PROCEDURES MANUAL

for

COMPRESSED AIR DIVING (SCUBA MODE)

by

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PREFACE

The writing of this manual was initiated by Director of Planning O. K. Mabry at the request of State Bridge Engineer F. G. Sutherland, and Richmond District Engineer L. E. Brett.

The preparation of the manual was facilitated through efforts of Richmond District personnel. A special note of appreciation is extended to District Bridge Engineer J. A. Tavenner for coordinating the schedules of the divers so that they could participate in the preparatory work.

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W. G. Lunsford is thanked for the effort he put forth in studying the material and performing the activities necessary to qualify him as a surface tender.

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INTRODUCTION

The Virginia Department of Highways and Transportation conducts underwater inspection, maintenance, and salvage activities as part of its routine operations. These activities are carried out by divers from the private sector working on a contract basis and Department employees trained in the use of SCUBA.

Throughout this manual, the Department's attitudes and expectations concerning the use of SCUBA by Department personnel are expressed. Emphasis is placed on the Department's concern for the employees' safety and its intention to avoid exposing them to dangerous or hazardous conditions.

The manual is intended for use by Department personnel at all levels who are responsible for diving operations. It is intended as a reference for divers familiar with the general aspects of an operation but in need of more specific information; as review material for divers who have been inactive for an extended period of time; and as a training reference for divers new to the Department's operations. In addition, it is intended to serve the supervisors responsible for overall construction and maintenance operations by providing general information about the use of SCUBA, a function which may from time to time fall under their responsibility.

The manual is not intended to be a comprehensive work on the use of SCUBA; it is meant to summarize and reference information available from a variety of sources. It contains references to such works as the U. S. Navy Diving Manual and the NOAA Diving Manual. The manuals to which references are made are to be available to district personnel responsible for diving operations.

1.0 SCOPE

The diving operations of the Virginia Department of Highways and Transportation will be conducted by Department employees and contractors and consultants from the private sector.

Department personnel will not operate beyond the no-decompression limits; they will be restricted to working in water no deeper than 100 fsw and using compressed air, using open-circuit SCUBA mode.

The basic requirements and qualifications for personnel and equipment and the instructions in diving procedures are as set forth in this manual.

No person voicing objection to working under hyperbaric conditions will be induced to dive; no one suffering a temporary physical impairment will be permitted exposure to hyperbaric conditions; and no one will be permitted to work under conditions that are likely to result in his adversely affecting the safety and health of another dive team member.

2.0 THE DIVE TEAM

Each dive team will consist of at least three members; namely, a designated person-in-charge (a surface tender and a project supervisor can be used in lieu of a qualified designated person-in-charge) and two qualified divers.

2.1 Designated Person-in-Charge

2.1.1 Duties

The designated person-in-charge (DPC) is assigned the overall responsibility for the diving operation. He is responsible for coordinating surface activities with all other related site activities.

2.1.2 Qualifications

The DPC does not have to be a certified diver. However, he must have at least the following qualifications:

1. The DPC must be certified in cardiopulmonary resuscitation (CPR) and first aid (American Red Cross Standard Course or an equivalent).

2. He must be trained in diving-related physics, physiology, the use of the dive table, and dive planning.

3. He must have experience or training in the use of the tools, equipment, systems, techniques, operations, and emergency procedures pertaining to the assigned tasks and diving modes of the dive team.

2.2 Divers

2.2.1 Duties

In general, the divers should dive as a two-man team and maintain visual contact with each other. However, in many situations, such as in dark water, it is preferable to have one line-tended diver in the water with the second diver on the surface acting as a "standby diver". In the latter case, a separate dive team member shall tend each diver in the water.

2.2.2 Qualifications

Each diver must possess the following qualifications:

1. A diver must have a standard certification from a basic SCUBA course conducted by a nationally recognized diving association such as the National Association of Underwater Instructors (NAUI), and the YMCA.

2. He must have completed any advanced underwater training required by the Department for his assigned task.

3. He must be trained in the use of the tools, equipment, and systems related to his assigned task.

4. He must be trained in the application of diving operations and emergency procedures.

5. He must be trained in cardiopulmonary resuscitation (CPR) and the American Red Cross Standard First Aid Course or an equivalent.

6. He must have passed the medical examination as outlined under section 3 of this manual.

7. He must maintain proper physical and mental fitness to assure his capability to perform strenuous activity.

2.3 The Surface Tender

2.3.1 Duties

The responsibilities of the surface tneder should be distinguished from those of the DPC. Where the DPC is responsible for coordinating the diving activities with all other related activities on the surface, the surface tender is responsible for only the activities of the diving operation. This distinction is made because the person selected as a surface tender will not typically be qualified to make judgements and decisions relating to the overall operation. In those situations where management thinks he is properly qualified, the surface tender may act as the DPC.

2.3.2 Qualifications

As is the case with the DPC, the surface tender does not have to be a certified diver. However, he must be trained in those aspects of diving which will enable him to efficiently carry out his duties. These qualifications include:

1. The surface tender must be certified in cardiopulmonary resuscitation (CPR) and the American Red Cross Standard First Aid Course or an equivalent.

2. He must be trained in diving-related physics and physiology.

3. He must have experience or training in the use of the tools, equipment, systems, techniques, operations, and emergency procedures pertaining to the assigned tasks and diving modes of the diving team.

3.0 MEDICAL REQUIREMENTS

Diving is categorized as a high-stress occupation. The environment within which the work is performed, combined with the interdependency of the team members, demands that each member be in mental and physical condition to carry out his assigned tasks in a safe manner. Consequently, it is required that members of the dive team who will be exposed to hyperbaric conditions undergo a medical examination.

3.1 Specific Requirements

The medical examination must be performed by a licensed physician familiar with the physiological effects of hyperbaric conditions. This examination shall have been performed at least 12 months prior to the employee's exposure to diving and updated at 1-year intervals from the initial or last equivalent examination and after an injury or illness requiring hospitalization of more than 24 hours.

The examining physician should be given information delineating unique problems encountered by a person subjected to an underwater environment; e.g., an inability to equalize middle ear pressure with that of ambient pressure. The U. S. Navy standards outlined in the U. S. Navy Dive Manual and a copy of the medical requirements in OSHA's rules and regulations for commercial diving operations would serve as examples for this information. The physician should also be given information describing the nature and extent of hyperbaric conditions to which the employee will be exposed, including diving modes and types of work he will be assigned.

The medical examination described herein should include but not be limited to

1. A medical history,
2. diving-related work history,
3. basic physical examination,
4. tests listed in Table 1, and
5. any additional tests the physician considers necessary.

Table 1

Tests for Diving Medical Examination

Test	Initial Examination	Annual Examination
Chest X-ray	X	
Visual Acuity	X	X
Color Blindness	X	
Hearing Test	X	X
Hematocrit or Hemoglobin	X	X
Sickle Cell Index	X	
White Blood Count	X	X
Urinalysis	X	X

Source: OSHA's, Commercial Diving Operations: Occupational Safety and Health Requirements, §1910.411.

3.2 Physician's Written Report

The physician shall furnish the employer a written report of the results of the medican examination. This report shall contain an opinion by the physician as to the employee's fitness to be exposed to hyperbaric conditions and any recommended restrictions or limitations to such exposure.

This written report will be a prerequisite for determining the initial fitness of an employee to be engaged in diving activities and should become part of the employees permanent file.

4.0 OPERATING REQUIREMENTS AND PROCEDURES

4.1 General Requirements

The following requirements should govern all diving using the compressed air, open-circuit SCUBA mode.

1. SCUBA diving shall not be conducted

   (a) At depths deeper than 130 fsw;

   (b) at depths deeper than 100 fsw or outside the no-decompression limits, unless a decompression chamber is ready for use;

   (c) against currents exceeding 1 knot, unless line-tended; or

   (d) in enclosed or physically confining spaces, as under culverts, piers, etc., unless line-tended.

4.2 General Procedures

The following procedures should be followed for all compressed air, open-circuit SCUBA mode operations:

1. Divers will dive in buddy teams within visual contact of each other or a standby diver shall be available for each diver in the water.

2. When a diver is in the water alone, out of view of his "buddy", or in a current in excess of 1 knot, he shall be line-tended.

3. A diver shall be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.

4. For each diver, a diver-carried reserve breathing gas supply shall be provided. The supply shall consist of

   (a) a manual reserve (J valve), or

   (b) an independent reserve cylinder with a separate regulator connected to the underwater breathing apparatus.

5. The valve of the reserve breathing gas supply shall be in the closed position prior to the dive.

4.3 Emergency Procedures

In the event of an injury or illness involving a dive team member, or other support personnel, at the dive site, the following procedures should be followed.

1. Remove the diver from the water.

2. Determine the type and extent of injury.

3. If injury is obviously minor, administer first aid and have employee obtain treatment at physician's office or hospital.

4. If injury is serious or in doubt:

   (a) administer on-the-site first aid (see 8.1 for CPR instructions); and

   (b) initiate accident management plan (see 8.2.5).

The emergency procedures include:

- First aid kit preparation, maintenance, and use (see 8.3)

- Emergency telephone number

  1. Operational decompression chamber (Section 9.1)

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2. Accessible hospitals

3. Available physicians

4. Nearest rescue squad and sheriff's department (Sections 9.2 and 9.3).

- Equipment check list (Section 12.0)
- Employee briefing pre-dive
- Employee briefing post-dive (Section 10.3)
- Establish emergency procedures
- Personnel assignments in the event of an emergency
- List of possible diving related injuries (Section 10.2)

4.4 Pre-Dive Procedures

The pre-dive procedures should consist of three parts. The first is a survey report; the second is the development of safety procedures; and the third is the development and presentation of a task briefing.

4.4.1 Survey Report

An inspection of the dive site must be conducted prior to diving operations. This report is to be filed with the DPC. The survey report will be the basis upon which the pre-dive procedures will be formulated. Included in the report will be an account of potentially hazardous activities in the area, surface environmental conditions, and underwater environmental conditions.

4.4.1.1 Potentially Hazardous Activities

Activities which could become a hazard to the divers should be noted and action that is required to minimize or eliminate these hazards should be specified. Examples of hazardous activities, the possible resulting hazard, and the mitigating measures to be taken are shown in Table 2.

Table 2

Potentially Hazardous Activities

Activity	Hazard	Mitigating Action
Construction/ maintenance	Falling objects, interference with safe entrance/exit and emergency procedures, obstruction of radio communications	Reschedule diving activity, coordinate activities, temporarily curtail maintenance/ construction activities.
Movable span (drawbridge activities)	Ship/boat traffic, movable underwater obstructions	Coordinate activities, reschedule activities.
Dam reservoir control	Increase in water flow/depth, decrease in visibility	Coordinate activities, schedule dive operations for most opportune time.
Inspection after floods	Entanglement and cuts due to debris	Conduct a search-and-clearing dive before beginning the main objective.

4.4.1.2 Surface Environmental Conditions

The types of conditions that should be noted in this section include weather conditions, general location of the dive site, air temperature (seasonal variations), altitude of the dive site, and surface visibility.

The surface conditions are important because they can affect the time of year that dives are best conducted, the type of protective clothing to be used, the way in which the dive tables will be used, and the means of communications needed between diver and shore or dive team and home base. (Note: Standard dive tables cannot be used in altitude diving.)

