NEW ENGLAND DIVISION

DIVING MANUAL

(Adapted from Los Angeles District)

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The manual was formulated by first defining: present diving operations, general water conditions, kinds of underwater activities, procedural concerns, and potential safety problems. This manual was conceived as a guide for all Division activities. It gives acceptable practices and emergency procedures.

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Section 1

INTRODUCTION

1.1 THE DIVING MANUAL AND PROGRAM

The intent of the New England Division Corps of Engineers' Diving Manual is to formally present "state of the art" guidance by which safe, efficient, and effective underwater activities shall be performed. The manual addresses safety problems which may be encountered during Corps activities, lists approved and prescribed procedures, details emergency procedures and provides guidance to assure that all diving activities are in accordance with all applicable regulations. This manual is a safety and procedural guidance document. The manual is a flexible and changing document, requiring annual updates (August of each year). This shall ensure that the latest information is incorporated into the Division diving operations.

The diving activities within the Divison are extensive and varied and include the fields of: archaeology, biology, chemistry, construction, enforcement, geology, inspection, maintenance, and survey. These activities are performed by Division employees often with the assistance of contract divers or other agency divers. The Division dive team members are highly trained technical professionals with scientific or engineering backgrounds. The Division presently has an annual retraining program for divers (see section 3.3). Each dive team member shall retrain in all aspects of this program. The dive team members shall only dive with divers retrained in like manner.

1.2 PREPARATION METHODOLOGY

The manual was formulated by first defining: present diving operations, general water conditions, kinds of underwater activities, procedural concerns, and potential safety problems. These entities were analyzed for operational procedure needs and methods for the incorporation of appropriate diving practices. The manual is structured to serve as guidance for each Division dive team member.

1.3 SCOPE AND USE OF THE MANUAL

Because of the high technical skill level of Division divers, the manual was conceived as a guide for all Division activities. It is not intended as a training manual. It is the responsibility of each team member to be thoroughly familiar with the manual. The Division Diving Officer has the authority to supersede this manual for emergency conditions and in the interest of increased safety. In an emergency, in which the Diving Officer is not available, the Dive Master may supersede this manual. The manual shall be used as a guidance by every dive team member including the Diving Officer. The Diving Officer shall enforce the procedures set forth in this manual and appropriate regulations for all Division and contract diving.

The Diving Manual gives acceptable practices and emergency procedures. Section 2 describes the Division Diving Program in detail. Section 3 discusses training and certification requirements including requirements for

annual recertification. Section 4 details operational procedures. This section covers pre-dive procedures including the dive plan and general safety checklist, general requirements that apply to Division diving operations, procedures at the dive site, and procedures for surface air-supplied diving, high altitude diving, and dam diving. Section 5 discusses emergency procedures including on-site management of diving accidents, accident reporting procedures, symptoms and treatment of diving diseases, emergency procedures for aborted or omitted decompression, emergency procedures for bringing an unconscious diver to the surface, first aid kit supplies, and emergency procedures for dam diving. Section 6 details Division equipment requirements, OSHA regulations on equipment, approved equipment for Division diving operations, and equipment maintenance procedures. Section 7 discusses record keeping procedures and types of records and forms. The Appendices include decompression and recompression treatment tables and lists of medically certified chambers in New England, support facilities, reciprocal agencies for diving, references, persons to notify of diving activities, and authorities on diving who may be contacted for information. The diving resumes of the authors are also included as an appendix.

1.4 UPDATE PROCEDURES FOR THE MANUAL

The manual shall be updated annually by the Diving Officer with the latest information and acceptable diving procedures. The Diving Officer shall document all revisions and the dates these revisions were made. These revisions shall address, but not be limited to, physiology, diving medicine, rescue techniques, procedures, and equipment. Written records of individuals receiving the manual shall be kept by the Diving Officer. Manuals without the most recent revisions shall not be used.

1.5 DESCRIPTION OF EXISTING DIVING OPERATIONS

Areas of study of present diving operations include: biological, chemical, archaeological, inspection, and survey. These activities account for approximately 90 percent of the Division diving activities; the remainder includes geology, enforcement, construction, and maintenance. The diving occurs primarily in the marine environment with diving from shore and off boats. Diving activities occur year-round in depths up to 132 feet. Freshwater diving may take place in Corps dams at altitudes higher than 5,000 feet. Ninety percent of the Division diving activities involves SCUBA with 10 percent either surface-supplied diving or breath holding.

Examples of Division diving activity:

- Sand sampling for environmental testing.
- Locating obstructions in navigational waters.
- Siltation studies for the geology section.
- Determination of marine biota in coastal projects.
- Installation and service of wave gauges.

- Pre- and post-construction surveys of construction activities in the waters of the United States.
- Inspections and maintenance of dam and debris basin structures.
- Collection of water and sediment chemistry samples.
- Photographic documentation.
- Environmental monitoring.
- Pollution control inspections.
- Mitigation for Corps of Engineers projects such as transplanting of kelp and eelgrass beds impacted by construction.

Section 2

DIVISION DIVING PROGRAM

2.1 STRUCTURE

The Division Diving Officer is responsible to the Division Safety Office, which in turn is responsible to the Office of the Chief of Engineers (OCE) Safety Office. This Safety Office (OCE) is responsible for the approval of all Division diving programs, regulations, diver training, and diver safety procedures.

2.2 AUTHORITIES AND RESPONSIBILITIES

2.2.1 Division Diving Officer (shall be appointed by Division Engineer) (hereinafter referred to as the Diving Officer)

Responsibilities include:

a. To ensure all Division diving operations are conducted in a safe and efficient manner.

b. Coordination of all diving activities including diver training and contractor diving.

c. Enforcement of all diving regulations.

d. Purchase and maintenance of approved diving equipment.

e. Maintaining records of all dives made by New England Division personnel.

f. Reporting to Safety Office during the first quarter of the new fiscal year, a record of all dives accomplished during the previous fiscal year.

g. Ensures that standards for all divers (including contract and other agencies' divers) are enforced.

h. Conducts training program to ensure that physical fitness, swimming ability, physical examinations, and other training needs for each diver are met annually.

i. Overseeing those portions of contracts that require diving.

j. To maintain highly qualified status and abilities as an active member of the Division dive team.

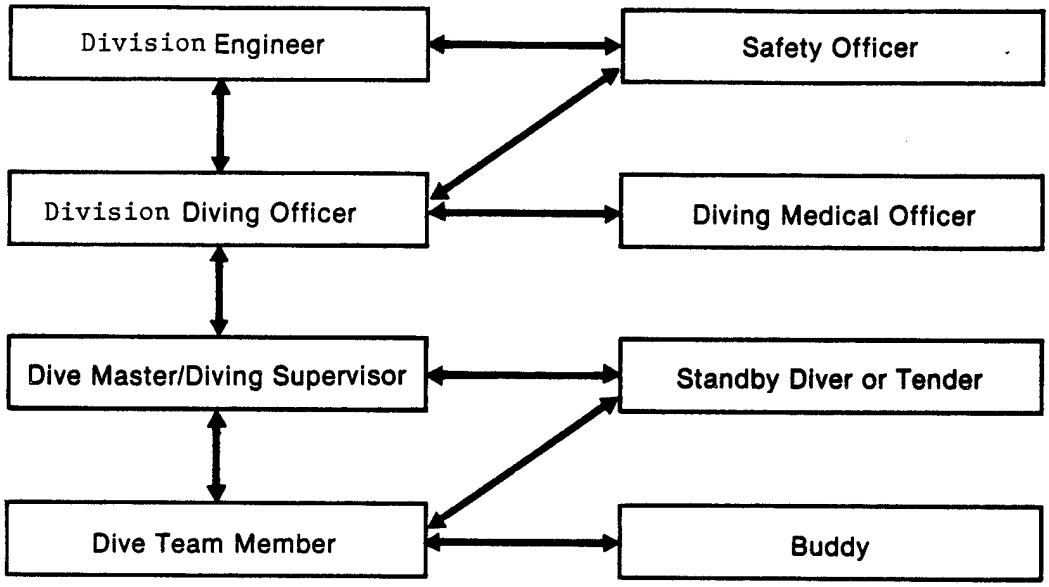

FIGURE 2-1
AUTHTORITIES AND RESPONSIBILITIES

2.2.2 Diving Medical Officer (Shall be appointed by the Diving Officer)

Responsibilities include:

a. conducting annual diving medical exams to determine the medical fitness for diving operations of each dive team member.

b. Advising Diving Officer on medical fitness of each dive team member.

c. Providing input in the event of a diving accident.

d. Aids in determination of emergency medical supply needs, equipment needs, procedures, and medical care of dive team members.

2.2.2.1 Diving Medical Officer Qualifications

a. M.D. with specialization and extensive experience in hyperbaric medicine related to diving operations.

b. Navy training, preferred.

c. Meets the recommendations of the Undersea Medical Society, Inc. for hyperbaric medicine training.

2.2.3 Dive Master (Shall be synonymous with Diving Supervisor)

Responsibilities include:

a. Conducts diving operations at the location of the dive.

b. Insures safety of the diving team while it is in the field.

c. Briefs divers on mission; maintains dive logs and submits them to the Diving Officer.

d. Ensuring that dive team members are able, ready, and properly equipped prior to diving.

e. Reporting equipment that is unsafe.

f. Terminating dives, should diving conditions become unsafe during the diving day.

g. Assuring the availability of emergency transportation and recompression facilities prior to diving activities, and overseeing the management of injured dive team members.

h. Keeping Diving Officer informed of all diving activities.

2.2.4 Safety Officer.

Responsibilities include:

a. Insures all safety regulations are followed within the Division..

b. Maintaining summary logs of all Division Diving Operations.

c. Inform Division Diving Officer of new safety regulations.

2.3 CONTACT LIST IN CASE OF A DIVING ACCIDENT

2.3.1 Immediate Contact List

The following persons must be notified immediately (by any responsible person at the dive site) when a diving accident/injury occurs or is suspected:

- Dive Master/Diving Supervisor
- Emergency aid personnel, Coast Guard, Hyperbaric chamber, appropriate diving medical officer
- Diving Officer
- Diving Medical Officer
- Safety Officer

Section A.1 has telephone numbers and locations of emergency facilities. This contact list is in addition to the required notification to properly treat the victim.

2.3.2 Follow-Up Contact List

The following persons must be informed that a diving accident has occurred, but they do not need to be contacted immediately:

- The Branch Chief of any diver involved in the accident
- The Personnel Office
- The Division Engineer

After verbal notification, a detailed written report shall be completed by the dive team member or Dive Master involved (see Table 7-6) and submitted to the Diving Officer and the Safety Officer.

2.3.3 Dive Team Member

Responsibilities (at all times) include:

a. Physical fitness for diving.

b. Maintaining his diving equipment.

c. Knowing this manual and appropriate regulations.

d. Personal and Buddy safety.

e. Notifying Dive Master of any problems or injuries.

Section 3

TRAINING AND CERTIFICATION

3.1 CERTIFICATION TYPES, METHOD OF OBTAINING CERTIFICATION AND PROCEDURES FOR MAINTENANCE AND REVOCATION OF CERTIFICATION

There are three certification types of divers, identified as proficiency classifications (ER 385-1-93), in the New England Division. All divers are qualified to participate in diving activities within their classification.

3.1.1 To qualify and be maintained as a Division dive team member an individual shall:

- Complete basic and intermediate diver training courses approved by the Diving Officer;
- Pass the annual medical, physical fitness, and mental examination;
- Meet recertification requirements prior to being certified and on an annual basis;
- Log a minimum of 12 work diving days per year at a schedule of approximately 1 diving day per month to maintain active status;
- Adhere to the Division Diving Manual and appropriate regulations at all times;
- Maintain safe practice and standards, and daily diving logs. One copy of each log shall be turned into the Diving Officer after each dive.

In addition to the above, all Division divers shall be assigned a proficiency classification based on training, skills, abilities and experience outlined in appendix A.14 (ER 385-1-93). Where stated as field operating activities, the Division has designated a Diving Officer.

3.2 REQUIREMENTS OF ANNUAL MEDICAL EXAMINATION

The annual diving medical examination shall be administered by the Diving Medical Officer and must include, but is not limited to, the following:

(1) Complete medical history

(2) Diving-related history

(3) Basic physical

(4) Chest x-ray

(5) Visual acuity

(6) EKG (12L) (Working EKG past age 35)

(7) Hearing test

(8) Hematocrit or hemoglobin

(9) Sickle cell index

(10) White blood cell count

(11) Urinalysis

(12) ENT with audiogram

(13) SMA-12

(14) O_2 tolerance test (Given Once: during first year)

Initial exam should also include musculo-skeletal and color perception examination with X-ray of knees, shoulders, and head of femur.

Waivers will only be given on concurrence of the Medical Officer and the Diving Officer.

3.2.1 Diving Medical Officer responsibilities:

a. After any medical examination required by this standard, the Diving Officer shall obtain a written report prepared by the Diving Medical Officer including:

- The results of the medical examination; and
- The Diving Medical Officer's opinion of the dive team member's fitness to be exposed to hyperbaric conditions, including any recommended restrictions or limitations to such exposure.

b. The Diving Officer shall provide the dive team member with the results of the physician's report.

3.2.2 Determination of diver fitness:

a. The Diving Officer shall assess the dive team member's medical fitness to engage in diving and otherwise to be exposed to hyperbaric conditions consistent with the recommendations in the Diving Medical Officer's report.

3.3 SUBJECTS TO BE COVERED IN ANNUAL RETRAINING DIVING COURSE

The following is a brief description of minimum topics to be covered in an annual retraining diving course for Corps dive team members:

a. Applied Sciences--This area shall provide the dive team member with a knowledge of physics, physiology, and anatomy as they relate to a diver's performance in the water. Emphasis is to be placed on the diver's physical fitness, diving hazards, personal limitations and

the behavioral changes needed to function safely as a diver. Material shall be presented in a manner which is of practical application to research and underwater work and specifically includes: gases, pressure, volume, temperature, density, buoyancy, vision and acoustics; the definition, cause, symptoms, signs, first aid, treatment, and prevention of decompression sickness, nitrogen narcosis, respiratory accidents, squeezes, overexertion and overexposure, air embolism and related injuries. Decompression tables shall be known to the extent that the dive team member can readily calculate decompression schedules and no decompression dives without error.

b. Diving Equipment--This area shall provide the dive team member with a knowledge of the purpose, features, types and use of skin, SCUBA, and surface air-supplied diving equipment. The dive team member is to be prepared to intelligently select, use, and care for the following: Mask, snorkel, fins, buoyancy compensator, knife, weight belt, wet suit, depth gauge, watch, submersible pressure gauge, compass, regulator, valve, and cylinder including valve and harness or backpack, plus any other useful accessories and tools he may be required to operate.

c. Diving Safety--This area shall provide the dive team member with a knowledge of lifesaving and first aid as applied to diving. Underwater communications, underwater orientation, dive planning, and safety rules are also to be covered. Shock, wounds, and drowning are to be covered under first aid. Lifesaving is to include rescues, tows, artificial respiration, and cardiopulmonary resuscitation as they apply to open water. The course shall include a water demonstration of competence.

d. Diving Environment--This area shall provide the dive team member with a basic knowledge of the physical and biological aspects of the Division's marine and freshwater environments. The fundamentals of conservation, regulations, dangers, water movement and water characteristics, including the environment's effect on the diver, shall be covered.

e. Introduction and Practical Application of Underwater Work and Photography--This area shall provide dive team members with an introduction to various kinds of underwater work techniques. The planning and scheduling of working dives shall be discussed and the practical use of various kinds of tools, sampling and photographic equipment shall be explained.

f. Surface Air Supply (SAS)--The divers certified in SAS shall be retrained annually by a nationally recognized school. This training shall include "State of the Art" equipment in SAS and chamber operations.

