A CURRICULUM GUIDE AND CONDENSED DIVING MANUAL FOR SCUBA DIVING

by

LON FLOYD

B.S., Kansas State University, 1967

5-2-72

A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Physical Education

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1971

Approved by:

Major Professor

ACKNOWLEDGMENTS

This author wishes to express his most sincere appreciation to Mr. Ray Wauthier and Mr. T. M. Evans for their guidance and encouragement throughout his undergraduate and graduate years. Appreciation is also expressed to Dr. Charles Corbin for advisement offered during the writing of this report. Finally, a special thanks to all of the professors who gave so generously of their time toward a valued education.

TABLE OF CONTENTS

TABLE OF FIGURES

CHAPTER I

AN INTRODUCTION TO SCUBA

For centuries man has ventured upon the surface of the water and believed the underwater world to be a gloomy, mysterious region inhabited by terrible sea monsters and housing grave dangers. The introduction of Scuba (self-contained underwater breathing apparatus) in 1943 gave man the freedom to explore this unknown world. This piece of equipment, invented by Jacques-Yves Cousteau and Emile Gognan, allowed men to prove the underwater world to be far from a horror house, but one of endless beauty and opportunity.

In the early stages of development this underwater breathing apparatus, also commonly known as an aqua-lung, was an expensive and dangerous item. Its use was limited to highly skilled scientists. Since that time advanced technology has produced a moderately priced and safe machine which allows the average individual the opportunity to explore the underwater world.

The major percentage of diving is done purely from a recreational standpoint. One can limit his participation to observation in the shallow waters of a lake, or experience the thrill of a dive into a deep ocean canyon. The variety of recreational opportunities are limitless.

The underwater hunter, armed with a speargun, is able to find a challenge equal to any on the land. His game may range from only a few ounces to hundreds of pounds. Spearfishing is not limited only to salt-water, as many inland fresh water lakes provide excellent hunting opportunities.

To the photographer, the underwater world provides an endless variety of fresh new scenes. The diver need not be a professional photographer with a great amount of expensive photographic equipment. Very suitable and exciting pictures can be produced with as little equipment as the

"family Brownie". Of course, some type of watertight housing is needed for the camera, but these can be constructed for as low as $15.00.[1]

Although not a scuba diver, Joseph Conrad quite aptly described diving for sunken treasure in this brief statement.

"There is something in a treasure that fastens upon a man's mind. He will pray and blaspheme and still persevere, and will curse the day he heard of it, and will let his last hour come upon him unaware, still believing that he missed it only by a foot."[2]

With this thought in mind, one may be a bit hesitant to attempt to dive for treasure, yet millions of dollars worth of gold and artifacts have been found by aqua-lung divers. Just as spearfishing is not limited to salt-water, neither is treasure hunting. Many valuable items have been recovered from lakes and rivers.

Not only does scuba diving provide for recreational activities, there are many professional opportunities being made available. Such areas as marine biology and ecology have become very necessary in today's world. Without the scuba apparatus, these areas would be severely restricted. Marine biologists are eagerly working toward methods which may someday allow us to grow much of our food beneath the surface of the water.

Oil geologists are also taking to the scuba equipment in search for oil. Bottom samples, coral samples, marine life analysis, and photographs are only a few of the items which must be collected and analyzed before a decision can be made to drill.

Underwater construction and repair are also becoming a profitable pursuit for the skilled diver. Salvage operations can be another profitable venture. This may range from light salvage such as fishing equipment, outboard motors and small boats; to heavy salvage such as ships and auto-

mobiles. Heavy salvage is best left to the very experienced diver or diving teams.

Realizing the above mentioned professional opportunities and the recreational aspects, millions of people have become avid scuba divers. Even though this underwater world is a friendly place, man is still out of his natural element. He must thoroughly learn and practice certain rules and laws. Once mastered, the student will be very much at home, and an exciting experience awaits him beneath the surface.

Purpose

The purpose of this report is to offer a curriculum guide and condensed diving manual to be used by those who are interested in learning to scuba dive. The report may also be used as a guide by an instructor preparing to teach a class in scuba.

Method of Study

This report was prepared by reviewing related literature from the Kansas State University Library, Physical Education Library, and the Manhattan Public Lebrary. The author gathered additional information while taking a course in scuba training to become a certified diver.

Techniques and procedures cited in the report were researched from recognized authorities in the field of underwater diving.

Importance of Study

With the fantastic advancements in underwater breathing equipment, the opportunity is available to the average individual to explore the underwater world. No longer is the enchantment of seeing ancient wrecks, multitudes of sea life, coral reefs and a chance to search for treasure limited to the wealthy few. With a moderate amount of training and a small investment, everyone who is physically healthy can dive and explore these wonders of the

underwater world. The recreational aspects are limitless, not to mention a rapidly growing need for professional working divers.

For these reasons, a total comprehensive program of scuba training is of vital necessity wherever conditions and facilities allow such training. Most high schools with pools and community recreation commissions which have available pools are severely limiting themselves by not adding scuba to their program.

A school which is attempting to establish a total aquatics program is virtually required to include scuba training in their course offerings. A figure quoted by Owen Lee, a noted diver and member of the famous "Clypso" diving team, states that scuba equipment sales have doubled every year since its invention and nearly a million divers in over a thousand clubs have taken to the underwater world. This figure would indicate a large interest in this type of activity.

In order to determine an even more workable figure which might indicate student interest, this author has designed a very brief questionnaire and asked Kansas State University freshman students to complete it. The questionnaire was completed by one hundred fifty women and one hundred fifty men who were enrolled in various basic physical education classes. The following three questions were presented to the students:

1. Would you be interested in enrolling in a University sponsored scuba diving class?
2. Would you take the class if it was for NO CREDIT?
3. Would you be willing to invest $12.00 for mask, fins, and snorkel if the University furnished all other equipment?

The results of the above questionnaire are as follows:

Results of Question Number 1:

	YES	NO
Total	197 or 66%	103 or 34%
Men	113 or 75%	37 or 25%
Women	84 or 56%	66 or 44%

Results of Question Number 2:

	YES	NO
Total	124 or 41%	176 or 59%
Men	67 or 45%	83 or 47%
Women	57 or 38%	93 or 62%

Results of Question Number 3:

	YES	NO
Total	178 or 59%	122 or 41%
Men	80 or 53%	70 or 47%
Women	98 or 65%	52 or 35%

From the above figures, one can readily assume that there is a high degree of interest among college age freshman in a scuba program. There is a slightly higher percentage of interest shown by the men than women, but the 56% affirmative response by the girls is a surprising figure.

The results of question number two indicate the students do feel it should be a credit course. With a total of 59% of the students answering that they would not take the course if it were for no credit, one would assume that this would have an influence upon basic no credit physical education classes. Yet, one may refer back to the high degree of interest indicated by the result of question number one and assume that if the class was offered through the basic curriculum, a small percentage of those answering negatively about no credit would change their minds and take it simply from an

interest standpoint.

The assumption is further re-inforced by the results of question number three, where 59% stated that they were interested enough to invest $12.00 for basic equipment.

When one considers the composite results of the three questions, it is easy to conclude that there is a great interest in scuba diving. Students have apparently had enough exposure to what scuba entails to have had their curiousity aroused significantly. It then becomes the school's responsibility to recognize this interest and develop a comprehensive aquatics program which includes a complete course in scuba training.

CHAPTER II

CONDITIONS NECESSARY TO TEACH SCUBA

Certain conditions must be present before a scuba program can be efficiently taught. These conditions vary between different locales, but the items discussed in this chapter are basic to all programs.

Instructor

Before a course can be offered in a curriculum, a qualified instructor must be hired to teach the class. The instructor needs certain basic qualities in conjunction with an advanced knowledge of technique and diving theory. These basic qualities include normal good health, pleasant yet firm personality, and an ability to command the respect of his students.

