit on the surface capable of supplying 120 degree water at 3 gallons per minute. Water from the lake was pumped through a 12 volt pump which is fueled by forty pound propane tanks. The hose dropping down to the divers could be used to warm extremely cold hands and faces.

Because of water contact to much of the face with normal masks, an AGA full face mask was used throughout the dive to alleviate mouth fatigue, cover more of the face, and provide nasal breathing. The regulators are twin positively pressurized, in a V-block manifold, with a female Colepalmer CPC connector for hydration. Both the male and female connectors have o-ring seals, and the connectors shut off once disconnected stopping the flow of water into the mask or allowing air out.

While each diver was on decompression, they had the capability of communicating with each other through a port drilled into the manifold parallel to the converging regulator hoses. A plastic female AMP, 4 pin connector was glued into the manifold block. Two of the gold pins were used for wireless communication and the other two pins were used by the amplification unit. The unit has its own underwater speaker so that divers could give instructions to each other while on decompression.

As the divers made their way up the decompression lines, gas switches were required to avoid having to remove the full face mask and expose the face to the extremely cold water. To accomplish this, the mask was rigged with 2 three-way ball valves. The top valve was used to allow the use of one or both regulators. The bottom was used to select from a gas source through one of the two quick connect stems. With this type of connection, the divers could easily switch to the required gases at the appropriate depths, making decompression much more relaxing considering the elements each diver was dealing with.

Upon completion of decompression, each diver emerged from the back, cold water abyss with a look of satisfaction and accomplishment. Each diver successfully completed the dive and stayed as warm as possible, the latter being almost unbelievable considering this dive began by cutting a hole in 20 inches of ice.

▲ **Greg Zambeck preparing for a dive in Lake Wausee, Wisconsin**

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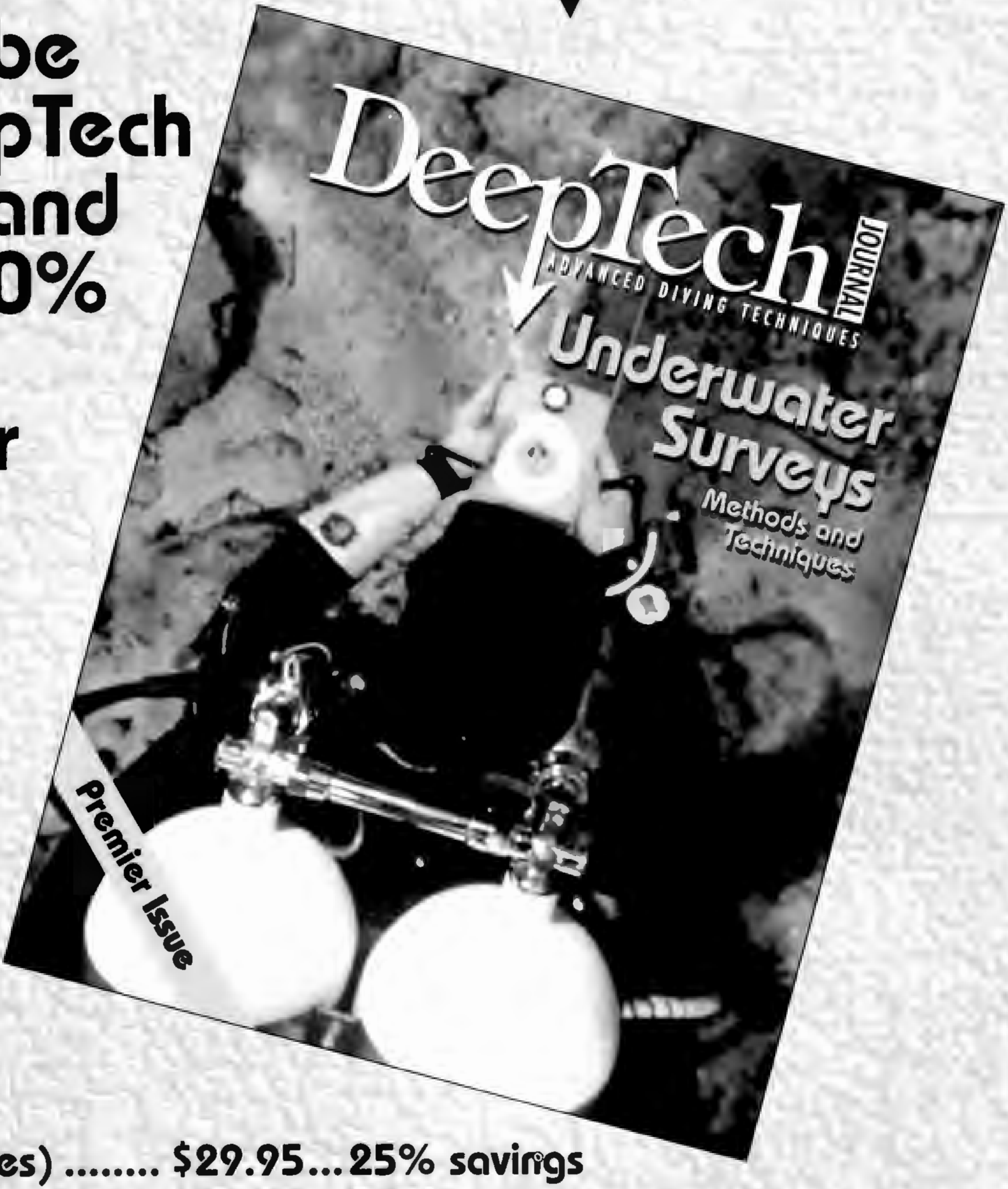