3.3.1 Examination--A written and practical ocean and pool exam shall be given to each new dive team member by the Diving Officer. This testing shall include all of the aforementioned.

3.4 REQUIREMENTS FOR ANNUAL RECERTIFICATION

The tests are to be administered by the Diving Officer who shall qualify himself.

1. Pool Swim Test

Skill	Score
500 yards swim (under 12 minutes and using 3 strokes)	1 or 10
Backstroke 100 yards	1- 10
Sidestroke or resting stroke 100 yards	1- 10
Treading 15 minutes (last 5 minutes hands out)	1 or 10
Drown proofing 5 minutes	1 or 10
Underwater swim 25 yards	1- 10
Mask, fins, snorkel 500 yards (under 8 minutes)	1- 10
Don and doff (mask, fins, snorkel)	1- 10
Surface dives (e.g. kelp and tuck)	1- 10
Entries	1 - 10
Buddy breathing (horizontal and vertical swim)	1- 10
Free ascent	1- 10
Bail out	1- 10
Diver rescue and tow	1- 10
Total	14- 140

(Time: 4 hours)
Passing Score: 98/140

2. Diving physics, physiology, medical aspects, diving procedures (regulations, repetitive dive tables, special situations, equipment use), lecture and demonstration of the latest information available.
(Time: 8 hours)

3. Diving first aid and emergency procedures lecture, demonstration, practice and written test.
(Time: 8 hours)

4. Cardiopulmonary resuscitation training for lifeguards.
(Time: 9 hours)

5. Written SCUBA test consisting of ten essay questions. The questions will cover the following subject areas: air embolism, decompression emergency procedures, diving first aid, medical aspects of diving, equipment, oceanography, diving procedures (repetitive tables, regulations, special conditions), physics, physiology, marine animals, and special diving operations. This test shall be written and updated annually by the Diving Officer.
(Time: 3 hours)
Passing Score: 75/100

6. Ocean training: surf entries and exits, kelp diving, navigation, skin and SCUBA skills, self rescue, and lifesaving skills.
(Time: 8 hours)

7. Those dive team members trained in SAS shall have annual retraining of lecture, pool, and ocean, including chamber operations.
(Time: 24 hours)

Section 4

OPERATIONAL PROCEDURES

4.1 THE DIVE PLAN AND GENERAL SAFETY CHECKLIST

4.1.1 Prior to any diving operations, except as noted, a dive plan shall be submitted and approved. Review and approval shall be made by the Division Diving Officer. When a diving plan for the same or a similar operation has been previously approved within the current calendar year, submission of a diving plan is not required; however, the Division Diving Officer shall be notified prior to the dive. Any diving that includes specialized procedures such as decompression diving, surface air-supplied diving or high altitude diving requires the submission of a dive plan each time. All contractors shall submit a dive plan 4 working days prior to any diving operations and be approved by the Diving Officer through the Contracting Officer. Contractors shall refer to appendix A.15.

4.1.2 A dive plan conforming to the format below shall be prepared for each diving program. A Dive Plan Form is shown in Section 7.2, Forms. An accident management procedure specifying particular actions to be taken in the event of an emergency shall also accompany the diving plan. A copy of the completed and approved plan shall be available at the dive site.

4.1.3 The required plan will contain at least the following items:

a. Purpose and location (including necessary maps and drawings).

b. Scheduled date and estimated duration of dive.

c. Diving apparatus/equipment to be used.

d. Maximum working depth and estimated bottom time, altitude, etc.; tables used, repetitive group, etc.; full workup of the dive including decompression tables if necessary.

e. Type of diving craft to be used.

f. Names and duties of dive team members.

g. Emergency numbers for ambulance, doctors, hyperbaric chambers, etc.

h. An Accident Management Plan.

4.1.4 As part of preparations for the dive, the Dive Master shall go through the General Safety Checklist (Table 4-1). If a boat is to be used for diving operations, the Dive Master should go through the Diving Boat Equipment Checklist (Table 4-2) to ensure that all necessary equipment shall be on board for the dive.

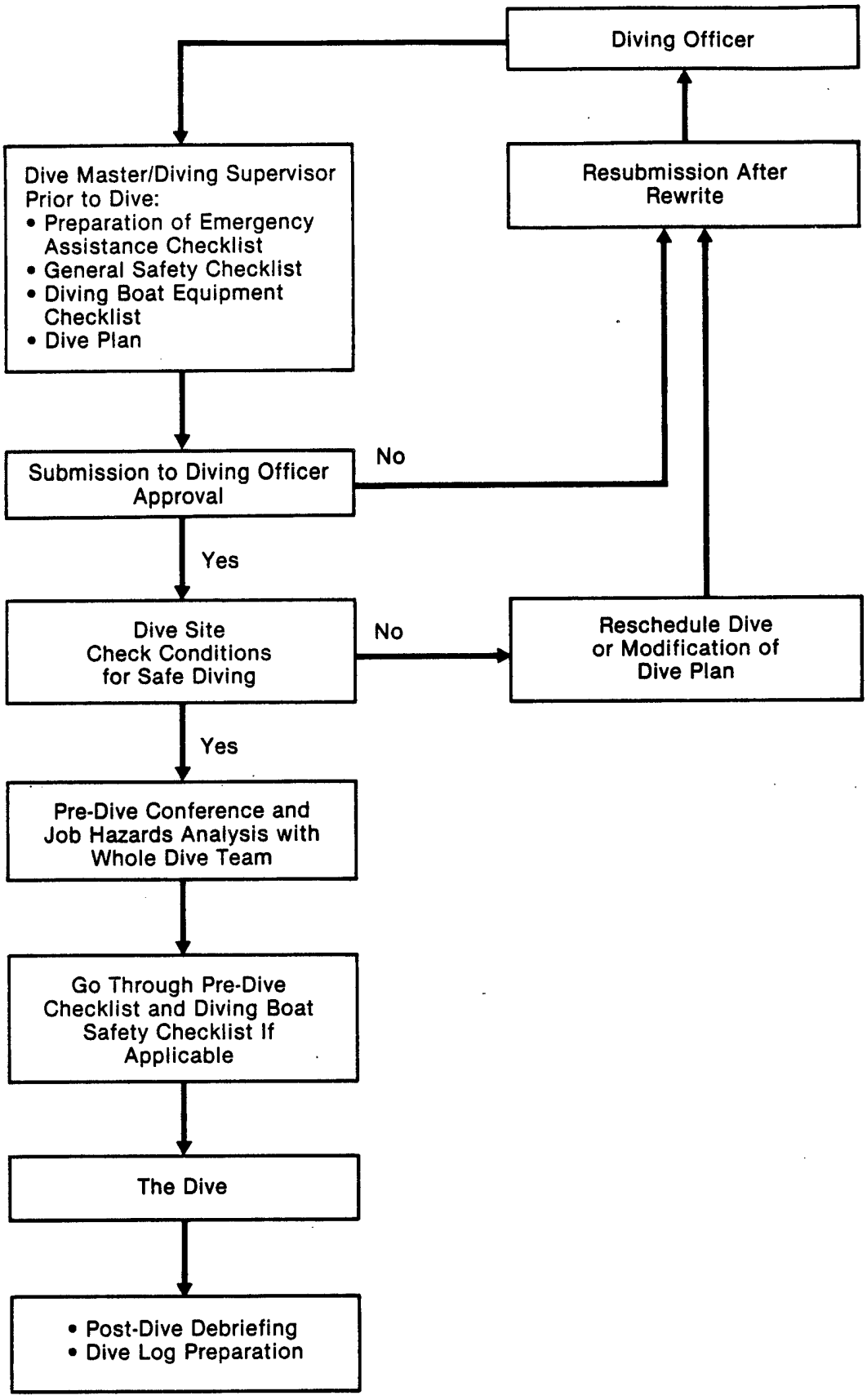

Figure 4-2.

PROCEDURES FOR DIVE MASTER

Table 4-1. GENERAL SAFETY CHECKLIST - STEPS IN PLANNING OF DIVING OPERATIONS
(Modified from U.S. Navy Diving Manual)

A. / / ANALYZE THE MISSION FOR SAFETY

Advanced planning is the <u>greatest single safety precaution</u> that can be taken.

/ / Objective definition.
/ / Environmental conditions.
/ / Emergency assistance.
/ / Relevant instructions.
/ / Safety instructions.

B. / / PIN-POINT POTENTIAL HAZARDS

/ / <u>Natural Hazards</u>

1. Atmospheric:
   ____ Extreme exposure of personnel to elements.
   ____ Adverse exposure of equipment and supplies to elements.
   ____ Delays or disruption caused by weather.

2. Surface:
   ____ Sea sickness.
   ____ Water entry and exit.
   ____ Handling of heavy equipment in rough seas.
   ____ Maintaining location in tides and currents.
   ____ Ice, flotsam, kelp, petroleum disrupting operations.
   ____ Delays or disruption caused by sea state.

3. Underwater and Bottom:
   ____ Depth exceeds diving limits or limits of available equipment.
   ____ Exposure to cold temperatures.
   ____ Dangerous marine life.
   ____ Tides and currents.
   ____ Limited visibility.
   ____ Bottom obstructions.
   ____ Dangerous bottom conditions (mud, drop-offs, sewer outfalls, etc.)

/ / <u>"On-Site" Hazards</u>

   ____ Local marine traffic.
   ____ Highpowered, active sonar.
   ____ Other conflicting operations.
   ____ Radiation contamination.
   ____ Pollution.

/ / <u>Mission Hazards</u>

   ____ Decompression sickness.
   ____ Communications problems.
   ____ Drowning.
   ____ Other trauma (injuries).

(Continued)

Table 4-1. (Cont'd)

/ / Object Hazards
____ Entrapment.
____ Entanglement.
____ Explosives or other ordnance.
____ Shifting or "working" of object.

C. / / MINIMIZE HAZARDS AND PLAN FOR EMERGENCIES

/ / Diving Personnel
____ Assign a complete and properly qualified Diving Team.
____ Assign the right person to the right task.
____ Verify that each member of the Diving Team is properly trained and qualified for the equipment and depths involved.

Determine that each diver is physically fit to dive, paying attention to:
____ General condition.
____ Last record of medical exam.
____ Ears and sinuses.
____ Severe cold or flu.
____ Use of stimulants or intoxicants.
____ Fatigue.
____ Hypothermia

Determine each diver's emotional fitness to dive (as far as possible):
____ Motivation (willingness).
____ Stability.

/ / Diving Equipment
____ Verify that the type of diving gear chosen and diving technique is adequate for the mission and particular task.
____ Verify that all equipment has been tested and approved for New England Division use.
____ Determine that all necessary support equipment and tools are readily available, and are the best for accomplishing the job efficiently and safely.
____ Determine that all related support equipment such as winches, boats, cranes, floats, etc. are operable, safe, and under the control of trained personnel.
____ Check that all diving equipment has been properly maintained with appropriate records, and is in full operating condition.

/ / Provide for Emergency Equipment
____ Obtain suitable communications equipment with sufficient capability to reach "outside help". Check all communications for proper functioning.

(Continued)

Table 4-1. (Cont'd)

____ Verify that a recompression chamber is ready for use, or notify the nearest command having one that its use may be required within a given time frame.
____ Verify that a First Aid kit is near at hand, and is completely stocked.
____ If oxygen will be used as standby first aid, verify that the tank is full, properly pressurized, and that all masks, valves and other accessories are fully operable.
____ If a resuscitator will be used, check the apparatus for function.
____ Check that all fire-fighting equipment is readily available and in full operating condition.
____ Verify that Emergency transportation is either standing by or on immediate call.

/ / Establish Emergency Procedures
____ Know how to obtain medical assistance immediately.
____ Assign specific tasks to the Diving Team and support personnel for different emergencies.
____ Develop and Post the Emergency Assistance Checklist, and ensure that all personnel are familiar with it.
____ Verify that a copy of the U.S. Navy Decompression Tables is available and up-to-date.
____ Be sure that all divers, boat crews, and other support personnel understand all diver hand signals.
____ Pre-determine distress signals and call-signs with all members of the diving team, boat crews, and other activities.

Thoroughly drill and train all personnel in Emergency Procedures, with particular attention to cross-training. Drills should include:

____ Emergency recompression.
____ Fire.
____ Rapid dressing.
____ Restoration of breathing.
____ Electric shock.
____ Entrapment.
____ Rapid undressing.
____ First aid.
____ Embolism.
____ Drowning.
____ Blow-up.

D. / / ESTABLISH SAFE DIVING OPERATIONAL PROCEDURES
____ Determine that all other means of accomplishing the mission have been considered before deciding to use divers.

(Continued)

Table 4-1. (Cont'd)

____ Be sure that contingency planning has been conducted.
____ Carefully state the goals of each mission, and develop a flexible plan of operations.
____ Completely brief the Diving Team and support personnel.
____ Designate a properly qualified Dive Master to be in charge of the mission.
____ Designate a timekeeper and verify that he understands his duties and responsibilities.
____ Determine the exact depth at the job-site through the use of a lead line or pneumofathometer.
____ Verify the existence of an adequate supply of compressed air available for all planned diving operations plus an adequate reserve for emergencies.
____ Be sure that no operations or action on the part of the Diving Team, support personnel, boat crews, technicians, winch operators, etc. may take place without the knowledge and by the direct command of the Dive Master.
____ All efforts must be made through proper planning, briefing, training, organization, and other preparations to minimize "bottom-time." Remember in all cases, water depth and the condition of the diver (especially fatique) rather than the amount of work to be done shall govern the diver's bottom time.
____ Decompression tables should be on hand, be up-to-date, and be used in all planning and scheduling of diving operations.
____ Instruct all divers and support personnel not to cut any lines until that action is approved by the Dive Master.
____ Be sure that the ship, boat, or diving craft is securely moored and in position to permit the safest and most efficient operations (Except in the case of emergency and critical ship repairs).
____ Verify that, when using surface-supplied techniques, that the ship, boat, or diving craft is in a least a two-point moor.
____ Ensure that, when conducting SCUBA operations, the boat can be quickly cast off and moved to a diver in distress.
____ Ensure that each diver checks his own equipment in addition to checks made by tenders, technicians, or other support personnel.
____ Designate a standby diver for all surface-supplied operations. And check that the standby diver is dressed (including breastplate) and ready to enter the water if needed.
____ Assign buddy divers for all SCUBA operations.
____ All efforts should be made to prevent the divers from being fouled on the bottom. If work is to be conducted inside a wreck or similar underwater structure, designate a team of divers to accomplish the task. One diver will enter the wreck, the other shall tend his lines from the point of entry.