The Professional Association of Diving Instructors (P.A.D.I.), Morton Grove, Illinois has developed criteria for educating certified instructors. The minimum requirements for becoming a certified instructor include successful completion of the Certified diver, Advanced diver, Divemaster, and Assistant instructor classifications. (Requirements for these levels can be found in Appendix B of this report). As an assistant instructor, one must spend a minimum of 60 days under the supervision of a qualified instructor. That instructor must then recommend his assistant to a P.A.D.I. Regional School. The regional school consists of advanced diving theory, scuba mechanics, and instruction concerning the newest available equipment. The assistant is also required to complete a very comprehensive written examination before final certification.

The recommended length of these schools is four days. The normal procedure is to meet two two-day weekends which will be separated by a two or, where possible, three week period. Regional schools are held throughout the United States, providing an opportunity for all assistant instructors to

gain this certified instructor classification.

Once the instructor becomes certified, each time he steps in front of a class or conducts check out sessions he is liable for the safety and well being of his students. In the event of an accident or mishap, the instructor is open to a liable suit. An instructor cannot afford to conduct classes without proper liability insurance.

For this reason, instructor's liability insurance policies have become available. According to a pamphlet on insurance received from the Professional Association of Diving Instructors, minimum coverage should include $50,000 to $100,000 liability, $5,000 property damage and $1,000 deductible. The pamphlet also indicated annual premiums range from $17 to $20.

Equipment

Below is listed the basic equipment necessary for scuba diving. Brief suggested beneficial qualities accompany each item.

Face Mask.-- The mask is the diver's window through the water and without it he is severely handicapped.

The mask should be constructed of soft flexible rubber to insure a tight seal around the face. The lens should be made of clear, shatterproof glass. Plastic lenses tend to fog in water and plain glass lenses are too easily broken.

A nose-pinching device is also built into some masks to aid in clearing your ears as the diver ascends and descends. Recommended masks are the "Aqua-lung Pro", "Clear-ease Pinocchio", the Waterlung, the Voit "Polaris", and the "Wide-View".[3] From personal experience, this author would also recommend the U.S. Diver's "Falcon". This mask is smaller, less bulky and takes less exhaled air to clear than the other recommended masks. One must keep in mind that personal comfort and preference is often more important

than another's recommendations.

Flippers.-- Flippers are important as they allow the diver to move through the water with ease and speed. The flippers available are of an endless variety. Again, personal preference is of utmost importance.

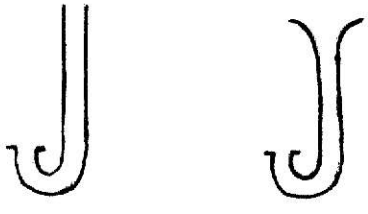
Generally, the more rigid the flipper blade the more powerful the force delivered by each stroke. Yet this requires more physical strength and conditioning by the diver. The beginning diver may prefer a more soft flexible rubber which requires less effort to manipulate.

Comfort is more important than design. A loose flipper may allow the formation of a blister due to rubbing and a tight flipper may cause lower leg and foot cramps. If the non-adjustable shoe type flipper is preferred, consideration should be given to the rubber boot necessary for cold water diving. A slightly larger size is needed to allow room for the boot.

Snorkel.-- Snorkels are "J" shaped tubes which permit breathing on the surface with the face in the water. The snorkel should be a plain, flexible rubber snorkel or one which has a flexible corrugated tubing between the mouthpiece and straight tube. The flexibility is very important as this prevents it from snagging on obstructions and pulling the mask from one's face.

From personal observation, it is believed the snorkel should be at least 7/8 of an inch in diameter. Smaller diameters cause increased air resistance and thus make breathing more difficult. The curve needed between the mouthpiece and straightpipe should also be as gradual as possible. The more acute the angle of the curve, the more air resistance produced. A flared top also helps decrease air turbulence.

Figure 1: Comparison of regular and flared snorkel



Floats.-- A float is a useful platform which has a variety of uses. Such uses might include a rest platform for use in case of exhaustion and trouble, or a platform upon which to carry spare equipment, souvenirs, or spearfishing game. It can also be a valuable vehicle for transportation from shore to diving areas.

An automobile inner-tube with an attached sack; a sturdy nylon or canvas air mattress; a paddleboard; or any boat with adequate water re-entry provisions are all acceptable floats.

Diver's Flag.-- The diver's flag signals to boat operators that a diver is underwater in the immediate vicinity. They should immediately reduce speed and leave the area. The official diver's flag is redish orange with a white stripe running diagonally from the top left corner to the lower right corner.[4]

Flotation Vests.-- These are self-inflating vests worn around the neck and chest area. It's purpose is to hold an unconscious person's head above water and can also be used for more rapid ascent to the surface.

The vest should be constructed of durable material with all metal and working parts guaranteed corrosion resistant. An emergency CO_2 cartridge is necessary, as well as an oral inflation valve.

Knife.-- The basic need a diver has for a knife is not as a weapon, but as a cutting and prying tool. The knife should be quite sturdy for prying with one saw-toothed edge and one smooth straight-edge. The weight belt and tank strap do not allow room for the knife and sheath to be strapped to the waist, so most divers prefer to strap the knife and sheath to the calf of the leg.

Wet Suit.-- A wet suit is worn so the diver can stay immersed in cold water for indefinite periods of time. The modern wet suit is composed of unicellular foam rubber. The rubber has tiny air bubbles in it which act as

pockets of insulation to keep the diver warm. They are called "wet suits" because a thin film of water is allowed inside the suit. This film is quickly warmed by the body's heat and provides insulation.

Water conducts heat at a rate twenty five times faster than air, for extended lengths of time, thus the body needs extra protection in water below 70 degrees Fahrenheit.[5]

Weight Belts.-- When a wet suit is worn the air spaces in the suit cause the diver to become quite buoyant. A belt with lead weights must be worn to off-set this buoyancy. The belt is worn around the waist. Of utmost importance is a quick release buckle which can be worked with one hand in case of emergency and the weights need to be dropped.

Compressed Air Cylinder.-- The air needed by the diver to remain under for extended periods of time is stored in a high pressure cylinder which is strapped to his back. Cylinders are available in many sizes, and in double and triple tank units. Their capacity is measured in the number of cubic feet of air compressed into the tank. Cylinders usually contain air compressed at approximately 2,000 pounds per square inch. The standard cylinder is termed a "single 70" because it contains 71.2 cubic feet of air.[6]

Tanks are constructed from high grade steel, but need to be pressure tested twice each year. The new models on the market are coated both on the inside and outside to retard corrosion which can readily weaken a tank.

Cylinder Valve.-- Cylinder valves control the air to the regulator. They are of two typed, "J" and "K". The "J" valve has a constant reserve which simply means that when the air pressure gets low in the tank the diver experiences a difficulty in breathing. This is an indication that he should pull the reserve lever and ascend because he only has about five minutes of air left in the cylinder.

The "K" valve has no reserve, thus no warning system.

Regulators.-- The regulator is the heart of the scuba system. It allows the diver to breath air at exactly the same pressure as the surrounding water pressure. An explanation of this intricate mechanism which operates the regulator is not within the scope of this paper.

Regulators are of two basic types, two-hose and single. As in previously discussed equipment, personal preference governs to a large extent the selection of a regulator. Both have advantages and disadvantages. One of the variances is in the exhaust location. The two-hose type allows the bubbles to be expelled behind the head where they never interfere with vision. The single type exhausts by the side of the diver's mouth and bubbles may at times blur vision. The two-hose type causes more water resistance where the smaller single hose type helps eliminate this problem.

Depth Gauge.-- An accurate depth gauge should always be worn. It is extremely difficult to judge depth.

Watch.-- A pressure proof watch is a necessity when doing deep-water work where keeping track of time is important.

Compass.-- Sense of direction is easily lost underwater and a compass is the only means of holding a course. This is particularly important in water of low visibility.

No equipment cost estimates will be cited by this author because of the multitude of companies selling equipment and price variances due to fluctuations in the economy. However, several equipment sources are listed in Appendix C.

Necessary Physical Facilities

A pool is normally most advantageous for teaching the elementary stages of scuba. A pool provides good visibility, a reasonably constant temperature,

and an easily accessable bottom from which to retrieve dropped articles. A lake which incorporates the above mentioned features is also acceptable.

The pool should have a shallow end to teach the basic exercises and a deep end to work on the more advanced skills. A depth of at least eight feet is necessary with twelve to fourteen feet being ideal.