4.4.1.3 Underwater Environmental Conditions

Underwater conditions prevailing prior to a diving operation must be identified from past records and general knowledge of the area. The conditions that must be included are bottom conditions (mud, debris), current, temperature, visibility, seasonal variations, pollution levels, and depth.

The underwater conditions will determine the best time of year for diving, protective clothing, and safety procedures (safety lines, entries, etc.).

4.4.2 Safety Procedures (See NOAA Manual, p. 8)

Safety procedures are an essential part of every dive. They may vary according to the uniqueness of each dive site but generally should include:

- Curtailing or coordinating potentially hazardous activities in the vicinity of the dive site.
- Determining the use of buddy system, line-tending, etc.
- Setting up tether lines, drag lines, and their location.
- Setting up entry/exit location. It should be noted that a prerequisite of an entry location (boat, dock, beach, rocky shore, etc.) is that this location must also permit the retrieval of an unconscious diver under emergency conditions.
- Establishing communications (line signals, hand signals, radio, and emergency recall systems). See hand and line signals (refer to Section 11.0).
- Determining protective clothing.
- Determining proper equipment (see Section 12.0).
- Determining the fitness of the divers.
- Preparing proper records (dive profile, residual nitrogen and repetitive group designators, (refer to dive tables, Section 14.0).
- Establishing a dive plan and filing with home office. Notifying appropriate agencies in the area (e.g., sheriff, rescue squad, etc.). A map with the loaction of the dive site should be prepared when necessary.
- Conducting task briefing.

4.4.3 Task Briefing

In the task briefing, the exact objective of the dive should be spelled out, along with a description of equipment to be used, the amount of time required to complete the task, and alternate plans to be used if problems should arise. During the briefing, safety procedures should be reviewed. It is important that any questions concerning the task be discussed and resolved prior to the actual dive operation.

In sum, the task briefing should include:

- Explanation of task objective (survey, inspection, maintenance, preparatory, etc.).
- Statement of equipment to be used.
- A decision on depth and time limitations.
- Restatement of normal safety requirements (e.g., the dive is to be terminated when any diver diminishes his air supply to 500 psi or when any diver or the DPC terminates the dive).
- Explanation of a recall system.

4.5 Actual Diving Procedures

During the actual dive the procedures planned in the pre-dive procedures are implemented. These include:

1. Carrying out a single-dive or repetitive-dive schedule.
2. Establishing a method of entry. The means used must extend below the water surface, and allow assisting an injured diver from the water.
3. Performing the operation. A three-man dive team performs the operation, either two divers are in the water as buddies or one diver is in the water and is line-tended by a standby diver; a DPC controls the operation.
4. Generating a depth/time profile during the dive (see dive tables, Section 14.0).

5. Securing or grounding all tools used. Power tools are in the off position when being exchanged.

6. Providing a reserve air supply for each diver.

4.6 Post-Dive Procedures

Upon termination of each dive, the DPC will:

1. Check the physical condition of each diver (Section 10.3).

2. Instruct the diver to report any physical problems, including symptoms of decompression sickness.

3. Notify the diver of the location of nearest decompression chamber.

4. Alert divers to the potential hazards of flying after diving; i.e., there should be at least 12 hours surface time between the completion of last dive and flying.

All records will be completed at the end of each dive and filed upon return to the home office. The record should include:

- name of dive team members
- date, time, and location of dive operation
- dive mode used
- objective of work
- water conditions
- maximum depth
- bottom time
- accident form, if needed (see Section 7.3).

5.0 EQUIPMENT AND AIR REQUIREMENTS

The equipment described in this section should be viewed as minimal for the Department's diving operations. Following each piece of equipment listed, there is a description of the equipment and, where applicable, maintenance standards for it.

5.1 Air Compressor System

Any compressor used to supply air to the Department's divers will meet the following standards. In the event that air is obtained from outside the Department, records will be maintained indicating that these standards are being met.

1. The air compressor shall be equipped with a volume tank with a check valve on the inlet side, a pressure guage, a relief valve, and a drain valve.

2. Air compressor intakes shall be located away from areas containing exhaust or other contaminants.

3. Air quality will be checked every 6 months.

5.2 Compressed Air

The compressed air used by Department divers will be tested for air purity every 6 months in accordance with standard air sampling procedures. Only compressors meeting the air quality standards given below will be used to provide respirable air to the diver.

Respirable air supplied to a diver shall not contain:

1. a level of carbon monoxide (CO) greater than 20 ppm;

2. a level of carbon dioxide (CO_2) greater than 1,000 ppm;

3. a level of oil mist greater than 5 miligrams per cubic meter;

4. a noxious or pronounced odor; or

5. dangerous particulate matter.

5.3 Compressed Air Cylinders (SCUBA Tanks)

5.3.1 Description

Diving cylinders are made of either steel or aluminum alloys. They are specifically designed and tested to hold high pressure compressed air. Department divers will use either the 72 cu. ft., 2,250 psi, steel tank or the 80 cu. ft., 3,000 psi, aluminum tanks.

5.3.2 Maintenance

All tanks used by Department divers will be visually inspected every 12 months and hydrostatically inspected every 5 years. These inspection and testing dates will be recorded and kept in an appropriate file.

Only tanks having current visual inspection decals and current hydrostat markings will be authorized for use by Department divers.

General care of tanks would include:

1. Protecting the tank from movement and damage during transport.

2. Use of a self-draining tank boot.

3. Maintaining at least 300 psi of air in tank at all times.

4. Maintaining at least 500 psi of air in tank for prolonged periods of storage.

5. Replacing air in tanks after prolonged storage.

5.4 Tank Valves

5.4.1 Description

The tank valve serves as an on/off mechanism and is threaded into the neck of the tank. Two basic types of valves are used in scuba: the "k" valve and the "j" valve.

The "k" valve is the simplest type. It has an opening for air to pass and an on/off knob at the side or top.

The "j" valve is similar to the "k", but is equipped with a constant reserve mechanism that acts as a warning device by slowly shutting off the air when the tank pressure drops below a preset pressure, usually 300 psi. This valve is bypassed when the diver engages the reserve mechanism; he can then ascend safely to the surface.

5.4.2 Maintenance

Most tank valves are made of chrome plated brass and are susceptible to damage. By following the maintenance described for the

tanks to which they are attached, the valves can be kept in good repair. If a valve becomes difficult to turn or is leaking, it should be taken to an authorized repair facility.

5.5 Regulators

5.5.1 Description

The regulator reduces the high pressure air from the scuba tank to ambient pressure that the diver breathes. The pressure of the air the diver breathes must always be equal to the surrounding water pressure.

There are two basic types of regulators: the single-hose and double-hose. The regulators used by the Department are single-hose, two stage regulators that meet the Department's standards.

5.5.2 Maintenance

The cleaning and maintenance of a regulator are fairly simple.

1. The regulator should be rinsed in clear water after every use (when rinsing the first stage care must be taken to ensure that the dust cap is in place). The purge button should not be depressed when the second stage is being rinsed.

2. The regulator should be allowed to dry before storage.

3. It should be stored loosely without bends or kinks in the hose.

4. Sprays or lubricants should not be used on regulators.

5. All regulators should receive a yearly overhaul by an authorized dealer.

6. They should not be adjusted or repaired by unqualified personnel.

5.6 Submersible Pressure Gauges

5.6.1 Description

These gauges are known by several names (tank pressure gauge, sea-view gauge, etc.). Their function is to monitor the air pressure in the diver's tank. The gauge should be attached to the high pressure part of the regulator or to the tank valve, and should be considered a required piece of gear for any open-water dive.

5.6.2 Maintenance

The general maintenance of this gauge should include the following.

1. Protecting the gauge from shock, and the hose from strain.

2. Rinsing the gauge with the regulator after every use.

3. Inspecting the gauge before use, noting that the gauge reads 0 when air is turned off with system purged, and at the expected psi when tank is turned on with "j" in the down position.

5.7 Depth Gauges

5.7.1 Description

The depth gauge is a device for monitoring the depth of the diver and is essential for controlling the dive planning of each dive. Depth gauges are usually available in three basic types: capillary, bourdon-tube, and oil-filled.

5.7.2 Maintenance

Depth gauges should be treated as delicate instruments and protected from shock and corrosion.

Depth gauges should be deadweight tested or calibrated against a master reference gauge every 6 months, and when there is a discrepancy greater than 2% of full-scale between any two equivalent gauges.

5.8 Wet Suit

Protective clothing prevents loss of the diver's body heat and protects him against minor abrasions, stings, and bites. Two basic protective suits are used in SCUBA diving: the wet suit and the variable-volume dry suit. The wet suit is the required dress for Department divers.

5.8.1 Description

The wet suit is the most common protective clothing used in sport diving because it is inexpensive and easily repaired and maintained. Water is allowed to enter the suit and is warmed by heat given off by the diver's body. The material used to make the wet suit (usually closed-cell foamed neoprene) acts as an insulator and provides a warm water layer and material layer of thermal protection between the diver and the water in which he is diving.

Wet suits are available in several thicknesses from 1/8 to 1/2 inch. The selection of thickness depends on the temperature of the water and the mobility desired. Although the thicker material will keep a diver warmer for a longer period of time it will also restrict his movement.

The wet suit usually consists of jacket and pants; however, hood, boots and mittens or gloves are available and recommended for cold water.

5.8.2 Maintenance

Wet suits should be washed in fresh water after each use, dried, and hung on wide hangers. It should be noted that wet suits have good durability and are easy to repair; however, extended exposure to sunlight, contact with petroleum products, and folding of the material will cause rotting of the neoprene.

5.9 Buoyancy Compensator (BC)

The BC has two basic functions; it acts as a flotation device on the surface of the water and a device for controlling buoyance beneath the surface.

5.9.1 Description

Although many types of buoyance compensators are manufactured and tested, there is no universal agreement on the best design.

However, there is agreement on the basic specifications for a BC to be considered adequate.

1. The BC should have the capacity to float a diver in full gear, which is generally accepted as 25 pounds of positive buoyancy.

2. It should be designed so that the diver, even if unconscious, will float in a face-up position.

3. It should have at least two separate mechanisms for inflation, one automatic. The automatic inflator may be CO_2 or air from a separate air cylinder; however, a large oral inflator hose capable of being operated with either hand is mandatory.

4. It should be equipped with an overinflation or pressure relief valve.

5.9.2 Maintenance

Maintenance of a BC is required to prevent deterioration of the material, to prevent corrosion and seizing of metal parts and to ensure that the CO_2 cartridge or air cylinders are fully charged.

The inside of the BC should be filled with clear water, agitated, drained, and again inflated for storage. All movable parts should be inspected, and metal parts such as the CO_2 trigger mechanism and the inflator mechanisms should be lubricated with a silicone lubricant. The CO_2 cartridge should be visually inspected for punctures and weighted to ensure a full charge. If the cartridge weight is less than 3 grams the weight specified on the cartridge, it should be discarded and replaced with a fully charged one.

The vest should be visually inspected for leaks frequently, especially immediately prior to diving. An easy inspection method is to immerse a fully inflated vest in water and look for air bubbles. By gently squeezing the inflated vest, the pressure relief valve can be inspected for proper functioning.