(Continued)

Table 4-1. (Cont'd)

____ When using explosives, take appropriate measures to ensure that no charge will be fired while divers are in the water.
____ Use appropriate safety procedures as outlined in relevant naval publications for all underwater cutting and welding operations. All these operations must be approved in writing prior to their undertaking.
____ Brief all divers and deck personnel on the planned decompression schedules for each particular dive. Check provisions made for decompressing the diver.
____ Verify that the ship, boat or diving craft is displaying the proper signals, flags, day-shapes, or lights to indicate diving operations are in progress. Both diver down-flag and alpha-flag must be flown.
____ Ensure that proper protection against harmful marine life has been provided.
____ Check that the quality of diver's air supply is periodically and thoroughly tested to ensure purity.
____ Thoroughly brief the boat crew using the diving Boat Operations Checklist.
____ Verify that proper safety and operational equipment is aboard small diving boats or craft (see Boat Equipment Checklist).

/ / Notify Proper Parties that Diving Operations are Ready to Commence
____ Diving Officer
____ Bridge, to ensure that ship's personnel will not:
Turn the propeller or thrusters
Get underway
Activate active sonar or other electronics
Drop heavy items overboard
Shift the motor
Operate rudder or steering mechanisms
____ Other interested Parties
____ Harbor Master
____ State Department of Fish and Game if collecting specimens.
____ U.S. Coast Guard
____ Notify Emergency Facilities having recompression chambers, as well as sources of Emergency Transportation that Diving Operations are underway and their assistance may be needed.

Table 4-2. DIVING BOAT EQUIPMENT CHECKLIST
(Modified from U.S. Navy Diving Manual)

ALWAYS REQUIRED

Anchor Gear & Spare
Binoculars
Blankets
Boat Hook
Boat Operations Checklist
Bucket & Soap
Bumpers, Boat
Call Signs, Mother Ship or Station
Charts
Compass
Decompression Tables
Descending/Decompression Line (when appr)
Diving Equipment
Diving Handbook
Drinking Water
Fire Extinguishers
First Aid Equipment
Flares
Flashlights
Fuel; Engine and Compressors
Gloves
Heavy Line
Lifesaving Gear (Standard)
Lights; Navigation, Surface, Underwater
Line, Working, 1/2" Manila
Logs, Diving
Mooring Lines
Pencils
Radio
Signals; Sound, Day-Shapes, Flags
Tide Tables
Timepiece
Tools

OPTIONAL

Blue Print or Sketch of Job
Boat Stowage Box
Bull Horn
Buoys; Mooring, Marker
Ear Ease
Food
Foul Weather Gear
Grease
Grease Pencils
Lift Bags
Luff Tackle
Matches
Markers, Waterproof
Pressure Gauge
Probe, 10' Pipe (1 inch dia.)
Radar Reflector
Sea Sickness Pills
Shackles, Snap Hooks
Slate, Underwater
Sun Shades
Sun Tan Lotion
Tank Rack, SCUBA
Tape, Electrical & Masking
Tape Measure (6')
Thermometer, Underwater
Tow Line
Towels
Wire and Fasteners
Whistles, Mouth

4.2 GENERAL DIVING PROCEDURES

a. Under ordinary conditions no dive team member shall dive alone. At least two divers shall be used for all underwater work except in an enclosed space. In this case the diver will be tethered to his dive buddy at the entrance or the surface with a standby diver and continual visual contact shall be maintained.

b. Dive team members will be briefed before the dive by the Dive Master (see Section 4.3.3, The Pre-Dive Conference and Job Hazards Analysis).

c. No dive team member shall enter the water before completing a pre-dive checklist (see Section 4.3.4, Pre-Dive Checklist).

d. Standard logs shall be used to record each dive (see Section 4.3.10, Records).

e. When multiple dives are necessary, deepest dives shall be accomplished first when practicable: All dives will be made within the "No Decompression" limits of the U.S. Navy tables unless prior permission for decompression diving has been granted by the Diving Officer.

f. Air tanks shall be handled with care and periodically inspected in accordance with appropriate DOT regulations. All air tanks must pass an annual visual inspection (VIP).

g. At no time shall a dive team member be expected to dive against his personal judgement.

h. A dive team member shall not work underwater when suffering from fatigue, emotional strain, respiratory infection, stomach upset, or when under the influence or after effects of alcohol or medication. The dive team member shall at all times be aware of his current physical condition and the diving situation, and should either not dive or restrict his diving accordingly. The Dive Master shall not allow a diver to dive if, in his judgement, the diver is unfit.

i. Dive team members shall be required to perform a minimum of 12 diving days per year at a schedule of approximately 1 diving day per month to maintain their active status.

j. The Diving Officer shall be responsible for making safety decisions for events not covered in this manual. On-site responsibility is that of the Dive Master.

k. In an emergency the Dive Master may waive regulations at the diving site.

l. When diving from platforms other than vessels in areas with potential boat traffic, a rigid replica of the international code flag "A" and diver down flag both at least 1 meter in height, shall be displayed

at the dive location in a manner which allows all-around visibility , and shall be illuminated during night diving operations.

m. Contractor diving shall follow the procedures set forth in the Division Diving Manual, the U.S. Navy Diving Manual, and OSHA regulations. Where conflicts arise, the more restrictive regulation shall prevail.

n. The Dive Master shall be responsible for the safe execution of the diving operation at the site. If at any time he considers that conditions are not safe, he shall abort the dive. In addition to dangerous water conditions, if at any time he considers that the operation has become unsafe due to poor handling, inadequate equipment, or for any other reasons, he shall abort the dive. Any diving operations aborted by any of the above actions shall not be resumed until the unsafe acts or conditions have been corrected and all persons concerned are in agreement that it is safe to proceed.

o. SCUBA diving shall not be conducted at depths greater than 130 feet unless previously approved by the Diving Officer.

p. A dive team member shall be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces. Divers entering confined spaces shall be tethered and tended by an underwater diver. Divers shall not enter areas known or suspected to contain flammable or poisonous atmospheres.

q. A diver-carried reserve breathing gas supply shall be provided for each dive team member consisting of: a manual reserve (J valve); or an independent reserve cylinder with a separate regulator connected to the underwater breathing apparatus. The valve of the reserve breathing gas supply shall be in the closed position prior to the dive.

4.3 PROCEDURES AT DIVE SITE

4.3.1 The Diving Team

a. Each diving team shall be made up of not less than three members. One member of the team shall be designated as Dive Master and shall be responsible for operation at the site. The Dive Master is responsible for preparing and submitting the diving plan, securing a suitable diving craft, conducting the pre-dive conference, inspecting equipment prior to a dive, and assuring that safe conditions are maintained and regulations are followed.

b. One team member shall serve as a standby diver and shall remain on the surface to assure that safe diving conditions prevail. The standby diver shall be ready to supply immediate assistance in the water if necessary. At the discretion of the Diving Officer when the divers are in buddy teams, the requirement for a standby diver for SCUBA activities may be waived. For surface-supplied diving, there shall always be a standby diver and he shall be suited up ready to go so that he could quickly provide assistance on the bottom.

c. SCUBA dives shall be conducted in buddy pairs. One member of each buddy pair shall be designated Senior Diver and will lead the buddy pair in the water. The buddy divers are jointly responsible for the assigned mission,and each keeps track of the depth and time factors for the dive. Each has responsibility for the safety and well-being of the other, being especially alert for symptoms of nitrogen narcosis, decompression sickness, and carbon dioxide poisoning.

d. When a tender is used, as in surface-supplied diving, he shall be a qualified diver. If during an operation a substitute tender must be employed, the Dive Master shall make certain that he is adequately briefed before he takes over the lines. The tender shall set up all diving equipment prior to a dive and notify the Dive Master so that he may inspect it. The tender shall keep the lifeline and/or air line in his hands at all times and perform no other duties when a diver is in the water.

4.3.2 Conditions Which Would Ordinarily Cause a Dive to be Cancelled

The Dive Master is responsible for safety at the dive site and shall cancel diving at any time he feels conditions have become unsafe. Under the following conditions listed in Sections 4.3.2.1, 4.3.2.2, and 4.3.2.3, a dive would ordinarily be automatically cancelled. The Dive Master shall permit diving under these conditions only if he can document that the actual circumstances of the dive were not unsafe. In addition, each individual diver is personally responsible for his own safety and may decline to dive if he feels that conditions are hazardous for his own physical condition and ability.

4.3.2.1 Boat Diving

The following conditions would normally cancel diving from a boat:

- Current - greater than 3.0 knots
- Sea State - greater than 6 (Beaufort Scale)
- Fog - visibility less than 100 yards
- Swell - greater than 10 feet
- Wind - great enough to hinder maneuverability of the boat
- Any dive team member not fit to dive

4.3.2.2 Shore Diving

The following conditions would normally cancel diving from shore:

- Surf - greater than 5 feet
- Fog - visibility less than 100 yards

- Current - greater than 1.5 knots
- Any dive team member not fit to dive

4.3.2.3 Equipment Malfunctions

The following equipment malfunctions or deficiencies would normally cancel diving:

- Loss of radio contact.
- If all required first aid equipment is not present at the dive site.
- If a functional resucitator is not available at the dive site.
- If a dive team member's personal equipment is not in proper working order. Any inefficiency in primary or backup equipment. Any unanticipated unavoidable hazard.
- Any dive team member not fit to dive.

4.3.3 The Pre-Dive Conference and Job Hazards Analysis

a. Prior to the dive, a pre-dive conference shall be conducted by the Dive Master at the dive site to review the plan of operation (discuss all phases of the dive, work to be accomplished, equipment to be used, and safety factors and emergency procedures). The Dive Master and dive team shall review depths and, when applicable, decompression tables. Anyone already familiar with the area shall inform the dive team of any pertinent information. The Dive Master shall review with the dive team all diving signals.

b. Prior to making individual dive team member assignments, the Dive Master shall assess the dive team members' current state of physical fitness and indicate to the dive team members the procedures for reporting physical problems or adverse physiological effects during and after the dive. Each dive team member has a responsibility to voice concerns about the safety of the operation. The "can do at all costs" attitude shall be discouraged.

c. As part of the pre-dive conference, the Dive Master, in conjunction with the dive team, shall conduct an "Activity Job Hazards Analysis" (AJHA). The AJHA shall be written down and shall be turned in to the Diving Officer along with the individual diving logs. The written AJHA shall include:

(1) Objective of dive (inspection, repair, debris removal, salvage, training, etc.).

(2) Exact location of work.

(3) Anticipated conditions or hazards:

- Weather

- Water conditions
- Type of bottom (mud, rock, gravel, coral, sand)
- Expected underwater visibility
- Depth
- Currents/tides/turbulence/boils
- Temperature (air)
- Temperature (water)
- Obstructions and/or underwater hazards
- Marine life

(4) Emergency Assistance Checklist (including names and phone numbers)

(5) Dive plan

(6) Lock crew availability (if applicable)

In the interest of overall safety, the Emergency Assistance Checklist shall be reviewed verbally with the dive team and all lock crew/flood control job site personnel (if applicable) then posted in a place of prominance near the project office telephone. Before diving begins, the Dive Master will go through the applicable pre-dive checklists as described in Section 4.3.4.

4.3.4 Pre-Dive Checklists

a. If diving operations are to be conducted from a boat, the Diving Boat Safety Checklist (Table 4-3) shall be gone through by the Dive Master prior to leaving the dock.

b. For all dives, whether from a boat or the shore, the Dive Master shall inspect the diving conditions and each dive team member using the Pre-Dive Checklist (Table 4-4) as a guide.

4.3.5 Documents and Equipment to be Available at Dive Site

The following documents and equipment shall be at the dive site.

a. A list, such as the Emergency Assistance Checklist shown in Table 4-5, shall be kept at the dive location with the telephone or call numbers of the following:

- An operational recompression chamber
- Accessible hospitals

- Available physicians
- Available means of transportation
- The nearest U.S. Coast Guard Rescue Coordination Center

b. The Dive Master shall have a copy of this diving manual and a site-specific dive plan at the job site during all dives.

c. A first aid kit as designated in Section 5.7, First Aid Kit Supplies, shall be available at the dive location. In addition to any other first aid supplies, an American Red Cross Advanced First Aid Handbook or equivalent and a resuscitator shall be available at the dive location. A means of emergency radio communication shall be at the dive site.

4.3.6 Hand Signals

Table 4-6 lists the standard hand signals to be used for underwater communication between buddy divers. These signals are illustrated in Figure 4-1. These signals, and only these signals, are to be used for the specified meanings. If it is desirable to communicate on additional subjects, such as the details of the work to be performed on a dive, the buddy divers shall agree on appropriate hand signals before entering the water.

Table 4-3. DIVING BOAT SAFETY CHECKLIST
(Modified from U.S. Navy Diving Manual)

All personnel involved in the operation of diving boats, launches, barges, floats, and other types of secondary small craft should be briefed and must understand the following safety precautions

1. Inspect the specified boat or craft and determine its suitability for the intended mission and operating environment. Ensure that:
   ___ Boat (craft) is sound, seaworthy, and well found.
   ___ Power plant is running well and fully tested.
   ___ Required safety and running equipment is on board and in workable condition.
   ___ Proper gear for diving operation is on board and operational.
   ___ The assigned boat crew is fully qualified to operate that particular craft.

2. Know the details of the Emergency Assistance Checklist. Make sure it is completely filled out for small craft operations, with a legible copy placed on board.

3. Inspect all communications gear, radios, CB units, underwater communications, power sources, 2-way radios, and ensure that they have been fully tested and are operational.

4. Determine that all nonpowered communication equipment (flags, sound signals, flares, radar reflectors, etc.) are on board, are complete, and are operational.