A compressor is also a very beneficial piece of equipment. Compressors are used to fill diving tanks and are specially equipped with air and oil separators. These are fairly expensive items, but a diving club with its treasury in good condition can make this investment and gain returns by selling air to neighboring clubs and individual divers. The cost would be approximately one thousand dollars.[7]

Upon completion of the necessary diving skill, the diver is ready for a free dive in open water. The locations are limitless for free dives. There are some general qualities which should be considered when selecting a free dive area. The body of water should be calm with little or no boat traffic. Visibility should be good due to the fact that little pleasure is derived from diving with poor visibility, especially for the novice diver. Sand or rock bottoms usually help maintain visibility. If near the ocean, a jetty, a reef, or a sunken wreck are usually good, because of the abundance of fascinating sea life.

A depth of thirty feet is accepted by most sources as appropriate for the first year diver.

Swimming Requirements

After a survey of several sources, but using the "University Guide for Diving Safety", published by Texas A & M University as a major reference source, this author has compiled the following list of basic swimming skills to be used as a pre-requisite to entering the scuba class.[8]

1. Swim continuously one thousand feet without fins.
2. Swim underwater sixty feet without fins.
3. Surface dive without fins to a depth of at least ten feet, recover a ten pound weight, and carry it underwater twenty five feet without surfacing.
4. Simulate rescue of a struggling victim for a distance of sixty feet.
5. Tread water for five minutes.
6. Tread water for one minute without using hands.
7. Float motionlessly for five minutes without any aids.

Medical Examinations

Through a review of existing literature and personal conversations with a local physician, this author has compiled the following general medical examination as a pre-requisite for entering the scuba class. This is by no means a complete list of tests, but should only act as a general guide for a physical examination.

1. Ear and Hearing Exam - rule out pre-existing damage. Further diving could bring about total loss of hearing.
2. Eye Exam - should show normal accommodation to light and distance.
3. Respiratory System - students with chronic lung disease, any interference with the free passage of air, or with poor gas exchange should be disqualified.
4. Cardiovascular - any disease which precludes active exercise should cause rejection of the student.
5. Blood Test - normal hemoglobin content necessary for oxygen transfer.
6. Sinus Cavities - normal passage necessary for equalization of pressure.
7. Gastrointestinal - chronic gastrointestinal diseases, especially

ulcer, may disqualify the student.

8. Psychiatric - this area is most difficult to evaluate. Judgement is usually left up to instructor as class develops and reactions under stress situations are observed.

CHAPTER III

TECHNIQUES IN USE OF EQUIPMENT

This chapter will be devoted to discussion of proper technique to be utilized in the care and use of scuba equipment. A discussion of the teaching sequence for each skill will be reserved for chapter four.

Face Mask.-- Mastering the porper skills of the face mask are very important to the scuba diver. Putting the mask on is a simple task, yet there is a proper method. Grasp the face plate in one hand and put the mask in place on the face. Breathe in gently through the nose and let go of the mask. If the mask falls, this indicates there is a leak around the perimeter and a different mask should be sought. When the proper mask is selected, be sure to use some type of anti-fog solution on the lenses. Many divers use saliva, but a solution of glycerine and alcohol works much better.

The occasion may arise when water fills the interior of the mask and the water must be removed. Practicing with one hand only, press gently on the top of the mask. At the same time tilt the head back and exhale a small amount of air through the nose. This air will force the water out the bottom of the mask and the mask is cleared.

Another technique to be mastered is the release of ear pain. This is done by various methods. Most masks are equipped with some type of nose pinch device for this purpose. To release the pain, use the nose device and pinch the nostrils together while gently exhaling through the nose. This equalizes the pressure on the inner ear and relieves the pain.

Snorkel.-- The snorkel is a simple device to use but does require a degree of concentration. The diver should practice taking a deep breath and submerging until the open end of the snorkel dips under the surface. Then he returns to the surface and blows the air forcibly through the snorkel.

This will push out the water which entered the tube. One should not worry about water entering the mouth. A certain amount of air will be trapped in the snorkel, thus preventing water from reaching the mouth area.

Flippers.-- Techniques in using the flippers is primarily an individual skill. Gene Parker, an expert diver, in his "Handbook on Skin Diving" recommends the straight leg kick as the most efficient.[9] More power is delivered with each stroke of the flipper when using the straight leg kick, but it also requires the most energy.

Other strokes such as the "porpoise" and "frog" kicks can be used to help lessen fatigue. Mr. Parker also recommends the diver alternate the various strokes so different sets of muscles are allowed periods of exercise followed by periods of rest.

Tank and Regulator.-- Proper care of the regulator and tank should be learned early in the instruction. If the equipment is not handled properly, it will not perform properly.

Each regulator should have a removable plug or cap that fits over the air orifice in the regulator yolk. The cap helps prevent foreign matter from entering the regulator when the regulator is not fastened to the tank.

Once the regulator yolk orifice is in position on the tank valve orifice and tightened only finger tight, the air can be turned on. One should hear a small gush of air as the air travels down the regulator hose to the regulator. A few sample breaths should be taken while still on land to insure proper functioning of the equipment.

The diver is now ready to don the tank and regulator. It is usually best to have a buddy help place the tank in position so it won't be dropped and damaged. Proper adjustment of the harness straps is essential. The tank should not be situated so low that it is difficult to reach the air valve on

the tank. Yet, if it rides too high on the back, as the diver looks up his head will rap against the tank valve. A position in between these two is required.

The harness strap buckles should always be of the quick release variety. One never knows when and under what conditions the equipment will need to be ditched. It has also been suggested by some experts that the waist buckle of the harness be located on one side of the body with the weight belt buckle on the other. This prevents them from over-lapping and causing confusion under a stress situation.[10]

Under some situations the mouthpiece may fall or be pulled from the diver's mouth. When this happens, clearing the mouthpiece of water is a simple matter. Hold the mouthpiece of a two-hose regulator above head level and allow the flow of air to clear the mouthpiece. Then quickly bring it down until it is in your mouth. The single hose regulator will house a purge valve which only need be pressed to allow air to be expelled under pressure and the water cleared from the mouthpiece.

Wet Suit.-- A good wet suit fits like a second skin over the diver's entire body. It should leave no openings or pockets for cold water to enter.

One should use extreme caution when putting on the wet suit, so as not to tear the rubber. Never grab a handful of suit and attempt to jerk it on, especially over a tight area. This may result in the tips of the fingers puncturing the suit. A gentle pulling action with the palm of the hand is much more desirable.

Weight Belt.-- As was stated earlier in this report, a quick release buckle is of prime necessity in selecting a weight belt.

If the diver is particularly buoyant, he will need a weight belt. One need put on only enough weight so as not to have to struggle to submerge.

A good test for proper weight selection is to dive to approximately ten feet. If the diver has selected the proper amount of weight, as he fills his lungs, he should begin to rise. Upon exhalation the diver should sink slightly.[11]

The weight belt rule is "last on, first off". One should never fasten any straps or other pieces of equipment over a weight belt, as this might cause confusion if the weight belt need be quickly removed in an emergency.[12]

High Pressure Compressors.-- Compressors are a necessary item for the scuba diver. There is a wide variety of kinds and systems. One of the most important considerations in filling a tank is to make sure the exhaust fumes do not enter the air intake on the compressor. If this occurs, the poisonous gas, carbon monoxide, may be pumped into the scuba tank.

Each compressor should have a filter system through which the air must pass before going into the tank. Oil or impurities in scuba air can be fatal.

During the filling phase, cylinders should be immersed in a water bath as a safety measure. If one should explode, most of the impact would be absorbed by the water. Also, cylinders will not overheat as quickly when they are placed in water because the water conducts the heat away.

CHAPTER IV

TECHNIQUES USED IN TEACHING SCUBA

Elementary Underwater Skills

Following the successful completion of all pre-requisites, the diving class is now ready to begin. Preceding any work with the tank and regulator, the student must show a high degree of proficiency in basic watermanship and skin diving skills.

Basic watermanship includes such skills as ability to maneuver under water with ease and perform a good surface dive. He must also have acquired a general confidence in his own ability in the water.