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DeepTech Journal Solicits Suggestions

The staff of DeepTech Journal wants this to be a journal about diving for divers and by divers. DeepTech is interested in suggestions for feature articles, editorials, and the regular Guru Diver column. Beginning next issue there will also be a regular column called Deep Thoughts which is a readers forum for hot topics, so keep those cards and letters coming. Please send mail to DeepTech Journal, P.O. Box 4221 Sarasota, Florida 34230-2360.

1995 NSS-CDS Workshop

The 1995 NSS-CDS Workshop will be held May 26- 29 in Branford, Florida. Speakers for the workshop include Rob Palmer, Jim Bowden, Terrence Tysall, Mike Cochran, Bret Gilliam, Hal Watts, Tom Mount, Ed Betts and Bill Turbeville. The event begins with a social gathering Friday, May 26 at 6 PM. Registration is scheduled for Saturday, May 27 at 7:30 AM. Clinics, classes, workshops, and guided dives will be among the activities. For details contact Gene Broome, PO Box 822, Branford, FL 32008, 904-935-1141. Also Look for DeepTech's Booth at the workshop.

The Sheck Exley Exploration Award

The Sheck Exley Exploration Award, currently being established by the NSS-CDS, recognizes and memorializes the many advances that Sheck brought to the diving and caving communities. His efforts have made underwater cave exploration safer, provided the basis for cave training, and set new standards by which all current exploration activities are measured. His untimely passing was a great tragedy, but his dedication and love of cave exploration left a legacy which will long outlive us all. The Award will promote and support exploration involving cave diving and is planned for annual presentation. The details of the award were unavailable at press time. To make contributions or for more information contact the NSS-CDS at P.O. Box 950, Branford, Florida 32008-0950.

Sulphur Springs Project

An exploration of Sulphur Springs in Tampa, Florida began in March 1994 by Frank Richardson and Jeff Petersen. An agreement was negotiated with the city of Tampa to explore the cave and search for reasons why pollution is entering the system. The project is being watched closely by the Environmental Protection Agency (EPA). The spring discharges 44 cubic feet of water per second into a concrete retention pool 50 feet in diameter. The water is then directed into the Hillsborough River. The cave winds under the buildings and streets of North Tampa, working its way from a series of sink holes to the North. The cave is covered with detritus, which makes visibility extremely poor. To date, a total of 5,000 feet of passage has been surveyed and mapped. At 3,600 feet, maximum penetration to date, a previously filled sink hole exists making an extremely tight restriction with intense flow. This sink was filled in by the city many years ago to build homes. Exploration past the sink is questionable and currently being investigated due to the extreme hazards of breakdown and the high flow. The team hopes that a safer way past the sink will be discovered. The team is conducting dye tests in efforts to connect the sink holes north of the spring. In addition, it is hoped that a way to make physical connection with the sinks will be found.

Nesbitt Spring Project

Project leader Jerry Fant is currently preparing for what is possibly the largest sump diving project in the United States. It is planned for August 1995 in a cave system located in northern central Arkansas 3.5 miles northeast of Mountain View. To date, 6,050 feet of surveyed passage with 2,500 feet being submerged has been explored. The cave system starts as a dry cave for approximately 600 feet to sump one. Sump one is 237 feet long with a maximum depth of 11 feet. Beyond sump one lies over 1,500 feet of dry passage before reaching sump two. Sump two is 157 feet long with a maximum depth of 11 feet. Beyond sump two lies over 1,500 feet of wall to wall streamway. Sump three is the object of the upcoming project and has been explored for over 2,000 feet with a maximum depth of 100 feet. Water temperature is 54 degrees with low visibility.