5. Know all pre-determined signals, proper call signs, etc.

6. Know all routing and emergency signals (for divers):
   ___ Sound (whistle, horn, recall)
   ___ Sight (hand signals from diver)
   Pick me up Pick me up now!
   Hold everything
   OK UP Down
   ___ Signals (Lights)_____
   (Day-Shapes)_____
   (Flags)_____

7. Determine that adequate and safe mooring equipment is on board, and personnel are familiar with proper mooring techniques.

8. Know who is in charge of the boat and responsible for giving of orders to "Stop" and "Start" the small craft. Orders to commence boat operations that affect divers are given only by the Dive Master.

9. Before getting underway, check with the Dive Master for:
   ___ An "all-aboard" head count.
   ___ His approval that all diving equipment, lines, safety equipment, etc. are on board.

10. Plan for various Boat Handling during Diving Operations to include:
   ___ Dropping off of divers
   ___ Picking up divers
   ___ Towing divers
   ___ Getting underway in an emergency.
   ___ Positioning boat in a 2 point moor, 4 point moor
   ___ Handling of divers' lines during descent, ascent, hanging-off, raising or lowering tools and gear, drop-off pick-up
   ___ Setting/retrieving of buoy markers
   ___ Moving or towing of platforms, rafts, rubber boats, search sleds, etc.

Table 4-3. (Continued)

11. Ensure that stowage of diving supplies and gear does not block access to:
    - ___ Fire extinguishers
    - ___ Life preservers
    - ___ Ground tackle
    - ___ Engine spaces
    - ___ Communication gear
    - ___ Bilge pump or switch
    - ___ Boat hook
    - ___ Heaving line
    - ___ Emergency lights
    - ___ Flares
    - ___ First Aid Kit
    - ___ Diving platform

12. Know these general safety precautions that apply to Boat Operations:
    - ___ Place all intakes for the diving air compressor upwind of engine or auxiliary power plant exhausts:
    - ___ Ensure safety of the boat when:
        - Handling gasoline, explosives or other dangerous material
        - Shoring and handling of heavy equipment.
        - Securing gear for heavy equipment.
        - Securing gear for heavy weather.
        - Cutting, welding, and other operations involving fire.
    - ___ When divers are down:
        - Do not change a moor
        - Do not set anchors
        - Do not drop heavy items overboard.

    - ___ And. . . NEVER START ENGINES WHEN DIVERS ARE UNDER BOAT OR ALONGSIDE.

Table 4-4. PRE-DIVE CHECKLIST
(From CERCR 385.4)

1. GENERAL
   - A. Water Depth
   - B. Wave Height
   - C. Current Velocity
   - D. Visibility
   - E. Water Temperature
   - F. Signals and procedures mutually understood

2. EQUIPMENT
   - A. Tank:
     - 1) Pressure, condition
     - 2) Straps over other gear (except weight belt)
     - 3) Quick release
     - 4) Valve open
     - 5) Reserve up
     - 6) Check for leaks
   - B. Regulator:
     - 1) Condition
     - 2) Function
     - 3) Quality of air
     - 4) Check for leaks
   - C. Mask:
     - 1) Condition
     - 2) Adjustment
     - 3) Snorkel
   - D. Fins:
     - 1) Condition
     - 2) Fit
   - E. Flotation vest:
     - 1) Condition
     - 2) CO_2 cartridge or other inflation device
     - 3) Oral inflation test
     - 4) Under belt and tank straps
   - F. Weight Belt:
     - 1) Quick release
     - 2) Over other gear
     - 3) Weight
   - G. Wet Suit:
     - 1) Condition
     - 2) Zippers closed
   - H. Knife:
     - 1) Condition
     - 2) Set in sheath
   - I. Other Equipment:
     - 1) Condition
     - 2) Secure and in proper position

Table 4-5. EMERGENCY ASSISTANCE CHECKLIST

RECOMPRESSION CHAMBER

Location

Contact

Response Time

AIR TRANSPORTATION

Location

Contact

Response Time

SEA TRANSPORTATION

Location

Contact

Response Time

HOSPITAL

Location

Contact

Response Time

DIVING MEDICAL OFFICER

Location

Contact

Response Time

SUPPLIES

Location

Contact

Response Time

COMMUNICATIONS

Location

Contact

Response Time

CORPS OF ENGINEERS DIVING OFFICER

Location

Contact

Response Time

U.S. COAST GUARD RESCUE

Location

Contact

Response Time

Navy Experimental Dive Unit
(904) 234-4355
Air Force Hyperbaric Duty Officer
(512) 536-3278
National Diving Network
(919) 684-8111

Table 4-6. STANDARD HAND SIGNALS FOR DIVERS
(Modified from Council for National Cooperation in Aquatics)

NR	SIGNAL	MEANING	COMMENT
1	Hand raised fingers pointed up, palm to receiver.	STOP	Transmitted the same as a traffic policeman's STOP.
2	Thumb extended downward from clenched fist.	GO DOWN OR GOING DOWN	
3	Thumb extended upward from clenched fist.	GO UP OR GOING UP	
4	Thumb and forefinger making a circle with 3 remaining fingers extended, if possible.	OK! OR OK?	Divers wearing mittens may not be able to distinctly extend 3 remaining fingers (see both drawings of signal).
5	Two arms extended overhead with fingertips touching above head to make a large O shape.	OK! OR OK?	A diver with only one free arm may make this signal by extending that arm overhead with fingertips touching top of head to make the O shape. Signal is for long range, like between diver and boat.
6	Hand flat, fingers together, palm down, thumb sticking out, then hand rocking back and forth on axis of forearm.	SOMETHING IS WRONG	This is the opposite of OK! The signal does not indicate an emergency.
7	Hand waving overhead (may also thrash hand on water).	DISTRESS	Indicates immediate aid required. This is the communication that will be used between diver and boat or diver and shore if trouble occurs.
8	Fist pounding on chest.	LOW ON AIR	Indicates signaller's air pressure is reduced to the quantity agreed upon in predive planning, or actuating reserve valve.
9	Hands to throat.	HELP ME TO SURFACE	Indicates problem or injury requiring immediate emergency assistance to the surface.
10	Hand slashing or chopping throat.	OUT OF AIR	Indicates that signaller cannot breathe for some reason.
11	Fingers pointing to mouth.	LET'S BUDDY BREATHE	The regulator may be either in or out of the mouth.
12	Clenched fist on arm extended in direction of danger.	DANGER	

All signals are to be answered by the receiver's repeating the signal as sent. Answers to signals 7, 9, 10, and 11 should include the receiver's approaching and offering aid to the signaller.

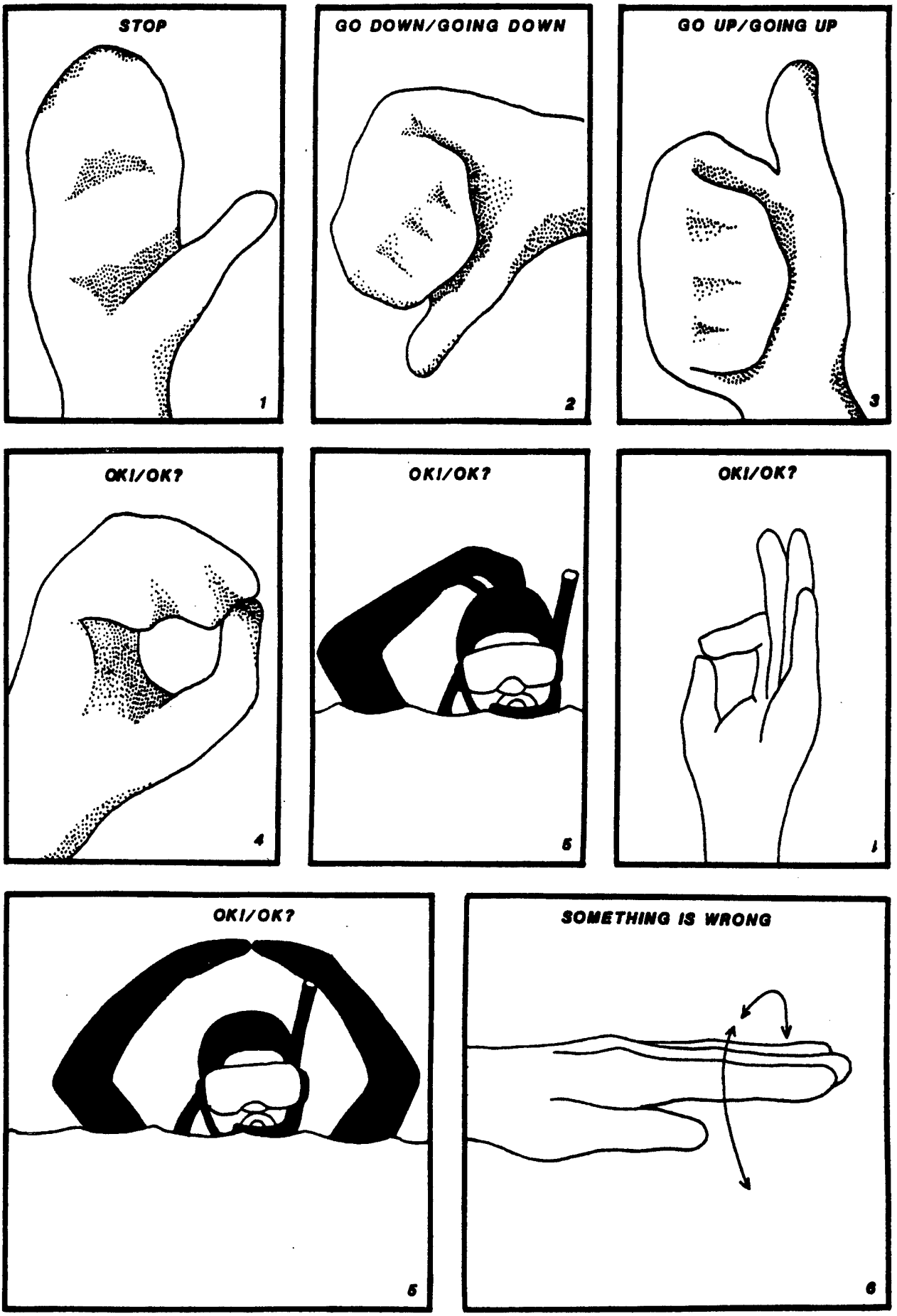

Figure 4-1 SKIN AND SCUBA DIVING HAND SIGNALS

Figure 4-1 (cont'd) SKIN AND SCUBA DIVING AND SIGNALS

4.4 SURFACE AIR SUPPLIED DIVING (Source: The NOAA Diving Manual)

4.4.1 General Procedures. These sections give a brief overview of Surface Air Supply (SAS) diving safety requirements in addition to the U.S. Navy Dive Manual and OSHA Regulations.

When underwater tasks require the diver to work in a specified area for an extended period of time, it may be safer and more efficient to plan the dive using umbilical diving techniques. The following advantages can be gained:

- Continuous air supply
- Communications
- Heat if required
- Comfort for extended duration
- Safety

Special procedures must be followed when diving with an umbilical. The procedures to be used are described below.

4.4.1.1 Tending

a. The most effective assistance can be given only by a tender who is very familiar with the equipment, procedures, safety precautions, conditions and difficulties inherent in diving. It is the tender's responsibility to see that the diver receives proper care while both topside and underwater. He shall check all equipment before sending the diver down, and aid the diver in dressing and computing decompression requirements. While the diver is submerged, the tender handles the umbilical and maintains communications, time, and monitors the air supply system.

b. The following procedures should be carried out prior to the dive. The Surface-Supplied Diving Operations Pre-Dive Checklist (Table 4-7) shall be used as an aid to make sure that all necessary preparations have been made:

- Assemble and inspect air supply system, including compressor and/or high-pressure cylinders and umbilical assembly, and pressure test for leaks. Check replacement and maintenance dates.
- When using high-pressure cylinders, gauge and mark each cylinder to ensure that all personnel know which cylinders are full and are to be used for the dive.
- Check air regulation or control system including emergency switching to secondary air supply and back-up regulator (if so equipped).
- Mask or helmet shall be prepared in the fashion prescribed by manufacturer.
- Notify nearest chamber so it is ready for immediate use in the event of an emergency and have personnel available to operate the chamber.

- Assemble all equipment for final check by tender, diver, and Dive Master.
- The tender and/or Dive Master shall enter necessary information into the diving log.

Table 4-7. SURFACE-SUPPLIED DIVING OPERATIONS PRE-DIVE CHECKLIST
(From U.S. Navy Diving Manual)

A. Basic Preparation
- Check that, for dives over 100 feet, a recompression chamber and diving medical officer are present on the diving station.
- Verify that the proper signals indicating underwater operations are being conducted are properly displayed.
- Make sure that all personnel concerned or in the vicinity have been informed that diving operations are underway.
- Determine that all valves, switches, controls and equipment components that influence the diving operation are properly "tagged-out" to prevent inadvertent shut-down or activation.

B. Equipment Preparation
- Assemble all members of the diving team as well as support personnel (winch operators, boat crew, watch-standers, etc.).
- Assemble and lay out all equipment that may be used on the dive, either as primary equipment or standby spares for the diver (or standby diver). This should include all accessory equipment all tools.
- Check all equipment for superficial wear, tears, dents, distortion or any other apparent discrepancies.
- Check all masks, helmets, viewing ports, faceplates, seals, and visors for broken glass or plastic.
- Check all belts, laces, and lanyards for wear and renew as needed.

C. Lightweight Diving Outfit (MK 1)
- Check wet suit for tears or excessive wear.
- Check faceplate and seal on the Mk 1 mask.
- Check that face seal and oral-nasal mask are properly attached to the main mask body.
- Check that all metal components are properly secured to the fiberglass body.
- Check that the nose clearing device slides in and out easily.
- Check mask straps for wear. Gauge the "bail-out" bottle.
- Check flippers, weight belt and other accessory equipment according to SCUBA equipment checklists in Chapter 6.
- Ensure nose pad is properly secured.
- Verify that the oil in the compressor is of a type that is proper for the particular compressor and is not petroleum-based. Check that the compressor oil does not overflow the "Fill" mark or contamination of the air supply could result from fumes or oil mist.
- Check that the compressor exhaust is vented away from work areas and, specifically, does not foul the compressor intake.
- Check that the compressor intake is obtaining a free and pure suction without contamination. Use pipe to lead intake to free suction if necessary.
- Check that compressors are not covered during operation.
- Check all filters, cleaners, and oil separators for cleanliness.
- Bleed off all condensed moisture from filters and the bottom of volume tanks (accumulators). All manifold drain plugs should be checked.
- Check that all petcocks are closed.
- Check that all bel-guards are properly in place on drive units.
- Check all pressure-release valves, check valves, and automatic unloaders. Make sure that the wing nut to the

(Continued)

Table 4-7. (Cont'd)

unloader is in the compressing position.
- Verify that all supply hoses running to and from the compressor have proper leads, are not passing near high-heat areas such as steam lines, are free of kinks and bends, and are not exposed on deck in such a way that they could be rolled over, damaged, or even severed by machinery or other activities.