Time spent in the water is one of the best methods of developing these qualities. Underwater stunts such as underwater tag games, somersaults, and retrieving objects from the bottom aid in the student's ability to handle himself underwater.

The student should practice surface dives until the dive can be made effortlessly and without splashing. The pike dive and feet first dive are used most often with scuba equipment.

To perform the pike dive, the student should start from a prone position in the water. At the first point where he wishes to dive, he should jacknife at the waist, thus causing the forehead to be aimed at the desired destination. At the same time raise the legs above the head. Then he pulls himself downward with the arms and allows the weight of the legs above the surface to help drive him downward.

A feet first dive is quieter and is also useful in weeds or kelp. Tread water as high as possible, then stop and allow the body to drop below the surface. Once submerged, a jacknife is performed and movement is started toward the bottom.

Figure 2: Pike Surface Dive

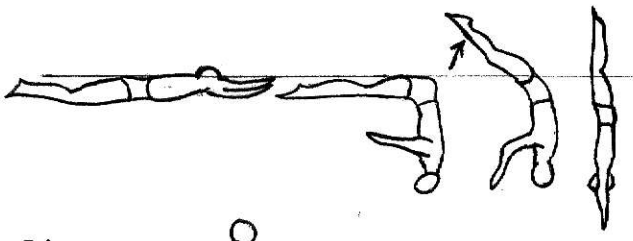
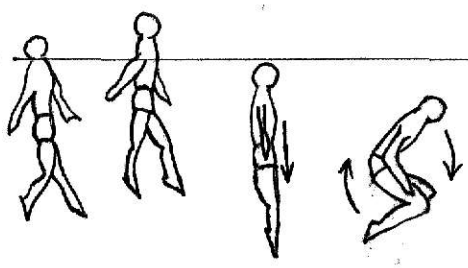


Figure 3: Feet First Surface Dive



Snorkel Training

The mask, snorkel and flippers should be introduced early in the instructional process. There are no short cuts or speedy miracle methods for learning the skills required to operate this equipment. Long periods of time spent in the water submerging, swimming underwater, surfacing, and clearing the snorkel are necessary for learning these skills. Games also aid in this learning process. Simple games such as underwater tag and underwater football are fun for the students, yet also require the students to practice the various skills which are required.

One of the most important techniques to be practiced is clearing the mask. The proper procedure is described in chapter three. The beginning student should begin by ducking under water, flooding the mask and clearing it; all while standing in shallow water. Another shallow water drill recommended is dropping the mask to the bottom and without surfacing, go down, put it on and clear it. When the snorkel is added the student must learn to surface and clear the snorkel before clearing the mask. A good exercise in breath control is to clear the mask first and *still retain* enough air to clear the snorkel.

The instructor may spot check the student's progress by having two students go to the bottom and trade masks. The students should be able to do this with moderate ease before they can be considered proficient.

Beginners have a tendency to breathe through the nose, thus fogging the mask quite rapidly. The instructor may wish the students to practice swimming only with the snorkel. Obviously, this discourages breathing through the nose.

To make sure the students have mastered the skills required concerning mask, snorkel, and fins, a test should be given. The instructor may wish to devise his own test, but the following is the required snorkel test given to scuba divers at Texas A & M:[13]

1. Swim one thousand feet with fins, mask, and snorkel alternating swimming on the surface and under water.
2. Recover and clear mask and snorkel from a depth of at least ten feet.
3. Demonstrate an acceptable head first and feet first surface dive.
4. Swim one hundred feet using the snorkel without the mask.
5. Swim one hundred feet with fins, mask, and snorkel without surfacing.

Upon successful completion of the snorkel test, the student is ready to don the scuba tank. Proper adjustment of the equipment is the initial lesson. Technique in doing this is outlined in chapter three.

Introduction to Scuba

With the tank and regulator adjusted, the student is now ready to experience the thrill of becoming a self-contained underwater unit. This initial experience is best had in shallow water. Laps swam around the shallow end may not be too exciting, but are necessary until the student has complete command of his equipment. Gradually, the student may be allowed to descend into the deep end. The instructor should re-emphasize the proper

technique to be used in releasing the ear pain caused by the increased pressure. Depths of only eight or nine feet are enough to bring on this pain.

Practice in clearing the mouthpiece and mask is very important during these early dives. Exercises similar to those used in learning the snorkel may be used equally as effectively with scuba equipment.

Swimming without the mask and breathing from the scuba is slightly different than breathing from the snorkel. Practice in surface dives with the scuba gear should also be done. Underwater stunts such as somersaults, standing on head at the bottom of the pool, and various rolls help the student to perform other functions without giving complete concentration to breathing. The ancient game of follow the leader can be readily adopted to scuba training.

Methods of entering the water with scuba gear may be introduced once the student has demonstrated that he can use the gear with a moderate degree of competence. Several methods for entry are recommended but in all of them one should remember to place one hand on the mask and the other on the side tank strap. If this rule is followed the mask won't be pulled off by the pressure of the water, and the tank won't shift around as the water strikes it. A head first dive is never recommended, as it is virtually impossible to keep water from entering the mask as the dive is made. Practice entering the water with the giant step. Take a large stride and hit the water with the legs far apart, so the force of the water will be absorbed by the legs. Other methods are a front roll, similar to a somersault, and pushing off backward. The main thing to remember is not to strike the water face down with the weight of the scuba on the back.[14]

Another of the scuba skills is termed buddy breathing. Buddy breathing is used when two divers must breathe from the same unit due to malfunction of one of the units. Proper body position must be maintained between

the two divers or a sudden surge or current might separate them. This position is best maintained by holding on to each other. A slightly different technique is used for the two-hose regulator and the one-hose regulator.

With the one-hose regulator, the two divers swim face down grasping each others outside shoulders. One diver would be using his right arm while the other would be using his left. The mouthpiece is passed back and forth with the free hand.

When using the two-hose regulator the divers face each other and grasp the shoulder area. One hand is released to pass and receive the mouthpiece.

In buddy breathing, the mouthpiece is handed to the partner with the opening pointed downward. This helps keep it as free of water as possible. Upon receiving it the diver exhales the breath he has been holding and takes two breaths. The mouthpiece is then handed back to the other diver and he completes the same procedure. This should be practiced both while sitting on the bottom and while swimming slowly around the pool.

Once the students have mastered the buddy breathing techniques, an exercise is introduced which incorporates several of the previously learned skills. It is known by several names such as ditch and recovery, ditch and don, and don and doff. The exercise is used to further instill confidence in the student that he has command of his equipment and that he is able to function under pressure situations.

The drill requires the diver to descend to the bottom of the pool in full gear. The diver must then remove all gear, place it gently on the bottom and ascend to the surface. Then dive back down and put on all the equipment. The instructor may want the student to leave his mask and fins on until he can better handle the tank and regulator.

Correct procedure is to dive and get the mouthpiece in first. If the

mask is nearby, the diver may want to put it on and clear it before putting the tank one, but this is not necessary. The tank may appear to be the hardest part, but when done properly is quite easy. From a sitting or kneeling position, grasp the tank on each side with the bottom end facing away from you. Lift it above the head and let it drop into position on the back. The straps should fall naturally around the shoulders. If the diver is quite buoyant, and has trouble staying down, he may want to place the weight belt over one or both knees while putting the tank on.

To increase the degree of difficulty, the instructor may want to dive down himself and shut off the air valve. The student must then turn it back on before he can get air.

Successful completion of the ditch and recovery phase brings the student to the introduction of the wet suit and weight belt. After putting these pieces of equipment on and getting them adjusted properly, as described in chapter three, the diver only need work until he finds the proper amount of weight required to equalize his buoyancy. This technique is also described in chapter three.

Advanced Underwater Drills

Blind Diving.-- Often times due to various water conditions the visibility under water is limited to the point where the diver is actually diving blind. He must then rely upon past diving knowledge and skills. One should prepare for this unpleasant experience by executing the following drill.

Darken the face plate of your mask by taping a piece of cardboard over the inside surface. Beginning in the shallow end, extend one arm to protect the head and swim back and forth across the pool. As one becomes more confident, he should move to the deep end and perform simple tasks such as retrieving objects or trying to tie a knot in a rope suspended from the side.