5.10 Dive Light

The dive light is an important piece of equipment. It has the obvious value of increasing the divers vision at night or in enclosed spaces. However, since water readily absorbs light, an artificial source is required for the discernment of colors underwater, an extremely important factor in distinguishing rust from discoloration.

The dive light is of little use in salty or murky water, where it reflects much as in fog.

5.10.1 Description

Diving lights are waterproof, pressure-proof, and usually battery powered. They are available in many designs and should be selected to fit specific uses. Some aspects of the dive light that might influence selection are buoyancy (positive/negative), battery type (rechargeable, typical, etc.) candlepower, activating mechanism, size, and shape.

5.10.2 Maintenance

The dive light should be rinsed with fresh water after each use. The batteries should be removed and stored when not in use. Lights with rechargeable batteries should be recharged according to the manufacturer's specifications. The O-ring should be cleaned and lubricated after each use.

Before starting on a dive trip, the battery and bulb should be checked and spares acquired.

5.11 Knife

The dive knife is an important basic tool. It can be used to hammer, pry, probe, or cut. It is not a weapon.

5.11.1 Description

As is the case with many other types of diving equipment, there are many styles of diving knives. Basically, the knife should be constructed of a corrosion resistant material; stainless steel for the blade and a durable material that affords a good grip for the handle.

Positioning of the knife is important for the diver. Basically, it should be placed where it can be reached with both hands, where it will not easily be entangled with other equipment or debris, and where it will not become discarded in an emergency (such as on the weight belt). A convenient placement is on the inside calf of the diver. For ease of placement, the type of scabbard accompanying the knife is important.

5.11.2 Maintenance

The knife should be rinsed after each use and coated with a protective oil. The blade should be inspected and kept sharp. The straps and body of the scabbard should be inspected for cuts and deterioration.

5.12 Mask

The mask is one of the most essential pieces of equipment. Its function is to provide a pocket of air between the diver's eyes and the water, thus providing the diver clear vision. The mask must cover the diver's nose, a feature which will allow him to equalize the pressure in his middle ear, and the pressure in the mask, with that of the ambient pressure.

5.12.1 Description

The typical mask has four basic features: the faceplate, usually tempered safety glass; a rubber skirt flexible enough to hold the faceplate and also fit the diver's face to form a seal; a metal or plastic band to secure the faceplate to the skirt; and an adjustable headstrap.

Optional features include wraparound faceplate, purge valves, finger pockets to aid equalization, and prescription lens attached to or ground into the faceplate.

The main features to be considered when choosing the mask is a comfortable fit and compatibility between the means provided for equalization and clearing and the work to be performed.

5.12.2 Maintenance

The mask should be rinsed after each use, the faceplate should be kept clear, and the skirt and headstrap should be examined for cuts and deterioration.

5.13 Snorkel

The snorkel allows the diver to survey the water while floating on the surface, and to swim comfortably without using his air supply. It can also be used as a first aid device in mouth-to-snorkel resuscitation — a version of mouth-to-mouth resuscitation.

5.13.1 Description

There are many designs for the snorkel but it is basically a rubber or plastic tube, 5/8 to 3/4 inches in diameter, 15 inches or less in length and a mouthpiece.

5.13.2 Maintenance

Maintenance consists simply of rinsing and visual inspection to detect cracking or deterioration and to ensure the proper fit of components (e.g. breathing tube to mouthpiece).

5.14 Swim Fins

The swim fin, or flipper, is used in diving to provide power rather than speed. The fins provide the diver with a method of moving from one point to another without using his hands and arms. The type of fin depends upon the preference of the diver, the physical makeup of the diver, and the work for which the fin is intended. Usually, the large rigid fin is used by working divers.

5.14.1 Description

The fin has three features: the blade, the rib, and the foot pocket. The width of the rib will determine the rigidity of the blade or the fin. The fin can be fitted to the diver's foot by means of a full-foot pocket or a foot pocket combined with an adjustable strap. The latter is recommended when the fin is to be used with varying types of foot cover (e.g., socks or wet suit booties).

5.14.2 Maintenance

The fins should be rinsed in clear water after use and inspected frequently for cuts and deterioration. The straps on the adjustable fins are especially prone to tearing and should be replaced at the first indication of wear.

The best maintenance of the swim fin is proper use. The two most frequent causes of damage result from improper donning, which stretches and tears the footpockets or straps; and walking with the fins on, which breaks down the rib and tears the blade.

5.15 Weights and Weight Belt

The use of weights enables the diver to achieve a slightly negative buoyancy. The weight belt is needed to secure the weights to the diver. Although this seems to be too obvious to mention, the use of an independent belt discourages the diver from securing weights to other straps and belts such as those connected to the BC and tank. The latter practice is very dangerous because the weights cannot be readily disposed of in an emergency.

5.15.1 Description

The weights are available in many sizes to enable the diver to achieve the desired buoyancy as accurately as possible. They are made of lead to minimize volume. The weights should be constructed so that they can easily be attached and removed from the weight belt.

The weight belt should be constructed of a material that will resist deterioration in water (usually nylon). It should be wide enough to fit comfortably on the diver and adjustable enough to fit snugly. When properly adjusted, the belt should not have excessive material hanging which could entangle or be entangled by other equipment. One of the most important requirements of the weight belt is a quick release mechanism that allows the diver to discard his weights quickly and effortlessly.

5.15.2 Maintenance

The only maintenance needed for the weights is a system to prevent loss and ensure the availability of enough different denominations of weight that the diver will not have to overweight to get below the surface.

The weight belt should be inspected for wear and the quick release mechanism inspected to ensure proper operation.

5.16 Watch or Bottom-Timer

A watch capable of operating in an underwater environment or a conventional watch used in conjunction with a bottom timer is required equipment for the SCUBA diver. In order for the diver to safely work in a hyperbaric environment, he must be aware of his depth, bottom time, rate of ascent, and surface interval. The underwater watch is capable of accounting for bottom time and surface interval; however, the bottom timer is a type of underwater stopwatch activated by pressure and cannot keep surface time.

5.16.1 Description

The diver's watch should be waterproof and pressure proof and be equipped with an elapsed-time bezel. The face should be large and easy to read even in conditions where visibility is poor.

The bottom timer is waterproof and is activated at a depth of from 5 to 10 feet. A valuable feature of the bottom timer is that the bottom time recorded is stopped and is available to the diver until he chooses to reset the timer.

5.16.2 Maintenance

Watches and bottom timers should be rinsed with fresh water after diving. Both devices should be visually inspected before a dive and at intervals during the dive to ensure that they are operating.

6.0 REQUIRED EQUIPMENT

6.1 Individual Diver

All equipment used by Department divers shall meet the standards designated in this manual. All equipment will initially be inspected and authorized by the diving supervisor. The general maintenance of the equipment will be the responsibility of each diver. The required items are listed below.

1. Two scuba tanks with reserve breathing air supply and back pack
2. One regulator with submersible pressure gauge
3. Buoyancy compensator and CO_2 cartridges
4. Wet suit (hood, booties, gloves)
5. Weights
6. Weight belt
7. Knife
8. Dive light
9. Depth gauge
10. Watch, (bottom-timer)

11. Mask
12. Snorkle
13. Fins
14. Dive bag
15. U. S. Navy decompression tables
16. Department dive manual.

6.2 Dive Team

1. First aid kit
2. Backboard
3. 2-way radio
4. Dive log and records
5. Dive flag
6. Safe diving manual
7. Ladder
8. Ropes
9. Dive lights
10. Boat
11. Lift bags
12. Floats
13. Bouys

7.0 RECORD KEEPING

Records will be maintained on file and will be available upon request by any employee or former employee, or their authorized representatives, and to appropriate representatives of any state or federal agency.

Records shall be kept on file for the following periods of time:

1. Dive team members' medical records — 5 years

2. Safe practice manual — current document only

3. Depth-time profile — until completion of the recording of the dive, or until completion of decompression procedure assessment where there has been an incident of decompression sickness

4. Recording of dive — 1 year, except 5 years where there has been an incident of decompression sickness or other injury

5. Decompression procedure assessment evaluation — 5 years

6. Equipment inspections and testing records — until equipment is withdrawn from service

7. Records of hospitalizations — 5 years

7.1 Depth/Time Profile

Dive Master_____ Date_____
Location_____

Time/Depth	Diver 1	Diver 2	Diver 3
NAME			
Terminate Dive 1			
Commence Dive 1			
Elapsed Time			
Commence Surf. Int.			
Diver may submerge			
Depth (max)			
NAME			
Terminate Dive 2			
Commence Dive 2			
Elapsed Time			
Commence Surf. Int.			
Diver may submerge			
Depth (max)			
TOTAL ELAPSED BOTTOM TIME:			
END DIVE 1			
END DIVE 2			

7.2 Diver's Activity Report

District

Date

County/town

Route

DIVE MASTER DPC
Designated Person-in-Charge

DIVE TEAM PERSONNEL	Time in Water	Max. Depth	Water Temp.
1.			
2.			
3.			
4.			
5.			

Activity Code
Bridge Location
Dive Objective
Bottom Conditions
Water (pollution)
Visibility
Water Temperature
Type of Entry

REMARKS:

7.3 Accident Report

MAIL TO: NAUI HEADQUARTERS
POST OFFICE BOX 630
COLTON, CALIFORNIA 92324

DIVING ACCIDENT AND/OR INCIDENT REPORT

Date of Accident _____ (Time and Date) Date of Report _____ Name of person Making report _____

Address _____

Telephone No. (Area Code _____) _____ Are you a currently certified diver? ☐ Yes ☐ No Type of certification and Agency _____

Names and addresses of any other witnesses (use back of Form for additional entries):

Name _____ Name _____

Address _____ Address _____

City _____ City _____

State _____ Zip _____ State _____ Zip _____

Telephone No. (Area Code _____) _____ Telephone No. (Area Code _____) _____

CHECK AS MANY AS APPROPRIATE:

TYPE OF ACCIDENT: ☐ Near Miss ☐ Fatality ☐ Bodily Injury ☐ Non-injury
☐ Breath Hold Free Diving ☐ Scuba ☐ Other (explain)

Name of victim _____ Address _____

City _____ State _____ Zip _____ Phone (Area Code _____) _____

Sex _____ Age _____ Marital Status _____ Height _____ Weight _____ Certified Diver ☐ Yes ☐ No ☐ Unknown

If Yes, what agency _____

What Level _____ In Training _____ Other (specify) _____

If you know, how would you describe victim's diving experience and level? _____

_____

_____

LOCATION OF ACCIDENT: ☐ Ocean - Name _____ Location _____
☐ River - Name _____ ☐ Lake - Name _____
☐ Quarry - Name _____ ☐ Swimming Pool - Where _____

_____

Describe exact location; country, state, city, bay, river, nearest geographic location, etc. _____

_____

_____

GENERAL CONDITIONS:

Water conditions: ☐ Calm ☐ Rough ☐ Hazardous. Were water conditions contributory to accident? ☐ Yes ☐ No ☐ Unknown. Was victim: ☐ Diving from shore ☐ Diving from boat. Did accident occur: ☐ on surface ☐ below surface.