D. General Equipment
- Check that all needed accessory equipment, tools, lights, special systems, spares, etc. are on scene and in working order. In testing lights, all tests should be conducted with lights submerged in water and extinguished before removal to prevent overheating and failure.
- Erect the diving stage or attach the diving ladder. In the case of the stage, be careful to insure that the shackle connecting the stage line is securely fastened with the shackle pin siezed with the wire to prevent opening. Secure the air-hose bulwark roller in place.

E. Preparing the Air Supply
- Check that a primary and suitable backup supply is available with a capacity in terms of purity, volume, and supply pressure to completely service all divers and accessory equipment throughout all phases of the planned operation.
- Determine that proper personnel are available to operate and stand watch on the air supply.
- Compressors -
  - Determine that sufficient fuels, coolant, lubricants, and anti-freeze are available to service all components throughout the operation. All compressors should be fully fueled, lubricated and serviced (with all spillage cleaned up completely).
  - Verify that the appropriate operating and service manuals are on hand.
  - Check maintenance and repair logs to insure the suitability of the compressor (both primary or backup) to support the operation.
  - Verify that all compressor controls are properly marked and any remote valving is tagged-off with "Diver's Air Supply - Do Not Touch" signs.
  - Make sure that the compressor is secure in the diving craft and will not be subject to operating angles that will exceed 15 degrees.
  - Verify that there is a pressure gauge on the air receiver and that it is functioning properly, and that the compressor is meeting its delivery requirements.
  - Check that the air supply is not being delivered below purity standards (smell, taste), or in excess of 95°F.
  - In all cases where compressors are used as a backup, either to a shipboard system, cylinder bank, or another compressor - the backup compressor will be kept running throughout the diving operation.
- Cylinders -
  - Gauge all cylinders for proper safety.
  - Verify the availability and suitability of the reserve cylinders.
  - Check all manifolding and valving for operation.
  - Activate and check delivery
- For all supply systems double check "Do Not Touch" tags.

(Continued)

Table 4-7. (Cont'd)

F. Activate the Air Supply

- Compressors -
  - Make sure that all run-up and warm-up procedures are completely followed.
  - Check all petcocks, filler valves, filler caps, overflow points, bleed valves, and drain-plugs for leakage or malfunction of any kind.
  - Soap-test all valves and connections.
  - Verify flow to helmets and masks.
  - Check all exhaust and air control valves.
  - Hook up and test all communications.
  - Check air flow from both primary and backup supplies to chamber.
  - Detach all shoes except that leading to chamber. Make sure chamber supply is completely shut off and no air is leaking to chamber, depleting the air supply.

G. Air Hoses

- Check that all hoses have a clear lead and are not subject to heating or damage.
- Check that no hose length used exceeds five years in age from the date of manufacture (age is marked on each length 4" from the end). Air hose used on ASR (Auxiliary Submarine Rescue) vessels may not exceed 3 years of age in any length.
  - If possible, make sure that the hose (or any length) has not been used in a burst test program. No length involved in such a program may be part of an operational hose.
  - Check that hoses are free of moisture, packing material, or chalk.
  - Soap test all hose connections after they have been hooked up to the air supply and pressurized.
  - Check that the newest (or best) hose length is the section nearest the surface, since that is the region in which the hose will be subjected to the greatest pressure change.
  - Check that all tie-offs, and the canvas chaffing over the first length of hose are in proper condition.
  - If possible, check gaskets at hoselength connections.

H. Test of Equipment with Activated Air Supply

- Hook-up all air hoses to helmets, masks, chambers, and make connections between backup supply and primary supply manifold.
- Check all doors and seals.
- Verify that all chamber electrical fittings are fitted with armoured cable and special lighting fixtures and bulbs. All switches should be on the outside of the chamber.

I. Recompression Chamber Checkout (Pre-Dive Only)

- Check that the chamber is completely free and clear of all combustible material.
- Check primary and backup air supply to chamber as well as all pressure gauges.
- Check that the chamber is free of all odors or other contaminants. Check the chamber oxygen supply, and that a suitable number of oxigen masks are rigged for at least two divers, one tender, and one medical assistant.
- Verify the presence of a sanitary bucket in the chamber in case of sickness.
- Verify that the medical kit is completely outfitted and in close proximity to the chamber.

J. Final Preparations

- Verify that all necessary records, logs, and timesheets are on the diving station.

(Continued)

Table 4-7. (Cont'd)

- Check that appropriate decompression tables are readily at hand.
- Verify that all air supply systems have a volume tank or accumulator installed in the air supply line between the supply source and the diver's hose connection. An oil separator must be installed between the volume tank and air source.
- Place the dressing bench in position, making sure that the diver will not have a long way to travel to reach the diving ladder or stage.

c. In tending the diver's umbilical assembly, or lines, the tender shall not hold the diver's line so taut as to interfere with the work. The diver shall be given 2 to 3 feet of slack when he is on the bottom, but not so much that he cannot be felt from time to time. Signals cannot be received on a slack line; consequently, the diver's lines shall be kept in hand with proper tension at all times.

d. Line-pull signals (see Table 4.8) consist of a series of sharp, distinct pulls, strong enough for the diver or tender to feel but not so strong as to pull the diver away from his work. When sending signals, take all of the slack out of the line first. Repeat signal until answered. The only signal not answered when received is the emergency "haul me up," and "come up" is delayed until the diver is ready. Continued failure to respond to signals may indicate that there is too much slack in the line, that the line is fouled, or that the diver is incapacitated. If contact with the diver is lost, the following procedures should be followed:

- If intercom communications are lost, the tender should attempt line-pull communications immediately.

- Depending upon diving conditions and previous arrangements made during planning, the dive may be terminated or continued to completion with line-pull signals. Generally, it is best to terminate the dive to resolve the problem or reorganize the dive plan.

- If the tender receives no immediate line-pull signal reply from the diver, he should take a greater strain on the line and signal again. Considerable resistance to the tender's pull may indicate that the umbilical line is fouled. A standby diver shall be dispatched as soon as possible.

- If the tender feels sufficient tension on the line to conclude that it is still attached to the diver, yet receives no signals, he must assume that the diver is unconscious. In this event, he shall dispatch a standby diver immediately.

- If it is considered unwise to use a standby diver, the diver must be pulled to the surface at a rate not exceeding 60 feet per minute. Prepare to administer first aid and recompression. Note: If the diver is wearing a closed-dress or variable-volume dry suit, this procedure is used only as a last resort. Subsequent blowup is almost unavoidable without the assistance of another diver. Therefore, when using a variable-volume dry suit a standby diver shall always be ready to enter the water.

e. The timekeeper or tender #2 shall continuously monitor the diver's depth and underwater time. He shall inform the diver several minutes before the expiration of bottom time so that the diver can make necessary preparations for ascent. In addition, he must continually monitor the diver's activity. For example, the tender can frequently evaluate the diver's exertion by counting the number of breaths per minute. Experienced tenders

will learn the diver's normal breathing rate. Significant increase in breathing rate may indicate potential overexertion situations. The tender may ask the diver to stop work, rest, and ventilate his helmet or mask.

f. The tender may also have to serve as timekeeper. This job includes keeping an accurate record of the dive time and details of the dive. When possible, a separate timekeeper should be used or the timekeeper duties should be handled by the Dive Master.

4.4.1.2 Dressing

a. The dressing procedures shall depend upon the type of diving dress or suit and helmet or mask used. Specific instructions or special manuals are supplied by the suit manufacturer. Prior to starting dressing procedures, the air supply system shall be operational and the mask or helmet completely prepared for diving. The following is a generalized dressing procedure applicable to most surface-supplied diving systems:

- Don diving dress or suit with assistance from the tender(s).
- Don diver's harness, secure, and adjust.
- If weighted diving shoes or ankle weights are used, they are placed on the diver by the tender and secured. If fins are used, they may be donned later with the assistance of the tender.
- Don neckring and secure if helmet is to be used.
- Don and adjust weight belt.
- Secure knife to belt, leg, or arm (diver's preference).
- With the diver or a second tender holding the mask or helmet, secure emergency gas cylinder.
- Don mask or helmet and secure mask harness or helmet clamp.
- Secure the umbilical assembly to harness.
- The tender ensures that the diver is properly dressed, that all equipment is functioning properly, and informs the Dive Master that the diver is ready.

4.4.1.3 Weighting

a. The amount of weight used by the umbilical diver will depend on the environmental conditions, mission requirements, and equipment used. In some cases the umbilical diver, like the SCUBA diver, may prefer to retain a state of neutral buoyancy. This is achieved in the same fashion as a SCUBA diver (e.g. with a buoyancy compensator being used to compensate for wet suit compression). The diver, properly trimmed, has a mobile capability comparable to that of a SCUBA diver within the range of his umbilical. Depending on the diving dress used and the mission requirements, the diver may choose to weight

himself in a negatively buoyant mode. For working in currents or using some tools underwater the diver may choose to use 20 to 30 pounds of extra weight on his belt or in the form of weighted diving shoes (or ankle weights). Naturally in this mode he will be working on the bottom.

b. Working in a negative mode is most desirable when using a variable-volume dry suit which enables the diver to inflate his suit in order to aid in bottom movement and ascent. Negative buoyancy is very important in live boating, and when taking decompression stops on a line in strong currents.

c. The standard SCUBA diving weight belt is satisfactory for handling no more than 25 pounds of weight. Some divers add a shoulder harness assembly to the weight belt in order to provide added comfort. One must be certain that belts equipped with shoulder harnesses can be readily jettisoned in an emergency and not foul on the umbilical assembly or emergency air system. The wider, heavy-duty, commercial-type weight belt is more desirable for weights in excess of 25 pounds.

4.4.1.4 Free-Flow/Demand Mask

The following procedures are recommended when preparing the mask for diving:

- Inspect the mask for any damage or loose fittings.
- Open free-flow valve, blow through the check valve, and then suck back to ensure that the check (nonreturn) valve is functioning properly.
- Check free-flow valve and regulator adjustment for free movement.
- Check exhaust valves to ensure that they are properly seated and free from foreign matter.
- Connect the communications wire and test communications.
- Purge gas supply hose to ensure that it is free from foreign matter.
- When using emergency manifold block, attach to gas supply hose and purge prior to attachment to mask.
- Verify that the emergency gas cylinder is filled to capacity, attach regulator, and connect to manifold block.
- Prior to connecting the primary gas supply hose, open the emergency cylinder valve and activate emergency system to verify proper function. Check for leaks and close emergency system valve.
- Connect primary gas supply hose and verify free-flow and demand system operation. Adjust the demand regulator to slight free-flow and then close until free-flow stops. Re-adjustments may be required at depth.

- Apply a thin film of antifogging solution during or prior to the dive. Liquid dishwashing soap is highly satisfactory.

- Put the mask on the diver and test both breathing systems.

- Secure the head harness as low as possible on the neck so that pressure is put on the base of the skull by the lower legs of the harness. The amount of tension will vary with individual preference.

- Secure the umbilical hose to the diver's harness (not to his weight belt).

4.4.1.5 Helmet

a. The procedures recommended when preparing the helmet for diving are the same as for a free-flow/demand mask with the following additions:

- Open free-flow valve, blow through the check valve, and then suck back to ensure that the check (nonreturn) valve functions properly. Another method of ensuring that the internal nonreturn valve is operating satisfactorily is to close the free-flow valve, connect an air supply to the helmet, and flow some air into the helmet. Without opening and free-flow valve, bleed and remove the air supply line. Submerge the helmet air hose connection in water; if no bubbles emerge, the valve is functioning properly.

- Ensure that neck ring seats and locks properly.

4.4.1.6 The Dive

a. When all personnel have completed dressing, checked equipment, and held final briefings, the captain (if diving from a vessel) and the Dive Master will be notified that the divers are ready to enter the water. He shall give clearance before the diving operation can commence. Entry technique shall depend upon staging area or type of vessel. Upon entering the water, the diver shall stop at the surface to make a final equipment check. The dive procedure is as follows:

- Adjust buoyancy if necessary. Whether the diver is weighted neutrally or negatively will depend on the mission requirements.

- Ensure that air supply system, helmet or mask, and communications are functioning properly. If not, corrections must be made prior to descent. Never dive with malfunctioning equipment.

- The tender should also verify that all equipment is functioning properly.

- The diver will be given permission to descend by the Dive Master.

- The diver will descend down a descent line. The descent line should be heavily weighted at the bottom and shall not be greased or oiled. A timer will be started when the diver begins his descent.

Descent rate will depend on the diver; however, it should generally not exceed 75 feet per minute. Diver shall take care that he descends straight down the line and does not spiral down and entangle his umbilical with the descent line.

- The diver must equalize pressure in his ears and sinuses during descent. If equalization is not possible, the dive shall be terminated.

- When descending in a tideway or current, the diver shall keep his back to the current so that he will be forced against the descent line.

- When the diver reaches the bottom, he shall inform the tender of his status.

- Regulate buoyancy and regulate air flow if necessary before releasing descent line.

- Attach distance line, if used, and proceed to work area. A distance line shall be used when visibility is extremely poor and the diver cannot see his descent line from a distance.

- Upon leaving the descent line, proceed slowly to conserve energy. It is advisable to carry one turn of the umbilical hose in your hand.

- Pass over, not under, wreckage and obstructions.

- If moving against a current, it may be necessary to assume a crawling position. Descent stage may be necessary.

- If the diver is required to enter wreckage, tunnels, etc., a second diver shall be present to tend the umbilical hose at the entrance.

- Avoid excessive exertion. The tender should monitor breathing rate and call for the diver to "stop, rest, and ventilate" as required. Also, avoid excessive excitement. This can enhance the onset of fatigue. Slow methodical efforts are always best in an emergency.

- The tender shall keep the diver constantly informed of his bottom time. Always notify the diver a few minutes in advance of termination time so he can complete his task and prepare for ascent.

4.4.1.7 Fouling

a. A surface-supplied diver's umbilical line may become fouled in mooring lines, wreckage, or underwater structures, or the diver may be trapped by the cave-in of a tunnel of shifting or heavy objects. The surface-supplied diver is in a much better situation to survive since he has a virtually unlimited air supply and generally the ability to communicate, thus facilitating rescue operations. Consequences of fouling may result in fatigue, exposure, and prolonged submergence, with subsequent prolonged decompression. If the diver becomes fouled, he should:

- Remain calm
- Think
- Describe his situation to his tender
- Systematically attempt to determine the cause and to clear himself
- Use a knife cautiously to avoid cutting portions of the umbilical assembly.

b. If efforts to clear himself prove futile, he should call for a standby diver, and calmly wait. Struggling and panic will only make the situation worse.

c. Divers shall proceed cautiously underwater and attempt to recognize obstructions, etc., which might cause fouling. Pass over or around if possible, not under. Proper precautions can usually avert fouling.