Another drill using the darkened face plate is to descend to the bottom and assume a sitting position. Ask a buddy to slip quietly into the pool some distance away from you and begin tapping on his tank with another metal object. The "blind diver" then should attempt to locate the "tapping diver" by the sound only.

The diver in water of low visibility may become confused as to which direction the surface is. The solution can be found quite rapidly. Simply take a deep breath and observe which direction the body rises or place the hand near the mouthpiece exhaust to determine which direction the bubbles are moving.

More Divers Than Scuba.-- A good confidence building scuba drill is to have more divers than scuba go to the bottom of a pool and remain under over an extended period of time. This requires a great amount of cooperation among the divers and a high degree of self-control by each diver. Each diver is to take only two breaths from any unit and then is required to move to another unit. The drill is actually an advanced form of buddy breathing. One less unit than the number of divers is recommended for beginning divers, yet an element of competition may be added to this drill. The class may be divided into equal groups with each group seeing how many divers can breathe from the least number of scuba units without a member of the team breaking for the surface.

Obstacle and Harassment Course.-- Once the instructor feels his class is gaining confidence in their equipment and are able to handle emergencies without panic, an obstacle and harassment drill might be used. This involves assigning the student a few tasks to perform, such as retrieving an object, towing a victim, or building something out of rubber blocks. As the diver goes about his chores, the instructor may rip off his air supply, or create

any kind of emergency he can think of at the time. Those students who are capable divers should be able to meet the crisis with composure. Those who panic need a little more practice before advancing to such things as the open water dive or open sea diving.

Proper technique in the use of scuba gear is of utmost importance. One error by the diver may very well cause a serious accident or may even be fatal. The skills and techniques described in this chapter should be thoroughly mastered and become "second nature" to the student if he is to be prepared to meet situations which he may encounter beneath the surface.

CHAPTER V

DIVING PHYSICS AND PHYSIOLOGY

Physics of Diving

A basic knowledge of the physical laws which govern the undersea world should be studied by the diving student before attempting to use scuba. Diving without a thorough knowledge of these laws is similar to a person trying to drive a car without first learning something about traffic laws.

The information concerning diving laws is voluminous and quite complex. This author has condensed the information and only touched the high points important to diving physiology.

Gases and Gas Laws.-- The diving student should gain a basic understanding of gases and the laws governing them. These laws become important to the diver as he descends and the increasing water pressure alters the properties and consumption rate of the gases in his tank.

The earth's atmosphere is a mixture of oxygen, carbon dioxide, nitrogen and trace amounts of many other gases. This atmospheric air normally consists of approximately 21% oxygen, 79% nitrogen, and .04% carbon dioxide.[15]

Oxygen sustains life on earth and without it man cannot exist. Yet, if 100% pure oxygen is breathed under twice the pressure exerted on the surface, pure oxygen is poisonous to man.[16]

Nitrogen composes the major percentage of the earth's air and on the surface has no ill effects upon the human body. But under pressure, extra quantities of nitrogen are absorbed into the body tissue. If proper procedures are not followed to eliminate this excess nitrogen, a diving disaster may result. A more detailed explanation of how and why this may occur will be given later in this chapter.

Carbon dioxide is produced inside the body as oxygen is consumed. The

amount of carbon dioxide in our blood affects the breathing rate, consequently, the more carbon dioxide produced the more the increase in breathing rate. Being reliant upon a limited amount of compressed air, the diver is concerned with this increase in breathing rate. Over-exertion, increased breathing rate, and low air pressure all spell trouble for a diver unless he understands and knows how to deal with laws discussed in this chapter.

Atmospheres of Pressure.-- Although we are normally not aware of it, we are always under a certain amount of atmospheric pressure. One doesn't notice this pressure of 14.7 pounds per square inch (psi) because the pressure of the outside of the body is equalized by the pressure on the inside of the body. This 14.7 psi figure denotes the weight of air which is one inch square and extends the entire length of the atmosphere. At sea level, a person is said to be under one atmosphere of pressure.

Water also exerts pressure. Through research scientists have found that at thirty three feet under water another 14.7 psi of pressure is exerted. The term one atmosphere has been given to this thirty three feet figure. So at thirty three feet, one is under the pressure of two atmospheres, the atmosphere exerted by the air above the surface and the one exerted by thirty three feet of water. At sixty six feet, three atmospheres are exerted; ninty nine feet, four atmospheres, etc. The water pressure plus the atmospheric pressure is known as absolute pressure. As is discussed later in this chapter, the effect on the body of the atmospheres of pressure are very important and must be understood by the student diver.

Boyle's Law.-- Boyle's Law states that at a constant temperature, the volume of a gas varies inversely as the absolute pressure, while the density varies directly as the absolute pressure.[17] This means that if the pressure of a gas is doubled, the volume is reduced to one half the original volume and

the density is doubled.

With the above law in mind, one can see there is a great pressure exerted on a diver's lungs as he descends. The regulator compensates for this by automatically adjusting the air breathed to the outside pressure.

The following illustration may help understand Boyle's Law: If one were to fill a balloon with one cubic foot of air at sea level and lower it into the sea, at thirty three feet, two atmospheres of pressure would be exerted on the balloon and the volume would be reduced to one half cubic foot with the density being twice that at sea level.

As the balloon descends to sixty six feet and the pressure is three times as great, the volume is cut to one third and the density of the air has tripled. As the balloon continues to descend, the pressure and density vary proportionally. In reverse, if the balloon were blown up with one cubic foot of air at thirty three feet and brought to the surface, the volume would double. Thus, if a diver were to breathe a deep breath under two atmospheres of pressure and hold it until he returned to the surface, the air in the lungs would double in volume. Considering the delicacy of the tiny air sacs of the lungs, one can see serious injury would result. This fact establishes one of the most important rules of diving, NEVER HOLD THE BREATH DURING ASCENT.[18] When ascending with scuba gear, always breathe normally, so the proper pressure within the lungs will be maintained. If an emergency should occur and the diver be forced to surface without air, always exhale as the ascent is being made.

Duration of Air Supply.-- Boyle's Law also tells how long the air in the tank will last at a given depth. Normal breathing is estimated at three fourths to one cubic foot of air per minute. On the surface an average tank of 71.2 cubic feet would last approximately seventy one minutes. Air is

consumed twice as fast at thirty three feet as it is on the surface. One can then calculate that the above tank would only last about thirty five minutes at thirty three feet. The cylinder would last approximately twenty four minutes at sixty six feet, and only eighteen minutes at ninty nine feet.

Dalton's Law.-- Dalton's Law states that in a mixture, each gas exerts a partial pressure equal to the percentage of total gas it represents. This simply means that as air contains 21% oxygen, the oxygen exerts 21% of the total pressure exerted by air. It can be quite easily calculated simply by multiplying 21 times 14.7 psi (air pressure at sea level). The result is that oxygen exerts 3.087 psi at sea level.

In conjunction with Henry's Law, as explained below, this law becomes quite important to divers.

Henry's Law.-- Henry's Law states that the amount of gas which will disolve in a liquid is directly proportional to the partial pressure of that gas.

This means that if the pressure on a gas doubled, a liquid will absorb twice as much of that gas. For a diver, this means that as he descends and the pressure increases so does the amount of gas absorbed by the blood according to its individual partial pressure.

These laws explain the causes of decompression sickness, oxygen poisoning, carbon dioxide poisoning and nitrogen narcosis. These diving diseases are discussed later in this chapter.

Physiological Aspects of Diving

Squeeze.-- The action of pressure upon the air spaces within our bodies are affected just as the balloon discussed earlier in this chapter was affected. The remainder of the body is composed of solids and liquids and are relatively unaffected by pressure.

The area most often affected by pressure is the inner ear. Pressure causes a sharp pain deep in the ear. Water pressure being greater on the outer ear than on the inner ear causes the drum to be pushed inward resulting in intense pain. When air is forced into the inner ear through the eustachian tube until the pressure becomes equal to outside pressure, the drum returns to its normal position and the pain ceases. The proper method of equalizing the pressure was described in chapter three.