I.A.N.T.D. Increases Insurance Offerings

The International Association of Nitrox and Technical Divers, Inc. has been given approval by their insurance underwriter to provide instructor liability insurance for all certification courses offered by the association from beginning open water scuba diver through all technical courses and rebreathers. They are now the only certifying agency that offers this wide range of liability insurance. Instructor liability insurance from I.A.N.T.D. is expected to cost approximately $500 per year for one-million dollars in coverage. Additionally, they can provide facility insurance for gas mixing and instruction for approximately $2,300 per year. For more information, contact the I.A.N.T.D. headquarters at 9628 NE 2nd Avenue, Suite D, Miami Shores, Florida 33138-2767, 305-751-4873, or fax 305-751-3958.

Ocean Expo 95

Ocean Expo 95 is scheduled for May 20-21, 1995 at the Radisson Convention Center in Miami, Florida. Ocean Expo is billed as a Dive, Travel, and Water Sports show. Several educational seminars and workshops are planned for the two day period including a series on technical diving called XPOTECH. This series plans to address mix technology, nitrox, rebreathers, and various technical diving exhibits. The South Florida chapter of NAUI's Southeast branch is scheduling two days of seminars on leadership development that is open to everyone. Admission is $7 for everyone over the age of 12, 12 and under are free. For more information contact Ocean Expo at 2233 Keystone Boulevard, N. Miami, Florida 33181, 305-891-6095, or fax 305-893-3486.

1996 Tek Conference

The 1996 Tek conference sponsored by AquaCorps is planned for January 12-17, 1996 at the New Orleans Convention Center in New Orleans, Louisiana. For information call 800-365-2655, or fax 305-293-0729, or email 73204,542 (Compuserve).

IN MY OPINION

Technical Diving: A Definition—Or Not!

by Win Remley

Technical diving is one of those phrases that has been overused to the point of losing it's meaning. That is, if it indeed had a well defined meaning to begin with. I'm not sure who may have been the first to utter those two controversial words, however, I do know that few things will generate as much argument as asking a typical group of scuba instructors to define the term or comment on how it should relate to the sport. If you ask ten instructors to define technical diving you will get ten different answers. Fifteen if they're NAUI instructors. NAUI instructors have a God given right to embroil themselves in controversy. I should know, I'm one myself—and proud of it.

In fact, what gave me the idea for this editorial was the Member's Forum in the March/April Issue of *Sources Magazine*, the NAUI publication for association members. In this article the following question was asked: "What is "technical diving?" Should recreational diving activities be defined or restricted based on this definition?" *Sources* received eleven responses from association members, mostly NAUI instructors. The responses were diverse. Two respondents said ALL diving is technical since it involves the use of technology (they may have something here). At the other extreme one respondent defined technical diving as an attitude. One respondent even submitted two different definitions—proving my point in the previous paragraph.

The controversy over technical diving seems to stem from the belief that it is somehow more dangerous than recreational diving (whatever that is). Consequently, if we endorse or encourage technical diving, divers might get injured or worse. And if that happens, it will give diving a bad name. Who knows, eventually divers may wind up categorized with bikers or something. Come to think of it, a lot of instructors I know ride motorcycles—hmmm!

To throw my two cents worth into the fray (after all, I am a NAUI instructor) I believe technical diving is no different from any other type of diving. If you get proper training, use proper equipment, and obey the rules, you have a reasonable chance of being able to tell others how cool the dive was. This is the same for a 50 ft. dive in the Florida Keys as it is for a 250 ft. dive under the ice on Lake Wausee, Wisconsin. The only difference between these two dives is that there's different training required, different equipment needed, and a very different set of rules to obey. The fundamental principals apply equally to both.