4.4.1.8 Blowup

a. Blowup is a hazard for the diver using a closed-dress (deep-sea or lightweight helmet connected to a dry suit) or variable-volume dry suit (UNISUIT or equivalent). Blowup is caused by over inflation of the dress or suit, too strong or rapid pull by the tender, or by the drag of the current causing the diver to lose hold of the bottom or descending line thus sweeping him to the surface. Accidental inversion of the diver, with subsequent filling of the legs with large amounts of air, may result in an uncontrolled blowup. This hazard even exists for the SCUBA diver when using a variable-volume suit.

b. The buoyancy characteristics of variable-volume dry suits shall not be used as a substitute for lift devices to carry objects to the surface.

c. Accidental blowup may result in injuries such as:

- Air embolism
- Decompression sickness
- Physical injury from the head striking some object such as the bottom of the ship.

d. The diver must be certain that all exhaust valves are functioning properly before descending. The diving suit or dress should be of proper size (especially length) to avoid excessive space in the legs for accumulation of air should the diver become inverted. This is especially true for divers wearing variable-volume suits. The diver shall be trained under controlled conditions in the use of all closed-type diving suits, regardless of previous experience with other types. "Controlled" blowups employed by some divers for ascent are discouraged.

e. A blowup victim shall not be allowed to continue the dive. If the diver appears to have no ill effects and is still within the no-decompression range as described by the tables, he shall be observed for signs of air embolism and decompression sickness adjacent to a recompression chamber.

f. If the victim is near or within the decompression requirements, he shall be recompressed in a chamber and decompressed in accordance with surface decompression procedures if it appears that surface decompression tables offer an immediate solution. If not, the victim would be recompressed in a chamber to depth as appropriate for U.S. Navy Treatment Tables 1A or 5. If no ill effects appear, treat the victim in accordance with the treatment table selected. If no chamber is available and the victim is conscious, he shall be treated in accordance with procedures for interrupted or omitted decompression. If the victim is unconscious, the procedures for handling victims of air embolism and decompression sickness shall be followed.

4.4.1.9 Normal Ascent

When bottom time is up or the mission is completed, the diver shall return to his ascent line and signal his tender that he is ready for ascent. The ascent procedures are as follows:

- The tender shall pull in excess umbilical line and take a slight strain on the umbilical line. He shall pull slowly and steadily at the prescribed rate (generally 60 feet per minute).
- A timer is started at the beginning of ascent and the tender shall watch the timer and pneumofathometer (if used) to control ascent rate.
- The diver shall regulate his buoyancy, if using a closed- or variable-volume suit, to aid the tender. Be cautious to avoid over inflation of the dress and subsequent "blowup."
- The tender or Dive Master must inform the diver well in advance of his decompression requirements. A diving stage may be required for long decompressions.
- When decompression is completed, the diver is taken on board via the ladder or diving stage.

4.4.1.10 Emergency Ascent

An emergency gas supply or "bailout" unit is a great asset in any type of diving, especially where direct ascent is prohibited. Upon failure of the primary gas supply, the emergency gas valve is opened, and the diver proceeds directly to the surface or first decompression stop. The free-flow valve shall be closed and the demand circuit used to conserve gas. Should the diver's hose be fouled to the degree of preventing ascent, and the primary gas supply is inoperative (not allowing sufficient time for the standby diver to descend), the diver shall alert the surface crew of his situation and notify them that he is cutting or releasing the umbilical hose to make an emergency

ascent. Some divers wear a small SCUBA tank with a separate single-hose regulator. In the event of primary gas supply failure, they simply jettison the mask and breathe from SCUBA while ascending. In this case, a SCUBA face mask should also be carried. If this situation occurs in waters of limited visibility, the umbilical should be followed to the surface.

Should gas failure occur when diving without self-contained emergency supply, the diver may drop his weight belt and ascend without removing the mask (exhaling throughout the ascent to prevent air embolism). In the event that the diver's hose is fouled, preventing him from surfacing with the mask on, the weight belt and harness (or harness attachment) should be released. The diver then removes the mask by grasping the main body and pulling the mask forward, up, and over the head.

4.4.1.11 Post-Dive Procedures

The divers shall be helped from the water and aided with removal of equipment by surface personnel. The divers shall be observed for signs of sickness or injury resulting from the dive and warming procedures shall be commenced as soon as possible. Preventive maintenance on equipment shall be undertaken as soon as possible after the dive. The divers and tenders shall report any defects noted during or after the dive and the defective equipment shall be tagged for corrective maintenance. Divers shall be debriefed and the log completed.

4.4.2 Standard Line-Pull Signals

All signals shall be answered with identical signals. When answering or giving signals, all slack shall be taken from the lifeline and air hose until the diver can be felt before the signal is given. The proper method for giving a signal is to give a gently distinct pull. Supplementary signals in addition to those listed in Table 4-8 may be made between the Dive Master and the diver to take care of any special circumstances that may occur. When a tender receives a signal he shall notify the Dive Master, answer the signal then act upon it.

4.4.3 Compressor Requirements for Surface-Supplied Diving

4.4.3.1 Gas Flow and Pressure Requirements

a. The capacity of the air compressor shall be known before use in surface-supplied diving.

b. No divers shall be permitted to dive beyond the capacity of the air compressor.

c. Pressure and gas flow requirements are dependent upon the type of diver apparatus used, e.g., Kirby Morgan Band Mask, Light-Weight Hats, MARK XIV Hard Hats, etc. These systems include free-flow, demand breathing, or a combination of both.

d. The purpose of specific compressor requirements are to guarantee adequate over-bottom pressure to prevent squeeze, and provide sufficient ventilation to preclude the incidence of CO_2 build-up in the diver's Life Support System regardless of the diver workload.

4.4.3.2 Determining Gas Flow and Pressure Requirements For Open Circuit System.

a. Minimum flow of 1.5 acfm is suggested, per diver, for light-weight gear on inspection dives or moderate work tasks, with 50 psig over-bottom pressure.

b. Minimum flow of 4.5 acfm is recommended, per diver, for MARK V type gear or for dives requiring heavy work, with 25 psig over-bottom pressure.

c. Obviously 4.5 acfm is ideal for diver safety, regardless of the equipment type used.

d. The following equations will assist the diving team in choosing a compressor compatible with safety and work requirements:

Gas Flow Required at Depth

$$S = 4.5 \frac{D + 33}{33} \text{ (Working Dive) or } S = 1.5 \frac{D + 33}{33} \text{ (Non-Working Dive)}$$

where,

S = Supply in cfm
D = Depth of dive in feet sea water (fsw)

Over-Bottom Pressure Requirements

$$P = 50 + 0.71\ D$$

where,

P = Dive station manifold pressure in psig
D = Depth of dive in fsw

Table 4.8. STANDARD LINE-PULL SIGNALS

From Tender to Diver	
1 Pull	Are you all right? Stop, say again. Wait one.
2 pulls	Go down.
	During ascent, 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 on the bottom. That's good. Say again. Wait one.
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.
Special Signals From the Diver	
1-2-3 Pulls	Send me a square Mark (short line).
5 Pulls	Send me a line.
2-1-2 Pulls	Send me a slate.

Searching Signals	Without a Circling Line	With a Circling Line
1 Pull	Stop and search where you are.	Stop and search where you are.
2 Pulls	Move directly away from the tender if given slack, move toward the tender if strain is taken on the 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.
7 Pulls	Go on (or off) searching signals.	Go on (or off) searching signals.

Signals	
3-2 Pulls	More air. Ventilate (if on O_2 go to open circuit).
4-3 Pulls	Less air. Circulate.
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.
Crane Signals	
1 Pull	Stop, hold it.
2 Pulls	Slack off.
3 Pulls	Take a strain.
4 Pulls	Hoist it clear.
7 Pulls	Go on or off crane signals.

4.5 HIGH ALTITUDE DIVING AND DECOMPRESSION (Source: Richard H. Geyer)

4.5.1 Introduction

Diving at any elevation greater than 1,000 feet presents complex problems and added hazards for the uninformed. All of these diving procedures shall be approved by the Diving Officer. Problems arise because physical laws concerning absolute pressures and gas partial pressures are affected. For instance; lower oxygen partial pressure in breathing air at high altitude can result in anoxia, causing unconsciousness after surfacing from a dive; and susceptibility to nitrogen narcosis or decompression sickness at unusually shallow depths must be anticipated due to the increased percentage of nitrogen.

a. Conversion Factor. The most vital detail necessary for the diver to develop is a workable conversion factor which places all aspects of diving that are influenced by high altitude in their proper perspective.

Finding a factor for any altitude is rather simple provided the diver knows the atmospheric pressure at sea level is 760 mm Hg. Dividing by the atmospheric pressure for his altitude (mm Hg), the variable, yields the conversion factor.

Example: For a dive site with an altitude of 6,000 feet the atmospheric pressure

is 610 mm Hg.

$$\text{C.F.} = \frac{760 \text{ mm Hg @ Sea Level}}{610 \text{ mm Hg @ 600 feet}} = 1.245$$

Rule: When applying the C.F. to find theoretical dive depth, multiply. When applying the C.F. to find atmospheric pressure, ascent rates, and theoretical decompression stop depths, divide.

b. Atmospheric Pressure. At 6,000 feet the pressure of one atmosphere is 11.8 psi instead of 14.7 psi found at sea level. This is due to the change in partial pressure of oxygen (2.36 pp or 16 percent) and nitrogen (9.44 pp or 84 percent).

One atmosphere of depth in a lake at 6,000 feet of altitude would be 27 feet instead of 34 feet found at sea level.

c. Depth of Dive. Due to the decreased pressure at altitude, the actual diving depth of a dive must be converted to a theoretical depth for use in the standard decompression tables.

Example: Diving in a lake at 6,000 feet to an actual depth of 110 feet, the theoretical depth would be 137 feet (110 feet actual x 1.245 C.F. = 137 feet Theoretical)

Note: See Table 4-10 for depth conversions.

d. Ascent Rates. Especially on decompression dives, ascent rates must be changed to correspond with the pressure differential ratio of altitude.

Example: The rate of ascent from dives at sea level is 60 fpm. By dividing the C.F. 1.245, for 6,000 feet of altitude, into 60 fpm, the adjusted rate of ascent is 48 fpm (60 fpm ÷ 1.245 C.F. = 48 fpm).

e. Decompression Stops. Diving at high altitude predisposes the diver to increased partial pressures of nitrogen. If there is a need for decompression the depths of decompression stops will need to be converted.

When figuring theoretical diving depth for decompression schedules, the rule of next greater depth still applies.

Example: If the "Tables" require decompression stops at 30 feet, 20 feet, and 10 feet for a diver at an altitude of 6,000 feet, the theoretical decompression stop depths would be at 24 feet, 16 feet, and 8 feet (actual stop depths divided by C.F. 1.245). Note: See Table 4-11 for conversion of stop depths.

f. "No Decompression Limits and Repetitive Dives". Single dives that fall within the "No Decompression Limits" are arrived at by using the theoretical depth of the dive.

When using the repetitive dive schedules, the diver must determine his repetitive group designations from the theoretical depth and residual nitrogen time to be applied to a second dive must be determine based on the theoretical depth of the repetitive dive.

Note: Time is not a function of altitude diving, therefore, the Residual Nitrogen Timetable for Repetitive Air Dives remains unchanged.

g. Compressor Output for Surface-Supplied Diving. Any high altitude environment affects output power on gasoline or diesel motors. Generally, engines will have a decrease in horsepower of about 3.5 percent for each 1,000 feet above sea level. This power reduction results in a cutback of engine rpm and subsequently lowers the air output from the diver's compressor.

Thus, a diver using surface-supplied equipment at high altitude will experience less cfm of free air available to his mask, Hookah, etc., and this could be a determining factor in how deep the diver can perform his work.

When using SAS gear for altitude diving, consult the engine compressor manual for the unit involved to get correct details on power reduction caused by altitude.

Table 4-9. ATMOSPHERIC PRESSURE (in mm Hg) AND CONVERSION FACTORS FOR ALTITUDES TO 10,000 FEET

	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
mm Hg	734	708	681	658	633	610	589	565	543	524
C.F.	1.035	1.073	1.116	1.115	1.200	1.245	1.292	1.345	1.396	1.450

Table 4-10. THEORETICAL DEPTH AT VARIOUS ALTITUDES (FFW)

Actual Depth	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
0	0	0	0	0	0	0	0	0	0	0
10	10	11	11	12	12	12	13	13	14	15
20	21	21	22	23	24	25	26	27	28	29
30	31	32	33	35	36	37	39	40	42	44
40	41	43	45	46	48	50	52	54	56	58
50	52	54	56	58	60	62	65	67	70	73
60	62	64	67	69	72	75	78	81	84	87
70	72	75	78	81	84	87	91	94	98	102
80	83	86	89	92	96	100	103	108	112	116
90	93	97	100	104	108	112	116	121	126	131
100	103	107	111	116	120	124	129	134	140	145
110	114	118	122	127	132	137	142	148	153	160
120	124	129	134	139	144	149	155	161	167	174
130	135	140	145	150	156	162	168	175	181	189
140	145	150	156	162	168	174	181	188	195	203
150	155	161	167	173	180	187	194	202	209	218
160	166	172	178	185	192	199	207	215	223	232
170	176	182	189	196	204	212	220	228	237	247
180	186	193	200	208	216	224	233	242	251	261
190	197	204	212	220	228	237	246	255	265	276
200	207	215	223	231	240	249	259	269	279	290
210	217	225	234	243	252	261	272	282	293	305
220	228	236	245	254	264	274	284	296	307	319
230	238	247	256	266	276	286	297	309	321	334
240	248	258	267	277	288	299	310	323	335	348
250	259	268	278	289	300	311	323	336	349	363

Instructions for Table 4-10: Table 4-10 lists theoretical dive depths at altitudes to 10,000 feet for actual dive depths to 250 feet of freshwater (FFW). To use this table, enter the left column (actual diving depth) to the actual, or next greater, depth for the dive. At the top of the depth column find the altitude of the dive site, or the next highest altitude if altitude falls between those listed. The figure given in the selected altitude column for the actual depth is the theoretical dive depth for that altitude.