Diving should be curtailed when a cold or infection causes swelling of the eustachian tube. When this occurs the air within the inner ear can't be equalized *and many* times even when air is forced in, germs from the infection bring on an infection of the inner ear.

The sinuses (air spaces in the bony structure of the head) are also affected by pressure. A cold or hay fever may clog the tiny tubes which lead to the sinuses. When diving, if the sinuses are not equalized a pain similar to ear squeeze will be felt. Diving must not be attempted until the condition is relieved.

The same method used in relieving ear squeeze works for relieving sinus squeeze.

Vertigo.-- With our sense of balance located in our inner ear, when one is affected by vertigo (ruptured ear drum) this balance is disturbed and dizziness sets in. As the ear drum ruptures and cold water rushes into the ear, the organs responsible for balance are greatly disrupted. This imbalance lasts until the water is warmed by body heat. Then the dizziness fades and balance returns.

The main danger from this is panic, which may cause the diver to make a wrong decision and result in further injury. To help ward off the dizziness one should grab a solid object or simply wrap the arms around the body

for stability.

Air Embolism.-- Air embolism is one of the most common diving diseases. As on ascends toward the surface after breathing underwater pressure, the air in the lungs expands. This expanding air may burst the tiny alveoli in the lungs and allow bubbles to enter the blood stream. Any bubbles too large to travel through the tiny arteries will form an obstruction, the circulation of blood will be blocked, and the tissue that depends upon blood for life will die. If the artery happens to lead to the brain, death or severe brain damage may result. The victim must be immediately recompressed to reduce the size of the bubble thus allowing the blood to pass. A decompression chamber must be readily accessible.

Embolism may occur in water no deeper than eight to ten feet. A very simple rule discussed earlier in this report eliminates any embolism problems. EXHALE WHILE ASCENDING TO THE SURFACE. This is undoubtedly one of the most important rules for a diver to learn and practice.

Another form of over-expanded air is termed emphysema. The air has entered the center of the chest and may or may not have entered the blood. Decompression is again the proper treatment required.

Pneumothorax describes a condition where the air has entered the area between the lungs and chest wall. Unless embolism is present, no decompression will be necessary.

Decompression Sickness ("The Bends").-- Decompression sickness is primarily a deep diving illness and is not a problem in shallow diving. A diver who goes no deeper than thirty three feet need not worry about decompression sickness.

As described earlier in this chapter, Dalton's Law states that the amount of gas that will be absorbed by a liquid is directly proportional to

its partial pressure. When a diver is at sixty six feet, nitrogen is being absorbed by the body at three times its normal rate according to Dalton's Law. The other important fact is that it normally takes a great deal of time for the gas to be released. If the diver ascends too rapidly and does not allow time for the nitrogen to pass back out of solution, it comes out in the form of bubbles. The bubbles block blood vessels and serious injury may result.

Immediate decompression must be obtained for decompression sickness cases. This decompression may take several hours, thus returning to a sufficient depth to compress the bubbles is virtually impossible.

Oxygen Poisoning.-- Pure oxygen can become quite dangerous and can cause convulsions and unconsciousness. Keeping Dalton's partial pressure in mind, one can calculate that at depths of around one hundred feet the partial pressure of oxygen is about equal to the partial pressure of pure oxygen. One can then conclude that the same conditions of convulsions and unconsciousness would occur.

Carbon Dioxide Poisoning.-- At surface pressure, 10% carbon dioxide in the inhaled air will bring about unconsciousness.[19] If carbon dioxide were present in the tank at a 2% level and the diver descended to one hundred thirty two feet or five atmospheres, the carbon dioxide would be absorbed at the dangerous 10% level. Although 2% in the tank is quite high, compressors sucking in their own fumes may allow this dangerous level to be reached.

Nitrogen Narcosis.-- Another diving hazard caused by an excess of nitrogen disolved in the blood stream is termed nitrogen narcosis. It is a kind of narcotic effect quite similar to drunkenness. It normally seizes the diver at depths below one hundred feet. The exact mechanism by which nitrogen produces this narcotic effect is yet unknown. The only danger of

narcosis is simply making a wrong choice in the intoxicated state and causing a permanent crippling injury or even death.

Shallow Water Blackout (Hyperventilation).-- Skin divers often take a series of deep forced inhalations thus reducing the carbon dioxide content. This allows them to hold their breath longer. This is called hyperventilation.

During the dive, due to the partial pressure more oxygen is absorbed by the blood and the diver feels quite comfortable. When the diver begins his ascent the pressure is decreased and lung capacity increases pulling some of the oxygen back into the alveoli. Near the surface, the amount of oxygen remaining in circulation can become so low as to cause the diver to "blackout" or become unconscious.

CHAPTER VI

RECOMMENDATIONS

Considering the rising interest in scuba diving, educators and Recreation Administrators must take a long hard look at this interest and assume action. Schools, recreation departments, Y.M.C.A, Y.W.C.A., and related organizations must expand their acquatics programs to include basic and advanced scuba classes. As has been stated in the report, the physical facilities are not prohibitive in most instances to conducting a scuba program. A pool and certified instructor is all that is needed to initiate the program. More sophisticated equipment may be added as interest is cultivated and the program expands.

Diving clubs should be formed by schools and committies which provide both recreational benefits and community services. Many clubs perform such valuable services as ecology dives to clean up acquatic recreational areas and provide an emergency underwater search and rescue squad.

By pooling resources and receiving group rates, diving club trips can provide an opportunity to explore the beautiful world beneath the surface of the water.

APPENDIX A

Annotated Bibliography

Books

Lee, Owen. The Complete Illustrated Guide to Snorkel and Deep Diving. New York: Doubleday and Company, 1963.

Owen Lee is a veteran member of Jacques-Yves Cousteau's famous oceanography team and has spent many years in underwater research. His book is very complete and written in layman terms so all can read and understand. The book is quite lengthy containing some 463 pages, many of which contain the author's own personal experiences and opinions. Mr. Lee's chapters on diving physics and physiology, underwater communications and "hookah" diving are particularly outstanding. This book would be an excellent supplemental reference source for the diving student.

Frey, Hank and Shaney. 130 Feet Down. New York: Harcourt, Brack and World Inc., 1961.

Hank and Shaney Frey are well known in the diving world. He currently is doing research in hydrodynamics and physics at New York University. Mrs. Frey is a free-lance artist and well known for her underwater photography. Another complete underwater text which is particularly outstanding for its photographs and for its drawings. These photographs and drawings are used to emphasize written points. The chapters on professional opportunities, search and recovery, and underwater art draw particular attention. Excellent supplemental reference book.

Barada, Bill. Let's Go Diving. Santa Ana, California: U.S. Diver's Co., 1962.

Bill Barada is an experienced diver well known for his research into today's ecological problems which are related to the underwater world. He is currently employed by "Skin Diver Magazine" as their environmental editor.

"Let's Go Diving" is a condensed diving instructional manual with over 75 illustrated drawings. The thirteen chapters deal with such things as basic equipment, snorkel diving techniques, physics of diving, medical aspects, and an excellent explanation of diving techniques. The book is recognized as one of the outstanding instructional manuals and is used by many instructors as their basic class test.

Hampton, T. A. The Master Diver and Underwater Sportsman. New York: Arco Publishing Co., 1970.

Captain Hampton is chief instructor at the British Underwater Center and is an acknowledged expert on diving in all forms. The book covers three basic areas: compressed air apparatus, oxygen rebreathing apparatus and standard diving gear. The majority of the book deals with "Hard Hat" (standard diving gear) techniques used by the professional working diver. Chapters are also included on underwater cutting, welding and blasting. The book would be excellent for those interested in professional construction and salvage work.

Borgeson, Lil. Skin and Scuba Diving. New York: Arco Publishing Co., 1965.

Mrs. Borgeson is a very well known woman scuba diver. She is best known for her treasure hunting articles.

Rather than opening with chapters on learning scuba, the book assumes one is already a certified diver. No instructional technique of elementary scuba is included.

The chapters deal with such topics as diving boats, cave diving, underwater hunting, killer fishes, and photography. Other information which is not usually found in books of this type is diving legislation, a manufacturer's directory and the authors own opinion of the ten best diving areas and their locations. The book would be of special interest to the more advanced diver.