Approximate Depth _____. Was victim diving: ☐ alone ☐ with a buddy. Had buddy contact been broken? _____

Other _____

Was visibility a contributing factor: ☐ yes ☐ no. If yes, describe _____

_____

_____

CONT

GENERAL CONDITIONS (CONT.)

Was entanglement a contributing factor: ☐ yes ☐ no. If yes, describe _____

_____

Was there an apparent equipment problem: ☐ yes ☐ no. If yes, describe _____

_____

Diving activity at time of accident: ☐ Receiving instruction ☐ game taking ☐ exploring ☐ competition ☐ work. Describe:

_____

_____

Was victim wearing: ☐ wet suit ☐ mask ☐ fins ☐ vest - type of vest _____ ☐ boyancy compensator ☐ tank ☐ Mae West ☐ weight belt ☐ regulator other _____

Comment on any unusual circumstances regarding victim's equipment _____

_____

_____

Was vest inflated: ☐ yes ☐ no. If yes, by whom: ☐ victim ☐ rescurer. Comment: _____

_____

Had weight belt been dropped: ☐ yes ☐ no. If yes, by whom: ☐ victim ☐ rescurer. Comment: _____

_____

Was there any apparent panic by victim: ☐ yes ☐ no. Comment: _____

If incident was injury or near-miss, please describe briefly what happened and nature of injuries, if any _____

_____

_____

_____

If fatality, length of time from accident until recovery of victim's body _____

Victim was recovered: ☐ on surface ☐ below surface. If recovery was below surface, at what depth _____

If fatality, was resuscitation attempted: ☐ yes ☐ no. Was cardio pulmonary massage attempted: ☐ yes ☐ no. Comment:

_____

_____

If near miss, was resuscitation attempted _____

_____

_____

_____

Current location of equipment if accident was a fatality _____

_____

CLOSING REMARKS:

_____

_____

_____

_____

_____

8.0 GENERAL ACCIDENT MANAGEMENT

8.1 Cardiopulmonary Resuscitation (CPR)

8.2 Emergency Procedures — open water

8.3 Diver's First Aid Kit

8.1 Cardiopulmonary Resuscitation (CPR)
(Taken from NAUI's Professional Resource Organizer.)

If a victim has no heartbeat, no circulation of blood in the body, .nouth-to-mouth resuscitation alone is not enough. Some means of mechanically circulating the blood is needed in addition to lung ventilation. The most expedient method involves depressing the sternum, the bone in the front center of the chest, squeezing the heart against the spine. The pressure is then released causing a pumping action.

CPR Technique

1. The victim is lying face up on a firm surface.
2. The rescuer is kneeling close at one side near the chest of the victim.
3. Using one hand, lift under the neck and tilt the victim's head back to establish a clear airway.
4. Place your ear close to the victim's mouthto listen for sounds of breathing while watching for movement of the chest or diaphragm area.
5. If no signs of respiration, quickly seal the nose with the free hand while keeping the neck in the extended position.
6. Inflate the lungs four times in rapid succession. Often this is adequate to start respiration.
7. Check the carotid (neck) pulse of the victim. The dilation of eye pupils may also provide a secondary check for lack of circulation but should not be relied upon as an absolute indicator.
8. If no pulse, clear clothing and equipment and begin chest compression. Use only the heel of the hand on the sternum. Depress the sternum *1½ to 2 inches*, for an adult. In case of a single rescuer, use 15 compressions inter-spaced by two quick ventilations at a rate of 80 compressions per minute . For two rescuers, use five compressions, at a rate of 60 compressions per minute, inter-spaced by one breath. Do not interrupt the rhythm.
9. As color returns to the victim, re-check for pulse. If heart starts continue only resuscitation. If breathing starts, keep the victim lying down and turn the head to the side if vomiting starts (to avoid aspiration of vomitus into the lungs).
10. Resuscitation attempts should be continued until:
    - The victim revives;
    - Competent medical authority takes over;
    - The rescuer is no longer able to continue.

CAUTION

Exact performance of CPR is critical. Severe damage to the liver, lungs and ribs can result when pressure is improperly applied to the chest. Full and complete mannequin practice is important before application of the technique.

Only the heel of the hand should be used. Place the heel of one hand upon the other, interlace the fingers of the second hand over the first to avoid the bottom fingers from resting upon the ribs. No pressure should be applied to the Xiphoid process, a small projection at the bottom of the sternum.

To locate the hand position, clear extraneous clothing and run two fingers up toward the sternum from the stomach area. When the sternum is felt, place two fingers down to locate the beginning of the heel of the hand's position approximately one inch above the bottom of the sternum.

Pressure should be applied evenly in a straight up and down movement, not in a jerking fashion.

THE ORIENTATION TO CPR GIVEN HERE IS JUST THAT — AN ORIENTATION. WHILE THE TECHNIQUE IS INHERENTLY SIMPLE, EXACT PERFORMANCE IS CRITICAL. PRECISE APPLICATION OF THE TECHNIQUE CAN ONLY BE LEARNED BY A NUMBER OF HOURS OF PHYSICAL PRACTICE UNDER A QUALIFIED INSTRUCTOR. ALL DIVERS ARE ADVISED TO ATTEND A CPR CERTIFICATION COURSE.

Complete training in CPR technique provides more details on variations and thorough "hands on" practice with mannequins as compression should never be practiced on "live" people. Schedules of course offerings are available by calling the local Heart Association or Red Cross Chapter.

8.2 Emergency Procedures — Open Water

Detailed plans and the implementation of emergency procedures must fit the individual course situation; some general considerations are given here.

8.2.1 Equipment

1. Complete first aid kit
2. Diver's tool kit
3. Blankets
4. Resuscitator or inhalator
5. Rescue gear, such as floats with lines
6. Communications by radio or telephone
7. Whistles
8. Diving flag

8.2.2 Personnel

1. DPC in charge of total operation
2. Dive Team Leaders in charge of each group
3. All diving done in buddy pairs
4. One staff member in the water for every 2 to 10 students, depending on conditions
5. Separate life guard(s), with no other duties, provided for safety

8.2.3 Procedures

1. Plan all activities
2. Check all equipment
3. Brief all personnel
4. Have simple signals
5. Have positive check out/check in system

8.2.4 Information

1. Have all possible emergency telephone numbers available, such as USCG, Police, Fire, Chambers, Ambulance, Harbor Patrol, M.D., etc.
2. Copies of the most needed numbers should be given to each staff member, with a complete list in the first aid kit, and with the check out board.
3. Include change to operate pay-phone with each phone number list.
4. Know location and method of transportation to nearest chamber.
5. Inform local authorities of your activities.
6. Have name and phone number of doctor, insurance company and person to contact in case of emergency for each student and staff member.

8.2.5 In Case of Accident

1. Give required first aid only.
2. Proceed quickly and simply with as little fuss as possible.
3. Use appropriate equipment as needed.
4. Be alert and ready for situations which may develop.
5. Have and use the help of others while controlling both the people and the situation.
6. Have victim cared for while making needed phone calls for doctor, chambe or ambulance.
7. Give closed chest heart massage if needed; always treat for shock.
8. Be ready to handle wounds with major bleeding, heart attacks and fractures as well as drowning and air embolism.
9. Be calm, helpful and courteous.
10. Do not remain silent, but do not talk t reporters or make any statements concerning your liability.
11. Do not comment on the quality of your behavior or make any medical or value judgements.
12. Make a list of witnesses — names, addresses and phone numbers.
13. Get all the victim's diving equipment, wash and hold.
14. Take photos of gear and area, but not the victim.
15. Make notes of all the facts, not opinions, for insurance purposes. Depending upon the gravity of the situation record in complete detail all facts and actions. A fatality would require an extremely accurate and complete report.
16. Contact District Headquarters, the insurance agent, and your attorney.

8.3 Diver's First Aid Kit

A first aid kit should be present at all dives. The contents may be simple or complex as the distance from medical assistance increases. The following items are basic and may be supplemented according to personal needs and capabilities of the user and local conditions.

Sterile compress pads for severe bleeding

Roll of 2" gauze bandage

Assorted band-aids

Adhesive tape 1" wide

Assorted gauze pads (sterile)

Cotton swabs

Assorted safety pins/needles

Triangular bandage

Antiseptic soap

Germicide spray (such as Bactine)

Sea sick pills (such as Bonine or Dramimine)

Decongestant tablets (such as Sudafed)

Scissors

Tweezers and/or splinter remover

Medicated stick (such as Chapstick)

Isoprophyl alcohol (about 70% solution or commercial product, such as Swim-Ear)

Sunscreen cream (such as Max-A-Fil)

Aspirin and/or Tylenol

Dimes and emergency phone numbers

Adolph's Meat Tenderizer

Cleaning agent (e.g. hydrogen peroxide, Listerine)

Gauze scrub pads (such as Betadine of Phisohex)

Baking soda

First aid book

Salt tablets

Waterproof metches

Drinking water and plastic cups

Blanket

Other.....

O_2

AMBU bag and mask

9.0 EMERGENCY INFORMATION

9.1 Available Decompression Chambers

9.2 Sheriffs of Virginia Counties

9.3 Rescue Squads in Virginia

9.1 Available Decompression Chambers

U. S. Naval Medical Research Institute
Bethesda, Md.
202-295-0540; 202-295-0282

Harhor Clearance Unit
Little Creek, Va.
804-464-7433

U. S. Army 77th Engineer Company
Fort Belvoir, Va.
703-664-1814
703-664-6990

General Information Nation Wide
Brooks Air Force Base
Texas
512-536-3278 (513-LEO FAST)