Table 4-11. THEORETICAL DEPTH OF DECOMPRESSION STOP (FFW)

Prescribed Depth	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
0	0	0	0	0	0	0	0	0	0	0
10	10	9	9	9	8	8	8	7	7	7
20	19	19	18	17	17	16	15	15	14	14
30	29	28	27	26	25	24	23	22	22	21
40	39	37	36	35	33	32	31	30	29	28

Table 4-12. CHANGES IN ASCENT RATES (in FPM) FOR ALTITUDES TO 10,000 FEET

Sea level	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
60 fpm	58	56	54	52	50	48	46	45	43	41

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4.5.2 Example Dives

Example A--Single Dive

The day's diving will be in a lake at an elevation 4,800 feet above sea level. A recovery job requires that the diver goes to an actual depth of 93 feet for 18 minutes bottom time.

1. Go to next highest altitude - 5,000 feet.
   Atmospheric Pressure at 5,000 feet = 633 mm Hg (from Table 4-9)

2. Conversion Factor = 1.20 (from Table 4-9)

3. Ascent Rate = 50 fpm - (60 fpm ÷ 1.20 = 50 fpm)

Actual Dive	Theoretical Dive
93 feet - 18 minutes	120 feet - 18 minutes (from Table 4-10)
No Decompression Required	Decompress 2 minutes at 8 feet (Table 4-11)

Note: Make certain that the ascent rate from depth to the 8-foot decompression stop of 50 fpm.

Example B--Repetitive Dive

The first dive of the day will be to a depth of 80 feet for 18 minutes at an altitude site of 8,000 feet. Following this dive there is a surface interval of 2 hours 43 minutes in order to rearrange topside equipment. Then a repetitive dive is carried out at a depth of 82 feet for 18 minutes bottom time.

1. Atmospheric Pressure at 8,000 feet = 565 mm Hg

2. C.F. = 1.345

3. Ascent Rate = 45 fpm

Actual Dive	Theoretical Dive
80 feet - 18 minutes (E)	108 feet - 18 Minutes (G)
S.I. = 2.43 (C)	S.I. = 2.43 (D)
82 feet - 18 minutes	121 feet - 18 minutes
+ - 11 minutes N_2	+ - 11 minutes N_2
82 feet - 29 minutes Total B.T.	121 feet - 29 minutes Total B.T.
	Decompression Required:
No Decompression Required	3 minutes at 15 feet and 18 minutes at 7 feet

Note: Check rate of ascent at 45 fpm to the first stop.

Example C. First dive at sea level, repetitive dive at altitude. The diver makes his first dive at sea level to a depth of 74 feet for 20 minutes. *Following the dive, it takes him 3 hours to fill his tanks and pack all the necessary gear for a dive trip to a mountain lake at an altitude of 4,300 feet (Surface Interval at sea level). The diver then drives to the dive site in 2 hours 8 minutes and begins his dive to 66 feet for 25 minutes.

1. Theoretical Depth at 5,000 feet = 84 feet

2. C.F. = 1.20

3. Ascent Rate = 50 fpm

Actual Dive	Theoretical Dive
74 feet - 20 minutes (E)	
No Decompression Required	
96 feet - 20 minutes (F)	84 feet - 25 minutes
S.I. = 5.18	+ 7 minutes N_2
	84 feet - 32 minutes Total B.T.
	Decompress 7 minutes at 8 feet

Note: Check rate of ascent at 50 fpm to the 8-foot stop.

4.5.3 Additional Notes and Cautions

4.5.3.1 There may be some occasions when a diver will need to make a dive at some high altitude and then return to sea level for a repetitive dive within a 12-hour period, or make his first dive at sea level followed by a repetitive dive in a lake at high altitude:

a. For a single dive or repetitive dives made at high altitude, the diver will follow the procedure of planning that considers theoretical dive depth and any decompression for his dive. After his trip to sea level (Surface Interval) he may assume the previous dive(s) was made at the altitude of his new dive site.

b. If the diver makes his first dive or repetitive dives at sea level and then travels to some high altitude for subsequent dives he must assume that the sea level dive(s) was made at the altitude of his new dive site.

NOTE: Based on a research report authored by Edel, Carroll, Honaker, and Heckman published in "Aerospace Medicine," October 1969, it is advised by this author that the surface interval following a "No Decompression" dive(s) at sea level should be a minimum of 2 hours, at sea level, before attempting trips to dive sites at high altitude.

*Surface interval at sea level must be a minimum of 2 hours before traveling to any altitude dive site.

It is further recommended that a diver who exceeds the "No Decompression Limits," for a dive(s) regardless of decompression carried out, must allow a surface interval of 24 hours, at sea level, prior to traveling to high altitude for other dives.

The above cautions are to be followed when considering airline travel as well, even in planes with pressurized cabins. If the plane does not have a pressurized cabin, then the dive(s) must be based on the highest altitude the airplane will reach.

Individual airlines can inform the diver of the altitude and pressure differential that their cabins will be pressurized to in flight.

Note: See Section 4.5.3, Additional Notes and Cautions.

4.5.3.2 Two cautionary notes on the maladies peculiar to high altitude environments are included for divers who may be considering dive trips to elevations greater than 7,000 feet.

The following remarks are reproduced from a personal communication written by W. Brandon Wright, Research Medical Officer at the U.S. Navy's Experimental Diving Unit for that activity's archives.

Acute Mountain Sickness - Altitudes greater than 7,000 to 9,000 feet have decreased partial pressures of oxygen which cause arterial hypoxemia. In response to hypoxic stimulation, hyperventilation occurs with secondary lowering of arterial CO_2 and production of alkalosis. The newcomer to high altitude typically experiences dyspnea (shortness of breath), rapid heart rate, headache, insomnia, and general malaise. These symptoms usually disappear within 3 to 10 days and general graded exercise may hasten acclimatization. Acclimatization is lost within a week at lower altitudes.

Altitude Pulmonary Edema - Pulmonary edema can occur in nonacclimatized persons who travel within a day or two to altitudes greater than 9,000 feet. Symptoms usually appear 6 to 36 hours after arrival and consist of dry cough, dyspnea and a feeling of pain in the chest. Treatment includes transportation to lower altitude, hospitalization with bed rest, oxygen and diuretic therapy. Prevention consists of taking adequate time for altitude ascent, and upon reaching altitude, avoid overexertion which can cause pulmonary edema even in well acclimatized individuals.

Diving is strenuous and should not be done at high altitude without adequate acclimatization. This might require as much as 3 months of graded increasing exercise programs at altitude.

Increasing the oxygen partial pressures in the diver's gas supply to account for the decreased atmospheric pressure may be helpful. However, the exertion of a dive may precipitate pulmonary edema which could severely interfere with respiration while diving and afterwards as well. The symptoms may be indistinguishable from the chokes type of

decompression sickness. Recompression with oxygen therapy would probably relieve the symptoms during treatment, but they might well recur following therapy.

The pulmonary edema of altitude exposure can be a serious, even fatal illness. No one should dive who has the slightest evidence of shortness of breath, cough, or tightness in the chest. Anyone who has obvious symptoms of this altitude disease should receive 100 percent oxygen to breathe and be rapidly transported to a hospital for prompt vigorous therapy.

4.5.3.3 Flying After Diving. No flying shall occur within twelve (12) hours of diving except in an emergency. If it is necessary to use air transportations within 12 hours after diving at high altitudes, the diver must plan his dive(s) in advance as though he were flying in an unpressured plane.

4.6 DAM DIVING

4.6.1 Procedures for Dam Diving

4.6.1.1 The dive team member shall not be submerged in any area where a leak from a valve or gate may entrap him.

4.6.1.2 When diving downstream of a dam, the submergible tanker gates shall be caulked to cut off underwater currents just downstream from the gates.

4.6.1.3 During the pre-dive conference, discuss changes above and below fixed crest dams.

4.6.1.4 Shut off sluices in flood control dams 1 hour prior to diver work on the upstream side of the dam.

4.6.1.5 When inspecting lock gates and valves, use the following procedure:

- Upper lock gates - high pool with at least one lock gate open.
- Lower lock gates - low pool with at least one lock gate open.
- Within the chamber - location and type of diving will determine pool level and lock gate positions.
- Filling valves - high pool with at least one lock gate open.
- Emptying valves - low pool with at least one lock gate open.

4.6.1.6 Diver inspection shall be thorough and accurate with meaningful data recorded. Dimensions, measurements, and specific information about the structure is required.

4.6.1.7 Tape recorders and/or radiotelephone communications shall be available when making inspections with surface air equipment.

Pages 58, 59, and 60 omitted.

Section 5

EMERGENCY PROCEDURES

5.1 ON-SITE MANAGEMENT (Source: NOAA Diving Accident Manual by Dick Rutkowski)

5.1.1 A major problem with divers is that they tend to ignore the mild symptoms of barotrauma in the early stages. By doing so, they eventually have more serious symptoms. Immediate diving accident identification can be broken down and handled in two categories—mild and severe symptoms (see Diving Accident Management Flowchart, Figure 5-1). To simplify identification all symptoms of gas embolism and decompression sickness will be considered together. To simplify the procedure, formal medical terms will not be used.

5.1.2 Mild Symptoms

Mild symptoms are those that can be treated at the dive site by the diver using surface oxygen (Fig. 5-1). Indifference, fatigue, skin rash, and weakness are considered mild symptoms. Although joint pain is also considered a mild symptom, it shall be treated as a severe symptom according to the flow chart because recompression is required.

If a diver comes up from a dive and acts indifferent, appears not to know what is going on, or ignores people trying to communicate with him, this may be an early warning sign of trouble. The same applies to extreme fatigue, weakness, or skin rash.

Do not hesitate, place this person on surface oxygen, head downward (Trendelenberg Position). Also refer to Figure 5-1 and follow the flow chart through to the final stage. Doing this often relieves the symptoms or prevents them from getting worse. Surface oxygen combined with the use of Trendelenberg Position has been successful in being the complete treatment. The biggest problem in the early stages is the diver's ego. Divers do not want to admit there is anything wrong with them and refuse to be put on oxygen because they feel others will think less of their diving ability. Do not let your ego or the patient's ego overrule common sense. Use surface oxygen and place the patient in the Trendelenberg Position immediately. If the symptoms appear to be relieved after the patient has been on oxygen for a short period of time do not remove the oxygen immediately, as bubbles will reload from gases in the surrounding tissue, and the symptoms will reoccur. If symptoms are relieved in 10 minutes, keep the patient on oxygen for 30 minutes total. Even if symptoms are relieved, the dive team member shall still go to the recompression chamber. If the symptoms get worse, find the new symptom on flow chart and follow chart recommendations.

5.1.3 Severe Symptoms

Severe symptoms are those of paralysis or any kind of loss of coordination or feeling. Severe symptoms require immediate treatment and evacuation into the hyperbaric trauma system (see Fig. 5-1). If the victim's vital signs cease to function, CPR will be required. This is first and foremost in diving accident

treatment. If a patient comes up from a dive, or anytime within 24 hours after a dive, and shows any of the severe symptoms indicated on the flow chart, immediately place the patient on surface oxygen and in the Trendelenberg Position, after insuring vital signs are functioning properly, and follow the flow chart to eventual evacuation to a recompression chamber.

It is important to remember that because these signs/symptoms can develop hours after diving, the patient may show up in a hospital emergency room or other medical facilities in the community. For this reason, it is important for paramedics and physicians to recognize the symptoms and to understand this hyperbaric problem so that the diving accident procedure can be initiated. It is also extremely important that any person delivering a diving accident patient to professional medical personnel explain this procedure to them, so that the patient will receive proper recompression if needed.

5.1.4 Emergency Evacuation

Once it has been established that the patient is a diving accident victim, and someone is caring for his immediate medical needs (vital signs, surface oxygen, and Trendelenberg Position), someone shall also be initiating the evacuation protocol into the hyperbaric trauma system.

Because many divers and/or boaters fail to plan emergency evacuation procedures in advance, a great amount of critical time is often lost, causing needless suffering and possible loss of life. The most important part of any dive and/or boat trip is to know your procedure for emergency evacuation.

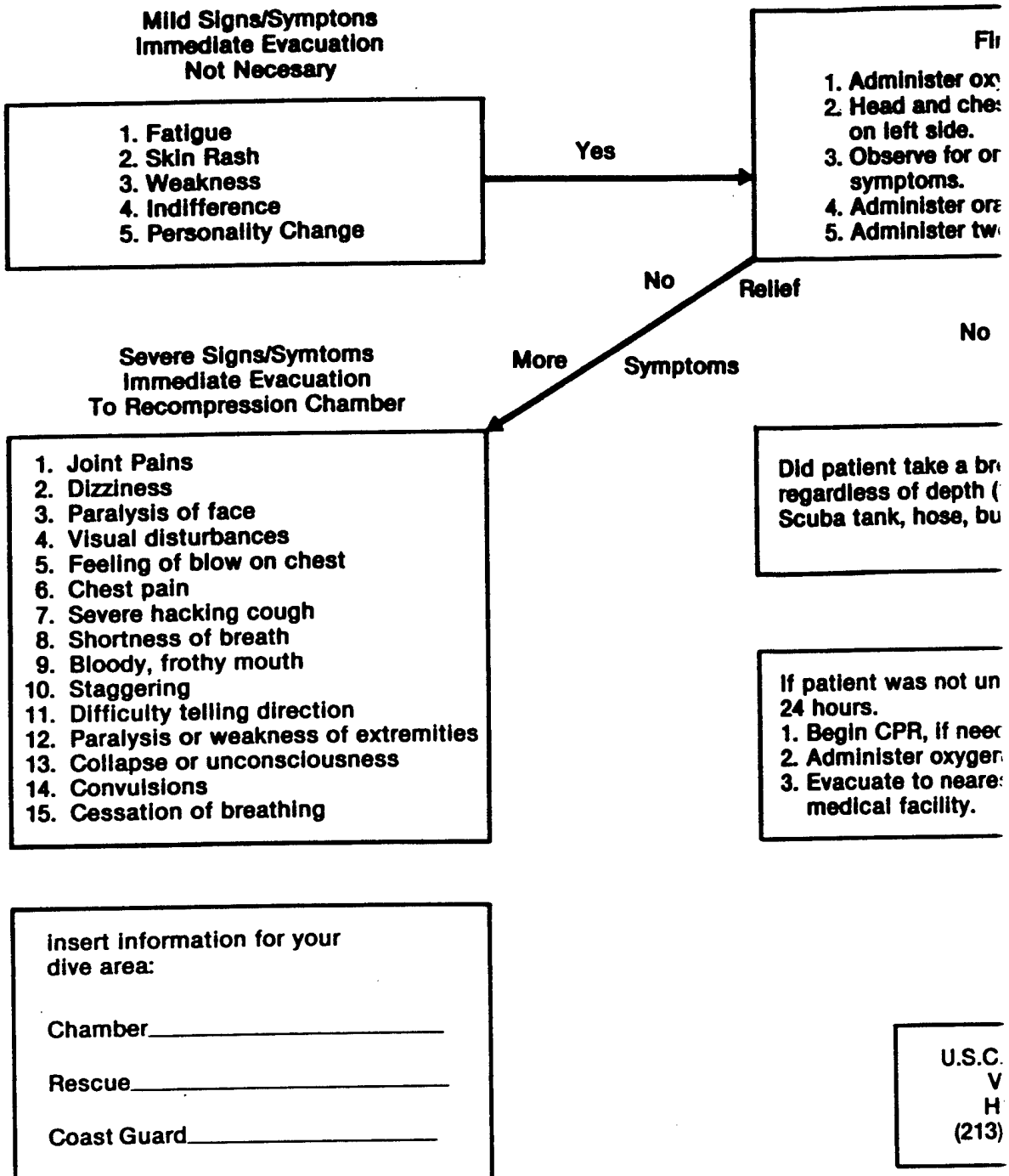
Many medical problems, including those resulting from diving accidents, could occur at anytime at sea. Because some symptoms are delayed in their onset, it is not only necessary to know how to contact a hyperbaric trauma team at sea, but also on land. Many divers have been diving in one country and returned to another before symptoms occurred.