Parker, Gene. Complete Handbook of Skin Diving. New York: Avon Books, 1965.

Gene Parker is an international authority and lecturer on self-contained diving with over 2,000 hours underwater. The book is written in paperback form and is divided into two parts. The first part deals with snorkel-diving and elementary scuba. A chapter on the underwater environment which includes water temperature, tides, currents, reefs, shoals, and many other physical features is of particular interest. Part two is a very complete survey of advanced diving activities. A chapter entitled "Make it Yourself" is good for the diver who is on a strict budget and wants to make some equipment himself.

The book is an excellent reference source, especially for unique underwater activities.

Ivanovic, Vane. Modern Spearfishing. New York: A.S. Barnes and Company, 1955.

A native of Yugoslavia, Mr. Ivanovic is a recognized oceanographer and diver. He has done much research work in Spain, France, Bermuda, and the Bahamas.

His book is very comprehensive covering nearly all aspects of spearfishing. Spearfishing locations, equipment and training, and the proper technique used in spearfishing compose the majority of the book. The dangers and moral ethics connected with the sport are covered, with the last chapter spent in discussing habits and locations of the most popular game fish. An excellent reference book.

Periodicals

Johnson, N. S. and Morgan, Bev. Underwater Recreation. Los Angeles: Arco Publishing Co., 1968.

Mr. Johnson and Mr. Morgan are both experienced divers and are members of the County of Los Angeles Parks and Recreation Commission.

The book is designed as an instructional manual for the beginning diver. All facets of elementary scuba are covered in the manual. Throughout the book humorous drawings are used to emphasize the point. The diagrams used in describing physical oceanography are very well done and are especially valuable in describing rip currents.

An instructor may choose to use this manual as his class text.

Professional Association of Diving Instructors, The Undersea Journal. Morton Grove, Illinois.

Published quarterly by P.A.D.I., this journal covers a wide variety of diving topics. Each article is written by a certified member of P.A.D.I. The articles are usually short, concise and to the point.

This journal should be a must for instructors, so they may keep up with the ever changing diving scene. It serves as an excellent reference source for student divers.

Tzimoulis, Paul J., Skin Diver Magazine. Los Angeles: Peterson Publishing Company.

This magazine published monthly has been recognized as one of the most outstanding magazines covering diving action around the world. The wide variety of articles cover all aspects of diving and beautiful full color photographs capture fantastic underwater scenes. The magazine articles are divided into seven categories including: adventure features, travel, photography, conservation, marine life, diving medicine, and techniques illustrated. Each issue also regularly covers new products, a feature on a "fish of the month," technifacts, and dive tour news.

The magazine is very informative and is entertaining for the diver and non-diver as well.

APPENDIX B

P.A.D.I. Certification Levels

Below is a condensed list of approved P.A.D.I. certification levels and their respective requirements. A detailed explanation of these classifications and requirements can be received by writing to: P.A.D.I., Box 13, Morton Grove, Illinois 60053.

JUNIOR DIVER

The category of Junior Diver pertains to all boys and girls who have not reached their sixteenth birthday. Certainly these boys and girls should have completed a course in scuba diving equivalent to that of the Certified Diver. The theory portion of the Certified Diver should be presented to the Junior Diver in language that they will be able to understand. Minimum requirements are the same for Junior Diver and Certified Diver.

CERTIFIED DIVER

The category of Certified Diver pertains to all males and females who have reached their sixteenth birthday. To achieve this certification they must complete the minimum requirements established by P.A.D.I. and be instructed by a P.A.D.I. Professional instructor.

ENROLLMENT: To enroll in a Junior or Certified Diver class the prospective student should be one who is interested in diving and be willing to work to achieve the requirements of the class. It is recommended that all students enroll in P.A.D.I. classes should be urged to undergo a medical examination.

WATERMANSHIP: The student must be relaxed in the water and must learn his degree of proficiency as well as the dangers and methods of safe diving.

A. Swimming Skills
   1. Floating and survival floating (5 minutes)
   2. Treading water (10 minutes)
   3. Crawl kick, dolphin kick, scissors kick, kicking on back, with fins. 150 yards minimum.
   4. Surface dives
   5. Underwater swim (60 feet)

B. Equipment Skills
   1. Clearing mask without purge
   2. Use of snorkel
   3. Buddy breathing
   4. Ditching and donning equipment
   5. Treading water with scuba (10 minutes)

6. Confidence test (ditch and donning equipment under pressure situations)
7. Watermanship test
8. ONE OPEN WATER DIVE NECESSARY FOR CERTIFICATION

NECESSARY KNOWLEDGE FOR SAFE DIVING: All students must be exposed to the bodies of knowledge inherent to safe diving.

A. Equipment
   1. Function of fins, mask, snorkel, weightbelt, and wet suit
   2. Function of tanks, valves, regulators (2 types)
   3. Divers flag, flotation devices

B. Physics and Physiology
   1. Air
   2. Function of: Boyle's Law, Dalton's Law, Henry's Law, Charles' Law, Acoustics and light under water
   3. Effects of water pressure
   4. Circulatory and respiratory systems
   5. Squeeze (sinus, ear and eye)
   6. Air Embolism
   7. Carbon monoxide, carbon dioxide, shallow water blackout, vertigo, nitrogen narcosis, decompression sickness, recompression chambers and decompression tables
   8. Heat exhaustion, sunstroke, cramps, and drowning
   9. First aid as it applies to the diver

C. Oceanography
   1. Currents, fresh water and salt water
   2. Equipment

D. Marine Life
   1. Fresh water marine life and hazards
   2. Salt water marine and hazards

E. A Diver's Log
   1. To be maintained by all students who are enrolling Advanced diving categories

F. Final Examination
   1. Multiple choice, true-false, and essay types acceptable

ADVANCED DIVER

All divers who have completed a basic course in skin and scuba diving are eligible for the Advanced Diver program. The Advanced program has been established to help the diver develop skill and enjoyment of the underwater world.

WATERMANSHIP: The student must be able to pass the basic scuba water test. As a requisite to enrollment the student must have completed five open water dives which must be logged dives. An open water dive in open water,

lake, river, quarry or ocean, using a complete tank of air on each dive. Regardless of the number of tanks of air used in the specific location on a given day it counts as one dive.

A. Swimming Skills
   1. Crawl kick, dolphin kick (two kinds), kicking on back, and scissor kick
   2. Hyperventilation in skin diving
   3. Floating (survival, inflating trousers, shirt or jacket to remain afloat)
   4. Underwater games

B. Lifesaving Skills
   1. American Red Cross Skill recommended

C. Search and Recovery

D. Complete five open water dives from four categories which must include a night dive
   1. Wreck dive
   2. Underwater navigation dive
   3. Collecting dive for fresh water or salt water aquariums
   4. A search and recovery dive (search pattern or lifting object from the bottom)
   5. Ice dive
   6. Underwater work dive
   7. Night dive (must be included as one of five dives)
   8. Underwater sleds, etc.
   9. Spear fishing dive (to include skin and scuba)
   10. Underwater photography dive
   11. Skin dive

E. A practical test to be administered in final session of course

NECESSARY KNOWLEDGE FOR SAFE DIVING: Students must be exposed to the knowledge in the watermanship skills.

A. Function of watermanship skills
   1. Lifesaving skills
   2. Search and recovery
   3. Underwater work
   4. Spearguns and their use
   5. The how of underwater photography

B. Advanced Physics and Physiology

C. Marine First Aid

D. Final Examination: multiple choice, true-false, and essay types acceptable

DIVEMASTER

All divers who have achieved the Certified Diver and Advanced Diver

categories are eligible for the Divemaster certificate. This certificate is a pre-requisite for enrollment as an Assistant Instructor.

WATERMANSHIP: By virtue of having completed the Certified Diver and Advanced Diver categories it is expected that all students be accomplished in the swimming skills, skin diving skills and scuba diving skills. As a requesite to enrollment the student must have completed twenty five dives which must be logged dives.