U. S. Navy
Experimental Diving Unit
Panama City, Florida
(904) 234-4350

2076

9.2 Sheriffs of Virginia Counties

Accomack	Accomac	804–787-1131
Albemarle	Charlottesville	804–296-2112
Alleghany	Covington	703–962-2221
Amelia	Amelia	804–561-2118
Amherst	Amherst	804–946-5517
Appomattox	Appomattox	804–352-8241
Arlington	Arlington	703–558-2455
Augusta	Staunton	703–885-7253
Bath	Warm Springs	703–839-2331
Bedford	Bedford	703–586-9521
Bland	Bland	703–688-3611
Botetourt	Fincastle	703–473-2743
Brunswick	Lawrenceville	804–848-3133
Buchanan	Grundy	703–935-2313
Buckingham	Buckingham	804–969-4294
Campbell	Rustburg	804–332-5161
Caroline	Bowling Green	804–633-5400
Carroll	Hillsville	703–728-7301
Charles City	Charles City	804–829-2401
Charlotte	Charlotte C H	804–542-5141
Chesterfield	Chesterfield C H	804–748-1261
Clarke	Berryville	703–955-1569
Craig	New Castle	703–864-5127
Culpeper	Culpeper	703–825-1232
Cumberland	Cumberland	804–492-4120
Dickenson	Clintwood	703–926-4732
Dinwiddie	Dinwiddie	804–469-7201
Essex	Tappahannock	804–443-3346
Fairfax	Fairfax	703–273-1441
Fauquier	Warrenton	703–347-3300
Floyd	Floyd	703–745-2144
Fluvanna	Palmyra	804–589-8211
Franklin	Rocky Mount	703–483-9227
Frederick	Winchester	703–662-6162
Giles	Pearisburg	703–921-3842
Gloucester	Gloucester	804–693-3890
Goochland	Goochland	804–556-4792
Grayson	Independence	703–773-6211
Greene	Stanardsville	804–985-2222
Greensville	Emporia	804–634-2814
Halifax	Halifax	804–476-6517
Hanover	Hanover	804–746-4130
Henrico	Richmond	804–643-5327
Henry	Martinsville	703–638-8761
Highland	Monterey	703–468-2210
Isle of Wight	Isle of Wight	804–357-2151
James City	Williamsburg	804–564-3365
King George	King George	703–775-2049
King and Queen	King and Queen	804–785-7400
King William	King William	804–769-2169
Lancaster	Lancaster	804–462-5111
Lee	Jonesville	703–346-1131
Loudoun	Leesburg	703–777-0445
Louisa	Louisa	703–967-1234
Lunenburg	Victoria	804–696-4452
Madison	Madison	703–948-5161
Mathews	Mathews	804–725-7177
Mecklenburg	Boydton	804–738-6171
Middlesex	Saluda	804–758-2779
Montgomery	Christiansburg	703–382-2951
Nansemond	Suffolk	804–539-5119
Nelson	Lovingston	804–263-4242
New Kent	Providence Forge	804–966-5582
Northampton	Eastville	804–678-5106
Northumberland	Heathsville	804–580-5221
Nottoway	Crewe	804–645-9044
Orange	Orange	703–672-1200
Page	Luray	703–743-6571
Patrick	Stuart	703–694-3161
Pittsylvania	Chatham	804–432-2041
Powhatan	Powhatan	804–598-3029
Prince Edward	Farmville	804–392-8101
Prince George	Petersburg	804–732-2164
Prince William	Manassas	703–361-5151
Pulaski	Pulaski	703–980-2040
Rappahannock	Washington	703–675-3332
Richmond	Warsaw	804–333-7861
Roanoke	Salem	703–387-6000
Rockbridge	Lexington	703–463-2014
Rockingham	Harrisonburg	703–434-0311
Russell	Lebanon	703–889-3148
Scott	Gate City	703–386-3722
Shenandoah	Woodstock	703–459-4071
Smyth	Marion	703–783-7204
Southampton	Courtland	804–653-2100
Spotsylvania	Spotsylvania	703–582-6384
Stafford	Stafford	703–659-4161
Surry	Surry	804–294-3156
Sussex	Sussex	804–246-5361
Tazewell	Tazewell	703–988-5966
Warren	Front Royal	703–635-4128
Washington	Abingdon	703–628-7183
Westmoreland	Montross	804–493-4032
Wise	Wise	703–328-3566
Wythe	Wytheville	703–228-2031
York	Yorktown	804–898-3087

9.3 Rescue Squads in Virginia

RESCUE SQUADS

County	City	Address	Telephone No.

10.0 MEDICAL SECTION

10.1 Examples of conditions which may restrict or limit exposure to hyperbaric conditions

10.2 Examples of diving-related injuries or sickness

10.3 Post-dive assessment of diver's physical condition

10.1 Conditions Which May Restrict or Limit Exposure to Hyperbaric Conditions

The following disorders may restrict or limit occupational exposure to hyperbaric conditions depending on severity, presence of residual effects, response to therapy, number of occurrences, diving mode, or degree and duration of isolation.

History of seizure disorder other than early febrile convulsions

Malignancies (active) unless treated and without recurrence for 5 years

Chronic inability to equalize sinus and/or middle ear pressure

Cystic or cavitary disease of the lungs

Impaired organ function caused by alcohol or drug use

Conditions requiring continuous medication for control (e.g., antihistamines, steroids, barbiturates, mood-altering drugs, or insulin)

Meniere's disease

Hemoglobinopathies

Obstructive or restrictive lung disease

Vestibular end organ destruction

Pneumothorax

Cardiac abnormalities (e.g., pathological heart block valvular disease, intraventricular, conduction defects other than isolated right bundle branch block, angina pectoris, arrhythmia, coronary artery disease).

Juxta-articular ostenonecrosis

10.2 Examples of Diving-Related Injuries or Sickness (NOAA Manual, 1979, pp. 2-1 thru 2-25)

10.2.1 Respiratory Problems

Though most physiological problems associated with diving are related to breathing gases at the high pressures encountered under water, respiratory problems may manifest themselves at the surface as well. In general, these problems relate to inadequate transport of oxygen to the cells and to the removal of carbon dioxide.

- Hypoxia

  The term hyposia, or oxygen shortage, is used to mean any situation in which tissue cells fail to receive or are unable to obtain enough oxygen to maintain their normal function. Hypoxia can result from interference with any phase of the oxygen transport process.

- Carbon Dioxide Excess (Hypercapnia)

  An excess of carbon dioxide in the tissues can be caused by interference with the process of carbon dioxide transport and elimination. In diving, carbon dioxide excess occurs either because of an excess of the gas in the breathing medium or because of interference with eliminating the carbon dioxide produced.

- Asphyxia, Suffocation, and Strangulation

  Asphyxia means the existence of both hypoxia and carbon dioxide excess in the body. Asphyxia results if breathing ceases for any reason. It occurs if a breathing gas low in oxygen and high in carbon dioxide is breathed. The term suffocation is sometimes used to indicate stoppage of breathing from any cause and the resulting asphyxia.

- Carbon Monoxide Poisoning, Smoking

  Inspired carbon monoxide combines with hemoglobin in the red blood cells, rendering them incapable of carrying oxygen to the tissues. Tissue hypoxia results even though there is sufficient oxygen in the air breathed. Hemoglobin combines with carbon monoxide about 210 times more readily than with oxygen so very small concentrations can be dangerous to life (U.S.Navy Diving Manual 1973).

- Overexertion

  It is possible for divers to exceed their work capacity before realizing they are in trouble from overexertion. This problem is considerably more serious under water than on land. The sensation of suffocation can produce panic and a serious accident. The diver may begin hyperventilating, thus demanding air at a higher rate than the regulator can provide.

- Hyperventilation and Breath-Holding

  The respiratory system utilizes both carbon dioxide (CO_2) and oxygen (O_2) tensions (partial pressures) in the body to regulate the process of breathing. Rising CO_2 tension and falling O_2 tension are monitored by biological sensors in the body, which normally trigger the breathing response when the levels are appropriate. Hyperventilation (rapid, unusually deep breathing in excess of the necessary rate for the level of activity) interferes with the normal operation of the respiratory control mechanism. Hyperventilation lowers the CO_2 level in the body below normal, a condition known as hypocapnia. This normally results in a feeling of lightheadedness. Over a longer period of time, weakness, faintness, headache, and blurring of vision can result.

10.2.2 Direct Effects of Pressure During Descent

Increased pressures can be tolerated, provided they are uniformly distributed throughout the body. However, when the outside pressure exceeds that inside the body air spaces, the differences in pressure may distort the shape of the involved tissues and cause injury. This is called barotrauma.

The effects on ears and sinuses are summarized below.

- Ears

  Injuries to the eardrum or inner ear may occur with as little as three pounds of pressure differential and they may happen anywhere in the water column. Marked pressure changes may cause ruptures between the inner and middle ear, leading to vertigo and hearing loss; this may happen even in shallow exposures.

- Sinuses

  Although paranasal sinus barotrauma rarely is described in divers, inflammation and congestion of the nose or nasal deformities or masses can cause blockage of the sinus opening. This blockage leads to a series of changes within the cavities, consisting of absorption of pre-existing gas, vacuum formation, swelling, engorgement, inflammation of the sinus lining, and collection of fluid in the sinus cavity. When such blockage occurs during descent in diving or flying, the intra-sinus vacuum becomes greater and the resulting pathological changes are more severe; there may be actual hemmorrhage into the sinus in some instances.

10.2.3 Effects of Pressure During Ascent

During pressure decrease, the air in body cavities expands. Normally, the air vents freely and there are no difficulties. If breathing is normal during ascent, the expanding lung air is exhaled freely. However, if the breath is held or there is a localized airway obstruction, the expanding air is retained, causing over-inflation and overpressurization of the lungs.

Several of the most commonly encountered physiological difficulties associated with pressure during ascent are described in the following paragraphs; each may be prevented by breathing normally during ascent, providing there is no localized airway obstruction.

- Pneumothorax

  Distended alveoli or temporarily enlarged fluid-filled blisters (emphysematous blebs) may rupture the membrane lining the chest (pleura), causing pneumothorax.

- Mediastinal Emphysema

  Mediastinal emphysema is the result of air being forced into the tissues about the heart, the major blood vessels, and the trachea (windpipe) in the middle of the chest.

  Gas trapped in the spaces between tissues may expand rapidly with continuing decompression, causing impaired venous return. The symptoms of mediastinal emphysema are pain under the sternum and, in extreme

cases, shortness of breath or fainting due to interference with circulation as the result of direct pressure on the heart and large vessels. Treatment in mild cases of mediastinal emphysema is symptomatic. In more severe cases, oxygen inhalation may aid resolution of the trapped gas. For severe, massive mediastinal emphysema, recompression is required.

. Subcutaneous Emphysema

Subcutaneous emphysema is a result of air being forced into the tissues beneath the skin of the neck extending along the facial planes from the mediastinum. Although not usually serious it is mentioned because it is a symptom of mediastinal emphysema.

. Gas Embolism

The most serious result of pulmonary overpressurization is the dispersion of alveolar gas into the pulmonary venous system. The gas is carried to the heart, and then into the arterial systemic circulation, resulting in gas emboli in the coronary, cerebral, and other systemic arterioles. Gas bubbles continue to expand with further decreases in pressure, which increases the severity of clinical signs.

10.2.4 Indirect Effects of Pressure

The indirect effects of pressure result from changes in the partial pressures of the gases in the breathing medium. The mechanism of these effects includes saturation and desaturation of body tissues with dissolved gas and changes of body functions by abnormal gas tensions.

. Decompression Sickness (Bends)

If the elimination of gas by blood flowing through the lungs is inadequate to parallel the rate of reduction of external pressure, the amount of supersaturation of gas in the tissues may permit the gas to come out of solution in the form of bubbles. Bubbles forming in the bloodstream will block circulation, while bubbles in tissues will distort the tissues as the bubbles expand. Symptoms occurring depend on the location of the bubbles, whether in joints, muscles, bones or nerves, and have been described as follows (Strauss and Yount 1977).

- Inert Gas Narcosis ("Rapture of the Deep")

  Nitrogen narcosis is caused by the raised partial pressure of nitrogen in compressed air. Although nitrogen is physiologically inert under normal conditions, it is able to induce signs and symptoms of narcosis or anesthesia at sufficiently raised pressures.

- Effects of Cold (Hypothermia)

  Hypothermia is a condition in which the deep tissue or core temperature of the body falls below about 97°F (36°C), which is the temperature at which malfunctions in normal physiology begin to occur (Beckman 1963). If the core temperature continues to drop below 36°C, diving operations should be terminated, because the consequences are serious.