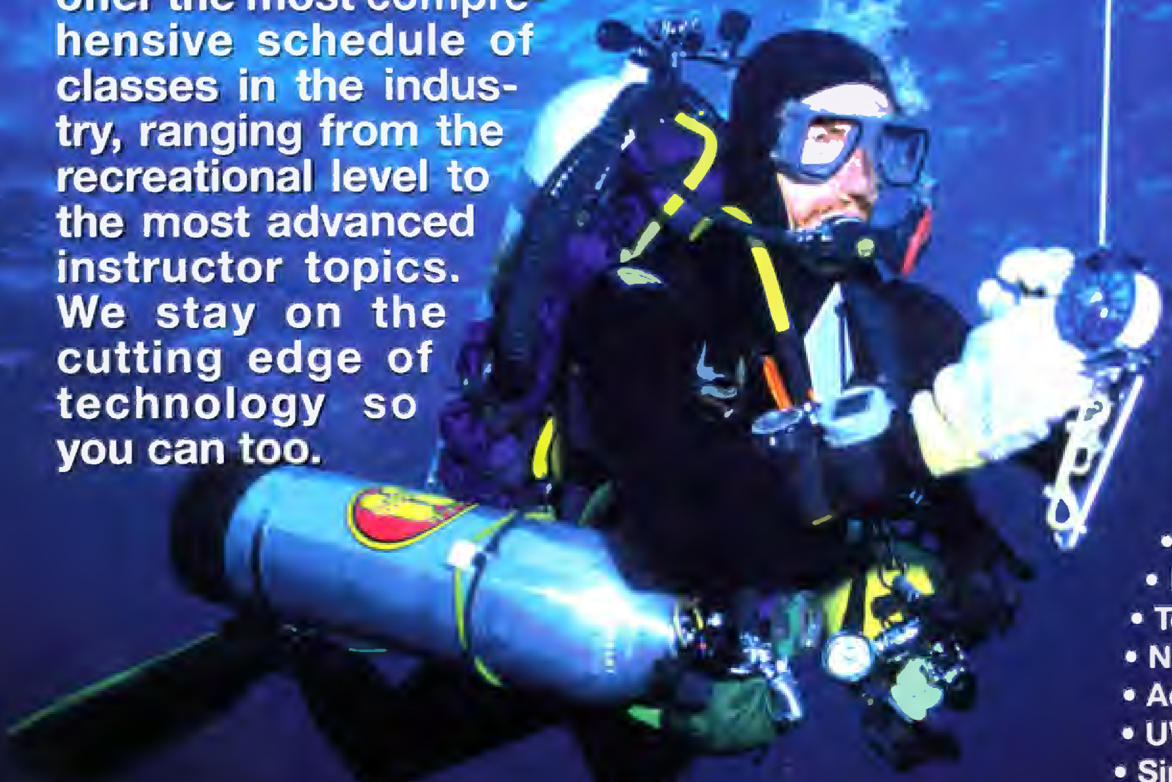
Stingray City in the Caymans is a cool dive even though it's only 15 feet deep. Davis reef in the Florida Keys is a cool dive (at night) and it's 30 feet deep. One could argue that there's twice as much risk diving Davis reef than Stingray City since it's twice as deep. Does this mean that we should stick signs in the sand that read, "Caution, Technical Divers Only?"—I don't think so.

Diving the kelp forests off the coast of Monterey, California has even more risk than Davis Reef, but with the addition of a couple of good dive knives strategically located, streamlining of all hoses and gear, and some additional training in kelp forest dive techniques, the additional risk can be brought down to acceptable levels (in spite of those pesky sea-lions). A diver not prepared or trained for entanglements, however, risks his life on this dive. Should we discourage people from experiencing this incredibly beautiful dive due to the increased risk?—I don't think so.

Extended range diving (a better term than technical diving) absolutely has more risk than typical recreational profiles. However, by obtaining proper training, proper equipment, proper experience, and using established techniques and procedures, the 250 ft. ice dive can be commenced with about the same chance of success as the kelp forest dive. Any diver, on the other hand, who dives beyond his or her ability in any environment is asking for trouble.

One look at the redundant gas supplies, redundant regulators, redundant depth gauges, redundant timing devices, redundant dive tables, redundant dive computers, redundant lights, safety divers, and emergency gear tells you that most extended range divers are serious about safety—also that they have spent a small fortune in dive gear.

Should we discourage and shame divers for pursuing the type of diving they enjoy? Or should we instead educate them on the risks involved and support them in learning ways to reduce that risk to acceptable levels. It wasn't so long ago that the world just shook its head at that crazy Cousteau guy and his aqualung. The NAUI credo "Safety through education" doesn't just apply to divers who enjoy open water dives at recreational depths. There can never be truly "safe" diving just as driving your car on the freeway can never be made truly "safe". Diving risk is measured on a spectrum. The greater the risk, the more training, equipment, and experience that's required to offset that risk.
It's that simple!



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