A. Pre-test
   1. Swimming skills (440 yard swim with combination of crawl kick, dolphin kick, backstroke kick, and scissors kick)
   2. Floating and treading water (15 minutes)
   3. Skin Diving skills
   4. Scuba Diving skills

B. Lifesaving water skills
   1. American Red Cross skills recommended

C. Open water dives
   1. Organize and carry out an open water dive with a buddy under direction of the Instructor. (underwater navigation)
   2. Organize and carry out an open water dive for a group of four divers under the direction of the Instructor
   3. Organize and carry out a night dive under the direction of the Instructor
   4. Organize and carry out a search and recovery dive under the direction of the Instructor
   5. Organize and carry out a skin diving trip for ten divers under the direction of the Instructor

D. Final Evaluation by Instructor on Divemaster's ability to accept responsibility for the five open water dives. It is suggested that the Instructor retain a copy of evaluation of Divemaster's ability to accept responsibility of open water dives

NECESSARY KNOWLEDGE FOR ACHIEVEMENT OF DIVEMASTER CATEGORY: Divemaster students must be willing to accept the responsibilities of leading divers in open water and must know and understand the knowledge necessary for safe diving and for emergency type situations.

A. Pre-test on physics and physiology. It is recommended that Instructors reteach or hit this area hard if students are weak

B. Divemaster Responsibilities on Open Water Diving
   1. Pre-trip planning
   2. Staging area
   3. Diving site
   4. Diving plan
   5. Diving system
   6. Repetitive dive tables
   7. Rescue equipment

C. Emergency evacuation
   1. Vehicles
   2. First aid equipment
   3. Contacting authorities
   4. Recompression chamber
   5. Airport

D. Divemaster Kit

E. First Aid
   1. Resuscitation
   2. Heat exhaustion, sun stroke, shock and sunburn
   3. Bleeding
   4. Broken neck and back in water
   5. Broken arms and legs, etc.
   6. Wounds of Marine animals
   7. Emergency equipment, stretchers, splints, etc.

F. Use of small craft

G. Psychology of Diving

ASSISTANT INSTRUCTOR

I. Assistant Instructor by virtue of the fact he holds a P.A.D.I. advanced diver and divemaster card should be expected to execute all skin and scuba diving skills exceptionally well.

II. He must have a working knowledge of the academic theory of skin and scuba diving.

III. He must have full command of teaching techniques, teaching methods, and evaluation techniques.

IV. Responsibilities of an assistant instructor.

INSTRUCTOR

I. Serve as an assistant instructor under certified instructor for 60 to 90 days.
   A. P.A.D.I. Instructor then determines the readiness of an assistant instructor to become instructor

II. P.A.D.I. Regional School.
   A. Content of P.A.D.I. Regional School

APPENDIX C

Listed below is a brief list of scuba equipment manufacturers and distributors. A complete list would encompass volumes and is not within the scope of this paper. Those listed are among the major sources in America.

Berry Distributors
4889 South Archer
Chicago, Illinois 60632

Central Skindivers
2608 Merrick Road
Bellmore, New York 11710

Dacor Corporation
161 Northfield Road
Northfield, Illinois 60093

Divequip
P.O. Box 339
Melborne, Florida 32901

Diver's Paradise
P.O. Box 243
Livingston, New Jersey 07039

French Underwater Industries
3763 Anna Street
San Diego, California 92110

Harvey's
11011 First Avenue South
Seattle, Washington 98168

Healthways
P.O. Box 45055
Los Angeles, California 90045

Henderson Aquatics, Inc.
Port, Elizabeth, New Jersey 08332

Imperial Manufacturing
4831 Arsenal Way
Bremerton, Washington 98310

International Marine Supply
P.O. Box 4157
Santa Barbara, California 93103

Mako Engineering
3131 N. E. 188th Street
Miami, Florida 33160

New England Divers Inc.
Tozer Road
Beverly, Massachusetts 01915

Oceanic Products, Inc.
631 Jackson Street
Hayward, California 94544

O'Neill Incorporated
1071 Forty-First Avenue
Santa Cruz, California 95060

Parkway Fabricators
29 Mileed Way
Avenel, New Jersey 07001

Rubatex Corporation
2655 South Commerce Way
Los Angeles, California 90022

Sea Research and Development, Inc.
P.O. Box 589
Bartow, Florida 33830

Seamless - Nemrod
253 Hallock Avenue
New Haven, Connecticut 06503

Swimaster
P.O. Box 958
Santa Ana, California 92702

Sportsways
2050 Laura Avenue
Huntington Park, California 90255

Sub - Aquatics
102 West Main
Newark, Ohio 43055

Subsea Products
P.O. Box 9532
San Diego, California 92109

Underwater Vision Inc.
Venice Eye Clinic
950 Cooper Street
Venice, Florida 33595

Underwater Ways, Inc.
211 Broadway
Lynbrook, New York 11563

U. S. Divers Company
3323 West Warner Avenue
Santa Ana, California 92702

FOOTNOTES

[1]Lee Owen, Illustrated Guide to Snorkel and Deep Diving (New York: Doubleday and Company, 1963), p. 188.

[2]Ibid., p. 166.

[3]Ibid., p. 13.

[4]Bill Barada, Let's Go Diving (Santa Ana, California: U. S. Diver's Company, 1970), p. 13.

[5]Hank Frey and Shaney Frey, One Hundred and Thirty Feet Down (New York: Harcourt, Brace, and World, Inc., 1961), p. 12.

[6]Barada, op. cit., p. 21.

[7]Ibid., p. 97.

[8]William Schroeder, University Guide for Diving Safety (Texas A & M University, 1970), p. 6.

[9]Gene Parker, Complete Handbook of Skin Diving (New York: Avon Books, 1965), p. 21.

[10]Ibid., p. 42.

[11]N. S. Johnson and Bev Morgan, Underwater Recreation (Los Angeles; Arco Publishing, 1968), p. 34.

[12]Parker, op. cit., p. 74.

[13]Schroeder, op. cit., p. 6.

[14]Barada, op. cit., pp. 50-51.

[15]Owen, op. cit., p. 96.

[16]Ibid., p. 33.

[17]Charles E. Dull, Modern Chemistry (New York: Henry Holt and Company, 1958), p. 120.

[18]Barada, op. cit., p. 37.

[19]Owen, op. cit., p. 118.

A CURRICULUM GUIDE AND CONDENSED DIVING MANUAL FOR SCUBA DIVING

by

LON FLOYD

B.S., Kansas State University, 1967

AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Physical Education

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1971

The purpose of this report was to offer a curriculum guide and condensed diving manual to be used by those who are interested in learning to scuba dive. This report may also be used by an instructor preparing to teach a class in scuba. This report was done by reviewing related literature and incorporating the authors' personal observations while becoming a certified diver. Procedures cited in this report were researched from several recognized authorities in the field of scuba diving.

The results of this report may be used in establishing and administering a basic scuba class. The basic areas included in the initial stages of the report are instructor qualifications, basic equipment, physical facilities, recommended medical examinations, and swimming requirements.

Proper procedures and techniques in the use of equipment is very important to the diver. One error in procedure could easily result in a fatal accident. A major section of this report is devoted to these procedures and techniques.

A series of graded teaching sequences are included in the report. Emphasis is placed upon practice procedures, drills and games used in learning the techniques necessary for safe use of the equipment. The teaching sequences range from elementary underwater skills through snorkel training and elementary scuba technique. Upon successful completion of these elementary phases, a discussion of the more advanced underwater drills is included in this section of the report.

A chapter also deals with the effect the underwater environment has upon the human body. Diving physics and physiology are important to the diver if he is to effectively cope with these underwater laws.

There is a considerable amount of interest in scuba diving among college age students at the present. However, to test the magnitude of this interest

a three statement questionnaire was constructed and presented to Kansas State University freshman physical education students. Sixty-six percent of the students answered - yes, that they would be interested in enrolling in a university sponsored scuba diving class. There was a higher percentage of men (75%) than women answering - yes, yet a surprising fifty-six percent of the women also answered positively.

On the basis of the information gathered within this report it may be said that educators must begin to recognize the considerable interest which exists in scuba diving and develop a more comprehensive aquatics program which might include a complete scuba course.