10.3 Post-dive Assessment of Diver's Physical Conditions

10.3.1 ANY DIVER WHO SURFACES FROM A DIVE AND COMPLAINS OF A PROBLEM OR DISPLAYS A DECOMPRESSION SICKNESS SYMPTOM SHOULD HAVE A NEUROLOGICAL EXAM PERFORMED TO FIND OUT IF THERE IS ANY OTHER SYMPTOM OF WHICH THE DIVER IS UNAWARE AND WHICH MAY LEAD TO SERIOUS COMPLICATIONS AT A LATER TIME. IF THE DIVER'S SYMPTOM/COMPLAINT IS OF A PAIN ONLY (TYPE I) NATURE, START THE EXAM IF NO SERIOUS SYMPTOMS ARE ENCOUNTERED. COMPLETE THE EXAM AND MAKE THE DIAGNOSIS, AND TREAT IF NECESSARY.

10.3.2 IF THE DIVER COMPLAINS OF A PROBLEM OR DISPLAYS A SERIOUS DECOMPRESSION SICKNESS SYMPTOM, MAKE A PROMPT DIAGNOSIS AND TREAT BY RECOMPRESSION AS PRESCRIBED IN APPROVED TREATMENT PROCEDURES. ONCE AT TREATMENT DEPTH, A COMPLETE NEUROLOGICAL EXAM SHOULD BE CONDUCTED AND THE DIAGNOSIS SHOULD BE CONFIRMED.

10.3.3 DURING THE COURSE OF THE EXAM, IF THE COMPLAINT/SYMPTOM PRESENTED ALLOWS TIME, THE FOLLOWING QUESTIONS MUST BE ASKED TO AIDE IN MAKING THE DIAGNOSIS.

3-1 HAVE YOU MADE A DIVE IN THE PAST 24 HOURS?

3-2 IF SO, WHEN?

3-3 WHAT WAS THE DEPTH AND BOTTOM TIME?

3-4 WAS THIS A REPETITIVE DIVE?

3-5 DID YOU HAVE THIS PROBLEM BEFORE THE DIVE?

3-6 DO YOU HAVE A HISTORY OF THIS PROBLEM?

3-7 DID YOU DO ANYTHING TO CAUSE THIS PROBLEM?

3-8 DID YOU TWIST, PULL, WRENCH, STRAIN YOURSELF, OR FALL DOWN?

3-9 WHEN DID THIS PROBLEM START?

3-10 BEFORE THE DIVE?

3-11 DURING DESCENT?

3-12 ON THE BOTTOM?

3-13 DURING SURFACE INTERVAL? (IF THERE IS ONE)

3-14 HOW LONG WERE YOU ON THE SURFACE WHEN THIS PROBLEM OCCURRED?

3-15 HAVE YOU BEEN ON ANY MEDICATION THAT COULD HAVE CAUSED THIS?

10.3.4 THE MORE INFORMATION YOU AS THE SUPERVISOR CAN OBTAIN AS TO THE ENTIRE PICTURE WILL BE A SUBSTANTIAL AIDE IN YOUR DIAGNOSING THE ACCIDENT AND PICKING THE CORRECT TREATMENT TABLE.

10.3.5 THE FOLLOWING IS A LIST OF GUIDELINES:

10-3-5-1 TREAT PROMPTLY AND ADEQUATELY.

10-3-5-2 DO NOT DELAY TREATMENT FOR THE ARRIVAL OF MEDICAL PERSONNEL.

10.3.6 NEUROLOGICAL EXAM

10.3.6.1 Preliminary examination

Note: In cases where chamber treatment is required this exam should take no more than 15 seconds and should only determine that the patients' life is in no immediate danger regarding the life-sustaining functions.

A. Life-sustaining functions

These are of primary importance.

1. Breathing

a. Is the chest moving?

b. Count number of breaths per minute

c. Place ear on patient's back just below shoulder blades. Have him breathe normally and deeply while checking for sounds in the chest area such as gargling, wheezing or sounds such as air rushing through a pipe. Compare the sounds with those of a normal person.

d. If patient is coughing, what type of cough is it? How often? And is there pain, blood, or phlegm? Did he have a cold or cough before the accident?

2. Heart

a. Listen for a pulse (at the neck or groin)

b. Take pulse rate per minute (do not use thumb)

3. Hemmorrhage

a. Stop any bleeding with direct pressure

4. Shock

a. Signs and symptoms are: low blood pressure, pallor, cold clammy skin, cyanosis (bluish skin due to oxygen deficiency of blood), weakness, lightheadedness, thirst, sweating, tachycardia (rapid heart action).

b. Check lips and fingernails for color.

c. Check pupils in eyes for dilation.

d. Is there dizziness, pain, or ringing in the ears?

e. How does the patient look generally?

10.3.7 Neuromuscular examination

The 7 parts aid in determining the extent of illness.

Note: When interpreting the results of this examination, be sure that abnormalities are a result of the diving disorder and not the result of a previous disorder; e.g., many divers will exhibit a hearing impairment as the result of time spent working around loud equipment.

A. Mental condition or status

Since less interference is required to impair the function of higher mental levels, test first for an organic brain syndrome by observing:

1. Orientation
    a. Time (the first function to go)
    b. Place (the next to go)
    c. Person (severe impairment)
2. Memory
    a. Immediate (test with a number series)
    b. Recent (happenings within last 24 hours)
    c. Remote (background)
3. Mentation (smarts)
    a. Test by using serial 7's. (Subtract 7 from 100, then 7 from the answer and so on. If an error is repeated like" 93, 90, 83, 80, 73, 70" this is called preservation and usually indicates impairment)
4. Level of consciousness
    a. Watch for any fluctuation
5. Seizures
    a. These are readily apparent.

B. Cranial nerves

What to check and how to test all 12 pair, if possible. Test one side vs the other side.

1. Sense of smell (Olfactory nerves)
    a. Test with coffee, one nostril at a time.
2. Sight (Optic nerves)
    a. Hold up fingers for him to count, testing one eye at a time.

3. Eye movement (Oculomotor, Trochlear, Abducens nerves)

   a. Have the patient follow with his eyes as you move your finger up and down, left and right.

4. Chewing (Trigeminal nerves)

   a. Can he clench his teeth

5. Mouth (Facial nerves)

   a. Can the patient smile?

   b. Does he lift both corners of his mouth?

6. Hearing (Acoustic nerves)

   a. Test one ear at a time.

7. Talking (Glossopharyngeal, Vegas nerves)

   a. Check for gagging and proper enunciation.

8. Shoulder muscles (Spinal Accessory nerves)

   a. Have patient shrug his shoulders while you press down on them.

9. Tongue (Hypoglossal nerves)

   a. Can he stick his tongue straight out (not to one side)?

C. Sensory nerves

1. Sharp vs dull (check one hand vs other)

   a. Using sharp and dull objects, see if patient can distinguish between them by testing

      (1) Back of the hand

      (2) Base of the thumb

      (3) Base of the little finger

d. Motor nerves

1. Muscle strength

   a. Have patient grip two of your fingers with each hand. Is the strength the same in each hand?

   b. With patient sitting or laying down, place your hands on his legs just above the ankle and press down lightly. Have him try to life his legs. Is the strength equal in each?

2. Range of motion

   a. Check normal movement of both arms and legs

3. Muscle tone

   a. Check if muscles are spastic (in state of contraction) or flacid (totally relaxed).

E. Coordination (Cerebellar function)

1. Point in space

   a. Can patient touch your finger held in front of him?

2. Finger to nose

   a. Can he move his finger from touching yours to tip of his nose, repeating the motion?

3. Gait

   a. Walking gait — check for rubber legs, staggering and unsteadiness

   b. Tandem gait — walking heel to toe

4. Rhomberg test for balance (vertigo)

   a. Have patient stand straight, feet together, arms extended in front with palms down, thumbs touching and eyes closed.

F. Reflexes

Note: Working in a chamber will usually preclude exacting examination of most reflexes. The knee will often be the only observable reflex.

1. Basic reflexes (check both sides with blunt instrument)

   a. Biceps

   b. Triceps

   c. Forearm

   d. Knee

   e. Ankle

2. Babinski reflex

a. Run a blunt object up the sole of the foot. If the toes curl forward, a normal Babinski is indicated. If nothing happens, no conclusion can be drawn. But if the toes flex backward and spread, this is a reliable sign of impairment, a spinal hit or long nerve involvement.

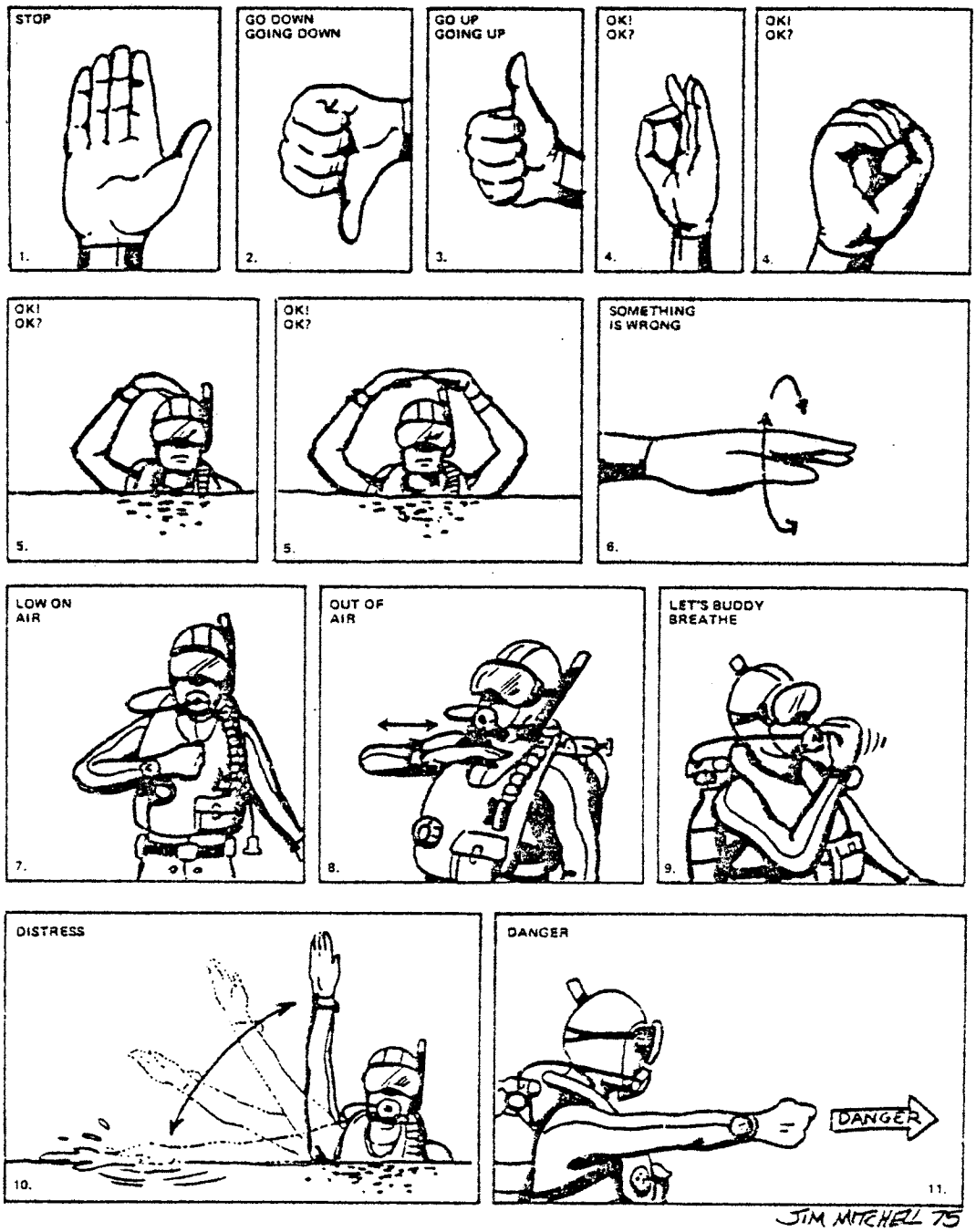
G. Language problem

1. Aphasia condition

a. Check for language foul-ups like misplaced words and wrong word order.

11.0 UNDERWATER COMMUNICATIONS

11.1 Diving Hand Signals
(Taken from Professional Organizer, NAUI)



11.2 Line Pull Signals for Surface-to-Diver Communication (Taken from NOAA Diving Manual)

Emergency Signals
2-2-2 Pulls "I am fouled and need the assistance of another diver"
3-3-3 Pulls "I am fouled but can clear myself"
4-4-4 Pulls "Haul me up immediately"
All signals will be answered as given except for emergency signal 4-4-4

From tender to diver
1 Pull "Are you all right?"
When diver is descending, one pull means "stop"
2 Pulls "Going down"
During ascent, 2 pulls mean "You have come up too far, go back down until we stop you"
3 Pulls "Stand by to come up"
4 Pulls "Come up"
2-1 Pulls "I understand," or "Answer the telephone"

From diver to tender
1 Pull "I am all right" or "I am on the bottom"
2 Pulls "Lower" or "Give me slack"
3 Pulls "Take up my slack"
4 Pulls "Haul me up"
2-1 Pulls "I understand" or "Answer the telephone"
3-2 Pulls "More air"
4-3 Pulls "Less air"
Special signals from the diver to the tender should be devised as required by the situation

---

Searching Signals	**Without circling line**	**With circling line**
7 Pulls	"Go on (or off) searching signals"	Same
1 Pull	"Stop and search where you are"	Same
2 Pulls	"Move directly away from the tender if given slack. move toward the tender if strain is taken on the life-line"	"Move away from the weight"
3 Pulls	"Go to your right"	"Face the weight and go right"
4 Pulls	"Go to your left"	"Face the weight and go left"

12.0 EQUIPMENT CHECK LIST

12.1 Individual Diver

Equipment	Date of Inspection	Condition	Comments
Tanks (2)			
Back Pack			
Regulator			
Buoyancy Compensator (BC)			
CO_2 Cartridges (Spares)			
Wet Suit			
hood			
gloves			
booties			
Weights			
Weight Belt			
Knife			
Light			
Depth Gauge			
Watch/Bottom Timer			
Mask			
Snorkel			
Fins			
Dive Bag			
Decompression Tables			
Department Dive Manual			

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12.2 Dive Team

Equipment	Date of Inspection	Condition	Comments
First Aid Kit			
Backboard			
Radio, 2-way			
Dive Log and Records			
Dive Manual			
Ladder			
Ropes			
Lights			
Boat			
Lift Bags			
Floats			
Buoys			

13.0 U. S. NAVY STANDARD DIVE TABLES

DECOMPRESSION TABLES

taken from

U.S. Navy Diving Manual of September 1973

prepared by

National Association of Underwater Instructors

DECOMPRESSION SICKNESS

1. All scuba divers should know the cause, symptoms, treatment, and prevention of decompression sickness, plus have available the telephone number, location and method of transportation to the nearest chamber. Call ahead to the chamber to be sure it is operational.

2. Factors which increase the likelihood of decompression sickness are: Extreme water temperatures, dehydration, age, obesity, poor physical condition, fatigue, alcoholic indulgence, old injuries which cause poor circulation, and heavy work during the dive.

3. The most frequent errors related to the treatment of decompression sickness are the failure: To report symptoms or signs early, to treat doubtful cases, to treat promptly, to treat adequately, to recognize serious symptoms, and to keep the patient near the chamber after treatment.

DECOMPRESSION TABLES

4. There is no safety factor built into the U.S. Navy Standard Air Decompression Table.

5. A "no decompression dive" is a dive which requires no decompression stops; it still causes nitrogen to go into solution within the body. This nitrogen must be taken into account as residual nitrogen in repetitive diving. The ascent rate of 60 feet per minute is a form of decompression.

6. Bottom time starts when the diver leaves the surface and ends only when the diver starts a direct ascent back to the surface.

7. If a dive was particularly cold or arduous, the next longer decompression time should be followed.

8. After diving, do not fly for 12 hours or, if you must fly, use the tables for altitude diving (see Skin Diver Magazine, November 1970). Plan all these dives to be "no decompression" dives using 2 hours as a minimum surface interval before any flying.

9. An exception to the tables occurs when a repetitive dive is to the same or greater depth than the previous dive AND the surface interval is short enough that the residual nitrogen time is greater than the actual bottom time of the previous dive. In this case, add the actual bottom time of the previous dive to the actual bottom time of the repetitive dive and decompress for the total bottom time and deepest dive.

10. Plan repetitive dives so that each successive dive is to a lesser depth. This will aid in the elimination of nitrogen and decrease the need for decompression stops. Always keep surface intervals as long as possible.

11. Plan your dive and dive your plan; always have an alternate plan if the actual depth and/or time of the dive is greater than planned.

REASONS FOR REPETITIVE DIVE PLANNING

12. To avoid decompression stops.
    a. Be able to use tables to compute maximum time of a repetitive dive without decompression stops.
    b. Be able to use tables to compute minimum surface interval needed to avoid decompression stops.
13. To stay within a particular decompression schedule or repetitive group.
14. To dive maximum depth or time on limited air.
15. To make minimum decompression stops.
16. To make the dive and take whatever decompression stops are required.

EMERGENCY INFORMATION AND NUMBERS

USCG: Telephone ..... Radio .....

POLICE: State ..... County ..... City .....

FIRE DEPARTMENT ..... AMBULANCE ..... HARBOR PATROL .....

CHAMBERS:

1. Location ..... Day ..... Night .....

2. Location ..... Day ..... Night .....

M.D. QUALIFIED IN UNDERWATER MEDICINE:

Name ..... Day ..... Night .....

NO-DECOMPRESSION LIMITS AND REPETITIVE GROUP DESIGNATION TABLE FOR NO-DECOMPRESSION AIR DIVES

Depth (feet)	No-decompression limits (min)	Group Designation														
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
10		60	120	210	300											
15		35	70	110	160	225	350									
20		25	50	75	100	135	180	240	325							
25		20	35	55	75	100	125	160	195	245	315					
30		15	30	45	60	75	95	120	145	170	205	250	310			
35	310	5	15	25	40	50	60	80	100	120	140	160	190	220	270	310
40	200	5	15	25	30	40	50	70	80	100	110	130	150	170	200	
50	100		10	15	25	30	40	50	60	70	80	90	100			
60	60		10	15	20	25	30	40	50	55	60					
70	50		5	10	15	20	30	35	40	45	50					
80	40		5	10	15	20	25	30	35	40						
90	30		5	10	12	15	20	25	30							
100	25		5	7	10	15	20	22	25							
110	20			5	10	13	15	20								
120	15			5	10	12	15									
130	10			5	8	10										
140	10			5	7	10										
150	5			5												
160	5				5											
170	5				5											
180	5				5											
190	5				5											

U. S NAVY STANDARD AIR DECOMPRESSION TABLE

Depth (feet)	Bottom time (min)	Time first stop (min:sec)	Decompression stops (feet) 50	40	30	20	10	Total ascent (min:sec)	Repetitive group
40	200						0	0:40	*
	210	0:30					2	2:40	N
	230	0:30					7	7:40	N
	250	0:30					11	11:40	O
	270	0:30					15	15:40	O
	300	0:30					19	19:40	Z
50	100						0	0:50	*
	110	0:40					3	3:50	L
	120	0:40					5	5:50	M
	140	0:40					10	10:50	M
	160	0:40					21	21:50	N
	180	0:40					29	29:50	O
	200	0:40					35	35:50	O
	220	0:40					40	40:50	Z
	240	0:40					47	47:50	Z
60	60						0	1:00	*
	70	0:50					2	3:00	K
	80	0:50					7	8:00	L
	100	0:50					14	15:00	M
	120	0:50					26	27:00	N
	140	0:50					39	40:00	O
	160	0:50					48	49:00	Z
	180	0:50					56	57:00	Z
	200	0:40				1	69	71:00	Z
70	50						0	1:10	*
	60	1:00					8	9:10	K
	70	1:00					14	15:10	L
	80	1:00					18	19:10	M
	90	1:00					23	24:10	N
	100	1:00					33	34:10	N
	110	0:50				2	41	44:10	O
	120	0:50				4	47	52:10	O
	130	0:50				6	52	59:10	O
	140	0:50				8	56	65:10	Z
	150	0:50				9	61	71:10	Z
	160	0:50				13	72	86:10	Z
	170	0:50				19	79	99:10	Z
80	40						0	1:20	*
	50	1:10					10	11:20	K
	60	1:10					17	18:20	L
	70	1:10					23	24:20	M
	80	1:00				2	31	34:20	N
	90	1:00				7	39	47:20	N
	100	1:00				11	46	58:20	O
	110	1:00				13	53	67:20	O
	120	1:00				17	56	74:20	Z
	130	1:00				19	63	83:20	Z
	140	1:00				26	69	96:20	Z
	150	1:00				32	77	110:20	Z
90	30						0	1:30	*
	40	1:20					7	8:30	J
	50	1:20					18	19:30	L
	60	1:20					25	26:30	M
	70	1:10				7	30	38:30	N
	80	1:10				13	40	54:30	N
	90	1:10				18	48	67:30	O
	100	1:10				21	54	76:30	Z
	110	1:10				24	61	86:30	Z
	120	1:10				32	68	101:30	Z
	130	1:00			5	36	74	116:30	Z

* SEE NO-DECOMPRESSION TABLE FOR REPETITIVE GROUPS

U. S NAVY STANDARD AIR DECOMPRESSION TABLE

100

Depth (feet)	Bottom time (min)	Time first stop (min:sec)	Decompression stops (feet) 50	40	30	20	10	Total ascent (min:sec)	Repetitive group
100	25						0	1:40	*
	30	1:30					3	4:40	I
	40	1:30					15	16:40	K
	50	1:20				2	24	27:40	L
	60	1:20				9	28	38:40	N
	70	1:20				17	39	57:40	O
	80	1:20				23	48	72:40	O
	90	1:10			3	23	57	84:40	Z
	100	1:10			7	23	66	97:40	Z
	110	1:10			10	34	72	117:40	Z
	120	1:10			12	41	78	132:40	Z

110

Depth (feet)	Bottom time (min)	Time first stop (min:sec)	Decompression stops (feet) 50	40	30	20	10	Total ascent (min:sec)	Repetitive group
110	20						0	1:50	*
	25	1:40					3	4:50	H
	30	1:40					7	8:50	J
	40	1:30				2	21	24:50	L
	50	1:30				8	26	35:50	M
	60	1:30				18	36	55:50	N
	70	1:20			1	23	48	73:50	O
	80	1:20			7	23	57	88:50	Z
	90	1:20			12	30	64	107:50	Z
	100	1:20			15	37	72	125:50	Z

120

Depth (feet)	Time to first stop (min:sec)	Decompression stops (feet) 50	40	30	20	10	Total ascent (min:sec)	Repetitive group
120	15					0	2:00	*
	20	1:50				2	4:00	H
	25	1:50				6	8:00	I
	30	1:50				14	16:00	J
	40	1:40				5	25	32:00	L
	50	1:40				15	31	48:00	N
	60	1:30			2	22	45	71:00	O
	70	1:30			9	23	55	89:00	O
	80	1:30			15	27	63	107:00	Z
	90	1:30			19	37	74	132:00	Z
	100	1:30			23	45	80	150:00	Z

130

Depth (feet)	Time to first stop (min:sec)	Decompression stops (feet) 50	40	30	20	10	Total ascent (min:sec)	Repetitive group
130	10					0	2:10	*
	15	2:00				1	3:10	F
	20	2:00				4	6:10	H
	25	2:00				10	12:10	J
	30	1:50				3	18	23:10	M
	40	1:50				10	25	37:10	N
	50	1:40			3	21	37	63:10	O
	60	1:40			9	23	52	86:10	Z
	70	1:40			16	24	61	103:10	Z
	80	1:30		3	19	35	72	131:10	Z
	90	1:30		8	19	45	80	154:10	Z

140

Depth (feet)	Time to first stop (min:sec)	Decompression stops (feet) 50	40	30	20	10	Total ascent (min:sec)	Repetitive group
140	10					0	2:20	*
	15	2:10				2	4:20	G
	20	2:10				6	8:20	I
	25	2:00				2	14	18:20	J
	30	2:00				5	21	28:20	K
	40	1:50			2	16	26	46:20	N
	50	1:50			6	24	44	76:20	O
	60	1:50			16	23	56	97:20	Z
	70	1:40		4	19	32	68	125:20	Z
	80	1:40		10	23	41	79	155:20	Z

* SEE NO-DECOMPRESSION TABLE FOR REPETITIVE GROUPS

RESIDUAL NITROGEN TIMETABLE FOR REPETITIVE AIR DIVES

*Dives following surface intervals of more than 12 hours are not repetitive dives. Use actual bottom times in the Standard Air Decompression Tables to compute decompression for such dives.

Repetitive group at the beginning of the surface interval

															A	0:10 12:00*
														B	0:10 2:10	2:11 12:00*
													C	0:10 1:39	1:40 2:49	2:50 12:00*
												D	0:10 1:09	1:10 2:38	2:39 5:48	5:49 12:00*
											E	0:10 0:54	0:55 1:57	1:58 3:22	3:23 6:32	6:33 12:00*
										F	0:10 0:45	0:46 1:29	1:30 2:28	2:29 3:57	3:58 7:05	7:06 12:00*
									G	0:10 0:40	0:41 1:15	1:16 1:59	2:00 2:58	2:59 4:25	4:26 7:35	7:36 12:00*
								H	0:10 0:36	0:37 1:06	1:07 1:41	1:42 2:23	2:24 3:20	3:21 4:49	4:50 7:59	8:00 12:00*
							I	0:10 0:33	0:34 0:59	1:00 1:29	1:30 2:02	2:03 2:44	2:45 3:43	3:44 5:12	5:13 8:21	8:22 12:00*
						J	0:10 0:31	0:32 0:54	0:55 1:19	1:20 1:47	1:48 2:20	2:21 3:04	3:05 4:02	4:03 5:40	5:41 8:40	8:41 12:00*
					K	0:10 0:28	0:29 0:49	0:50 1:11	1:12 1:35	1:36 2:03	2:04 2:38	2:39 3:21	3:22 4:19	4:20 5:48	5:49 8:58	8:59 12:00*
				L	0:10 0:26	0:27 0:45	0:46 1:04	1:05 1:25	1:26 1:49	1:50 2:19	2:20 2:53	2:54 3:36	3:37 4:35	4:36 6:02	6:03 9:12	9:13 12:00*
			M	0:10 0:25	0:26 0:42	0:43 0:59	1:00 1:18	1:19 1:39	1:40 2:05	2:06 2:34	2:35 3:08	3:09 3:52	3:53 4:49	4:50 6:18	6:19 9:28	9:29 12:00*
		N	0:10 0:24	0:25 0:39	0:40 0:54	0:55 1:11	1:12 1:30	1:31 1:53	1:54 2:18	2:19 2:47	2:48 3:22	3:23 4:04	4:05 5:03	5:04 6:32	6:33 9:43	9:44 12:00*
	O	0:10 0:23	0:24 0:36	0:37 0:51	0:52 1:07	1:08 1:24	1:25 1:43	1:44 2:04	2:05 2:29	2:30 2:59	3:00 3:33	3:34 4:17	4:18 5:16	5:17 6:44	6:45 9:54	9:55 12:00*
Z	0:10 0:22	0:23 0:34	0:35 0:48	0:49 1:02	1:03 1:18	1:19 1:36	1:37 1:55	1:56 2:17	2:18 2:42	2:43 3:10	3:11 3:45	3:46 4:29	4:30 5:27	5:28 6:56	6:57 10:05	10:06 12:00*
NEW → GROUP DESIGNATION	**Z**	**O**	**N**	**M**	**L**	**K**	**J**	**I**	**H**	**G**	**F**	**E**	**D**	**C**	**B**	**A**
REPETITIVE DIVE DEPTH																
40	**257**	**241**	**213**	**187**	**161**	**138**	**116**	**101**	**87**	**73**	**61**	**49**	**37**	**25**	**17**	**7**
50	169	160	142	124	111	99	87	76	66	56	47	38	29	21	13	6
60	**122**	**117**	**107**	**97**	**88**	**79**	**70**	**61**	**52**	**44**	**36**	**30**	**24**	**17**	**11**	**5**
70	100	96	87	80	72	64	57	50	43	37	31	26	20	15	9	4
80	**84**	**80**	**73**	**68**	**61**	**54**	**48**	**43**	**38**	**32**	**28**	**23**	**18**	**13**	**8**	**4**
90	73	70	64	58	53	47	43	38	33	29	24	20	16	11	7	3
100	**64**	**62**	**57**	**52**	**48**	**43**	**38**	**34**	**30**	**26**	**22**	**18**	**14**	**10**	**7**	**3**
110	57	55	51	47	42	38	34	31	27	24	20	16	13	10	6	3
120	**52**	**50**	**46**	**43**	**39**	**35**	**32**	**28**	**25**	**21**	**18**	**15**	**12**	**9**	**6**	**3**
130	46	44	40	38	35	31	28	25	22	19	16	13	11	8	6	3
140	**42**	**40**	**38**	**35**	**32**	**29**	**26**	**23**	**20**	**18**	**15**	**12**	**10**	**7**	**5**	**2**
150	40	38	35	32	30	27	24	22	19	17	14	12	9	7	5	2
160	**37**	**36**	**33**	**31**	**28**	**26**	**23**	**20**	**18**	**16**	**13**	**11**	**9**	**6**	**4**	**2**
170	35	34	31	29	26	24	22	19	17	15	13	10	8	6	4	2
180	**32**	**31**	**29**	**27**	**25**	**22**	**20**	**18**	**16**	**14**	**12**	**10**	**8**	**6**	**4**	**2**
190	31	30	28	26	24	21	19	17	15	13	11	10	8	6	4	2

RESIDUAL NITROGEN TIMES (MINUTES)

GENERAL INSTRUCTIONS FOR AIR DIVING

NEED FOR DECOMPRESSION

A quantity of nitrogen is taken up by the body during every dive. The amount absorbed depends upon the depth of the dive and the exposure (bottom) time. If the quantity of nitrogen dissolved in the body tissues exceeds a certain critical amount, the ascent must be delayed to allow the body tissues to remove the excess nitrogen. Decompression sickness results from failure to delay the ascent and to allow this process of gradual desaturation. A specified time at a specified depth for purposes of desaturation is called a decompression stop.

NO-DECOMPRESSION SCHEDULE

Dives that are not long enough or deep enough to require decompression stops are no-compression dives. Dives to 33 feet or less do not require decompression stops. As the depth increases, the allowable bottom time for no-decompression dives decreases. Five minutes at 190 feet is the deepest no-decompression schedule. These dives are all listed in the **No-Decompression Limits and Repetitive Group Designation Table for No-Decompression Dives,** and only require compliance with the 60-feet-per-minute rate of ascent.

REPETITIVE DIVE PROCEDURE

A dive performed within 12 hours of surfacing from a previous dive is a repetitive dive. The period between dives is the surface interval. Excess nitrogen requires 12 hours to be effectively lost from the body. These tables are designed to protect the diver from the effects of this residual nitrogen. Allow a minimum surface interval of 10 minutes between all dives. For any interval under 10 minutes, add the bottom time of the previous dives to the repetitive dive and choose the decompression schedule for the total bottom time and the deepest dive.

INSTRUCTIONS FOR USE

Time of decompression stops in the table is in minutes.

Enter the table at the exact or the next greater depth than the maximum depth attained during the dive. Select the listed bottom time that is exactly equal to or is next greater than the bottom time of the dive. Maintain the diver's chest as close as possible to each decompression depth for the number of minutes listed. The rate of ascent **between** stops is not critical for stops of 50 feet or less. Commence timing each stop on arrival at the decompression depth, and resume ascent when the specified time has lapsted.

—— N O T E S ——

(for sample problems, work sheets, and dive diagrams)

14.0 GLOSSARY

Air Embolism — An obstruction of blood flow caused by an air or gas bubble.

Ambient Pressure — The total pressure surrounding a diver.

Barotrauma — A pressure related injury.

Bends — A type of sickness or injury due to the formation of gas bubbles in the blood or tissues.

Bottom Time — The amount of time a diver spends on a dive measured from the time he begins his descent until he begins his ascent, usually calculated for the greatest depth obtained.

Buddy Breathing — An emergency ascent technique in which two divers use the same regulator and air tank.

Current — A horizontal movement of water.

Cylinder — Used in diving to denote a compressed air SCUBA tank.

Dark Water — Used to denote water with minimum visibility.

Decompression Sickness — See Bends

FSW = abbreviation for feet of sea water, usually refers to pressure equivalent.

Gauge Pressure — The pressure indicated on a guage which <u>does not</u> represent absolute pressure.

Hypothermia — A debilitating condition brought on by excessive loss of heat from the body.

Narcosis — A condition which resembles drunkeness or euphoria believed to be caused by breathing nitrogen at a high partial pressure (usually experienced by divers at or below depths of 100 feet).

Residual Nitrogen — That amount of nitrogen remaining in the body from previous dives.

SCUBA — An acronym meaning self-contained underwater breathing apparatus.

Sport Diver — A term which distinguishes those who dive for sport or enjoyment rather than for commercial purposes.

15.0 SELECTED REFERENCES

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