5.1.5 Communications

Contact the Coast Guard directly, 2285 HF or Channel 16 VHF marine band. Declare an emergency and state type of emergency, e.g., "There is a diving accident victim needing treatment in a recompression chamber." Give your exact location by direction and distance from prominent landmarks. Give all symptoms of the victim and dive history, if applicable. State the condition of victim, e.g.; can he walk, sit up, or is he unconscious. Describe any unusual circumstances, and the number of victims. Give detailed description of your boat, including any outstanding features for identification. Give weather, sea condition, wind direction and speed.

If you should change your location, keep all concerned advised of your new location and your intentions.

The Coast Guard does monitor CB, CH 9. This is a very unreliable means of communications for many reasons. If you are unable to raise the Coast Guard via CB, contact someone else to relay your messages.



Unconscious diver must go immediately and directly to recompression chamber regardless diving depth.

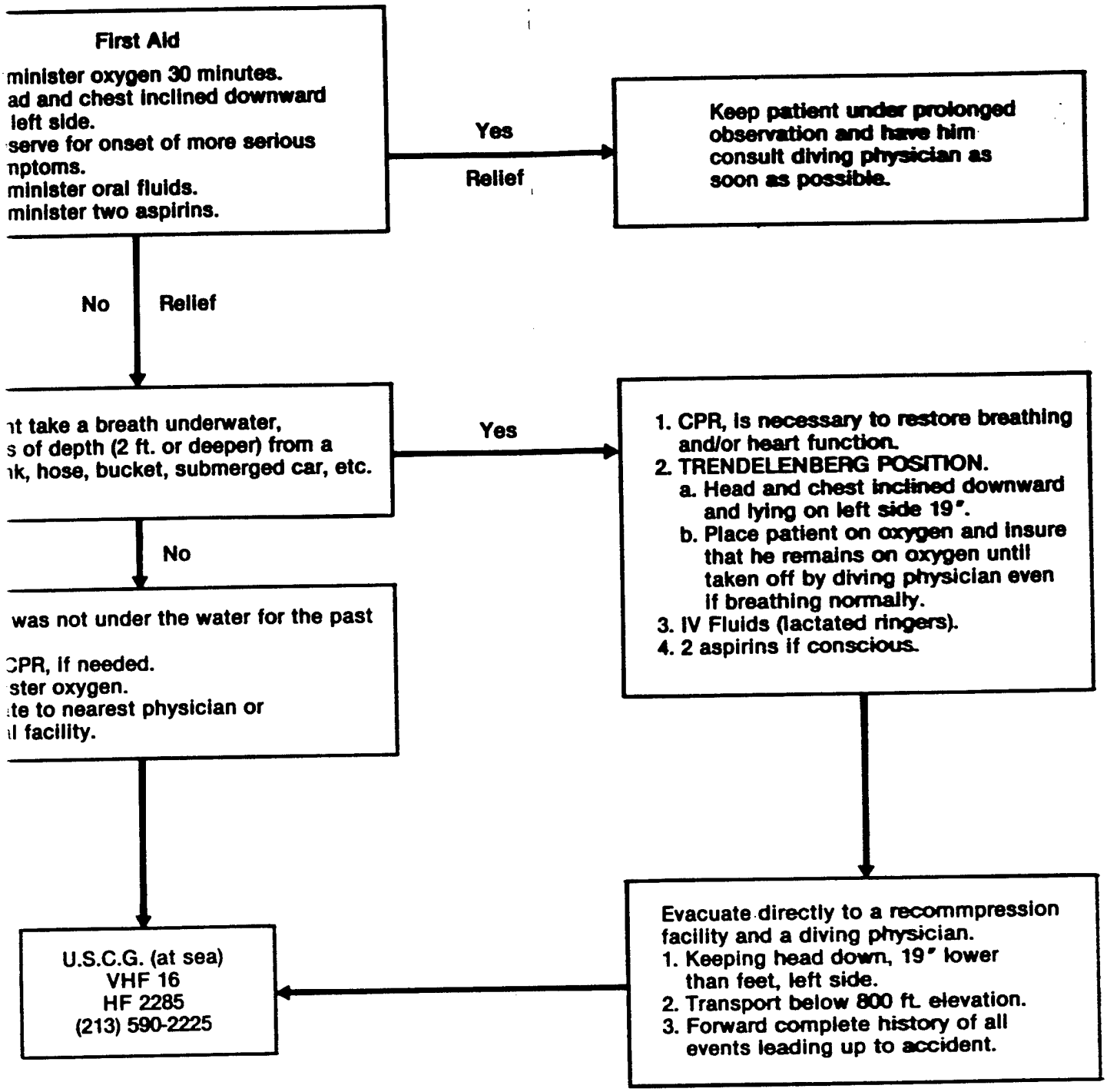
NOTE: Head down increase pressure and oxygen to upper part of body.

Oxygen begins to off load bubbles and delivers a greater supply to areas cut from oxygen.

Aspirin prevents platelet clumping. Fluids help balance blood electrolytes.

by: Dick Rutkowski, NOAA, AOML

Figure 5-1. Diving acci



Diving accident position (Trendelenberg) use for: embolism, bends or near drowning.

- Head lowered (30° best angle)
- Leftside lower (If possible)
- Administer 100% oxygen (If available)
- Strap victim in place but do not interfere with respiration

Diving accident management flowchart.

If you have no radio on your boat, then if practical, hail a boat with a marine band radio and give them the information to relay to the Coast Guard. Keep them with you for further contacts. The International Convention for safety of life at sea requires the providing of assistance to vessels in distress.

If no other boats are immediately available, proceed immediately to the nearest inhabited dockage and telephone local paramedical or U.S. Coast Guard services. Advise them of a diving accident, state your need for transportation and your EXACT location. Have someone remain at the telephone for further assistance. Ensure that they are aware at this time that a recompression chamber will be needed.

If symptoms occur on land after diving, contact local paramedics or U.S. Coast Guard. They should be able to assist or advise location of nearest recompression chamber.

When the rescue aircraft arrives in your area, wave, fire flares or smokes. LET THEM KNOW YOU ARE THE ONES WHO WANT ASSISTANCE. Do not assume the pilot will recognize you. He may waste valuable time searching for you unnecessarily.

5.1.6 Medical Evacuation Procedures

The following medical evacuation information shall be forwarded with the patient. If possible, take time to explain the following steps to the physician or paramedic. Do not assume they understand the reasons why oxygen should be administered to a diving accident victim. If a person is breathing normally, the physician may take him off oxygen not realizing the patient must be kept on to continue to offload the bubbles. When this has been explained the following steps shall be followed:

- Maintain breathing and heart functions, ensure airway is open and remains open.
- Keep patient on oxygen and incline head downward, left side down, during transportation.
- Ensure that paramedics/physicians understand why head downward, left side, on oxygen is required until patient arrives at chamber.
- Ensure that paramedics/physicians understand why patient needs to be taken to a recompression chamber instead of a hospital.
- Do not remove oxygen from diving accident patient unless you need to reopen airway, or he shows signs of oxygen convulsions, even if patient is breathing normally. Without oxygen, nitrogen bubbles will reload and cause increasing symptoms.
- Keep patient out of hot sun, watch for possibility of shock.
- Do not give any pain killing drugs:

I.V.s can be given to prevent vascular collapse or dehydration (D5LR, Plain LR or D1/2N); and two aspirins orally.

(Even this medication should be verified with a physician before being administered).

- Instruct flight crews to fly or pressurize aircraft below 1,000 feet. This should only be attempted without hazard to aircraft.

- Provided the aircraft can handle extra weight, diving buddy should be transported with patient, as he may also need recompression and can be useful with information, comfort and contact with patient's parents/ relatives.

- A complete history of all events leading up to the accident and until evacuation must be forwarded with the patient.

- Depth gauges, tanks, regulators, and other diving equipment shall be forwarded with patient if weight limitations allow, especially if the accident is fatal.

5.1.7 Helicopter Evacuation Procedures

Each helicopter evacuation is different, each one presents its own problems, but knowing what to expect and the procedures to follow can save time, effort, and perhaps a life.

- Try to establish communications with the helicopter. If your boat is unable to furnish the necessary frequency, try to work through another boat.

- Maintain speed of 10 to 15 knots, do not slow down or stop.

- Maintain course into wind about 20 degrees on port bow.

- Pull all antennas down if possible, without losing communications.

- Secure all loose objects on/or around decks.

- Always let the lifting device (stretcher) touch the boat before handling it to prevent electric shock.

- Place life jacket on patient.

- Tie patient in basket, face up.

- If patient cannot communicate, place in the stretcher as much information as you can about him, such as, name, age, address, what happened, and what medication he has been given.

- If the patient is a diving accident victim ensure flight crew has copy of, or is instructed on, medical procedures for diving accidents.

- If diving accident victim, ensure flight crew delivers victim to hyperbaric trauma system (recompression chamber complex).

- If patient dies, inform flight crew so that they take no unnecessary risks.

5.1.7 Recompression Chamber Requirements

Diving accident management protocol suggests a recompression chamber that is multi-man, multi-lock, and six atmospheres. Do not take critical diving accident victims to a chamber which is a one-man, single-lock, three atmospheres. There are two major reasons why:

5.1.5.1 Pressure must be sufficient to reduce bubble size (gas embolism requires six atmospheres).

5.1.5.2 Physicians have no way getting hands on victim to:

- Maintain vital signs.

- Keep airway clear.

- Perform neurological examinations, necessary to determine proper treatment, or reoccurrence of symptoms.

- Monitor vital signs during treatment.

- Operations may have to be performed, such as intubation.

- Pulmonary overdistention cases may have air leakage causing a tension pneumothorax which must be relieved, and monitored during decompression periods.

- Oxygen convulsions may close off victim's glottis, and victim could develop an embolism while dropping pressure to relieve convulsions.

Be very cautious about transporting patients in small one-lock chambers for the above reasons. It is often better to transport without chamber and maintain vital signs using surface oxygen and the Trendelenberg Position.

Victims shall be taken to medically certified chambers listed below. Any other chamber may refuse to treat the victim, and time is of the essence in bubble-related accidents.

Medically Certified Chambers

- Portsmouth Naval Shipyard, Portsmouth, NH
  (207) 439-1000, ext. 1740

- Submarine Base New London, Groton, CT
  (203) 449-3666 24 hr/hosp
  (203) 449-3805

- Norwalk Hospital, Norwalk, CT
  (203) 852-2000
  (203) 852-2479

- U.S. NAVAL UNDERWATER SYSTEMS CENTER, Newport, RI
  Civilians referred through the Coast Guard.
  (401) 841-3776 (chamber phone)

5.2 ACCIDENT REPORTING

In the event of a diving accident, the following persons shall be notified immediately:

- Dive Master
- Diving Officer
- Diving Medical Officer
- Safety Officer

The underwater Accident Report Form (Table 7-6) shall be filled out as soon as possible after the accident.

As part of the follow-up after a diving accident, the following offices and persons should be informed of the incident:

- Personnel Office
- The injured diver's Branch Supervisor
- The Division Engineer

5.3 SYMPTOMS AND TREATMENT OF DIVING DISEASES

5.3.1 Decompression Sickness

Decompression sickness is the result of formation of nitrogen gas bubbles in the blood or tissues.

Mechanism: Ascending without regard for depth and bottom time. Nitrogen comes out of solution too quickly and forms bubbles which may block blood vessels or interfere with neural functions.

Symptoms: Concerning onset of symptoms:

50 percent occur within 30 minutes
85 percent occur within 60 minutes
95 percent occur within 3 hours
99.9 percent occur within 24 hours

Various symptoms of decompression sickness have been found to occur with the following frequency:

Local pain.	89 percent
leg	70 percent
arm	30 percent

Dizziness ("staggers")	5.3 percent
Paralysis	2.3 percent
Shortness of breath	1.6 percent
Extreme fatigue and pain	1.3 percent
Unconsciousness	0.5 percent

Note that in 100 cases of decompression sickness, symptoms beyond local pain will occur, on the average, in only 5 cases.

Treatment: Recompression in a recompression chamber according to the U.S. Navy recompression tables.

Prevention: Strict observance of the decompression tables; plan the dive and stick to depth and time schedules.

5.3.2 Nitrogen Narcosis

Nitrogen narcosis is intoxication of the diver due to the breathing of compressed air at depths of 100 feet or more. The actual cause is related to the high partial pressure of nitrogen.

Mechanism: When a diver breathes air at depth, the nitrogen produces an intoxicating effect similar to that of alcohol, anesthetic gases, or narcotic drugs. Some individuals are more susceptible to this effect than others, but most feel it near 100 feet. High partial pressure of nitrogen at depths of 100 feet or more appears to affect the central nervous system, producing the narcotic or drunken state.

Symptoms: The response to nitrogen is not the same for all divers - changes in mood, decreased ability to work and concentrate, slowing up of mental activity, slowed reflexes, observations become inaccurate, strange and irrational actions, drunken feeling.

Treatment: Ascent to lesser depths and the effect will dissipate. No after effects.

5.3.3 Air Embolism

Air embolism is the plugging of a blood vessel by a bubble of air or any other gas the diver has been breathing that entered the circulatory system directly from the lungs. When this condition occurs in a diver, arteries up to capillaries of the brain are usually affected.

Mechanism: Caused by holding the breath upon ascent. If the breath is held during ascent, the air in the lungs will expand as ambient pressure is reduced. Expansion will tear blood vessels, allowing bubbles of air into the bloodstream.

Symptoms: Dramatic and sudden. Occur within a few seconds of surfacing or before. Loss of consciousness is the main symptom. Weakness, dizziness, paralysis, paralysis in extremities, visual distur-

bances, auditory difficulties, frothy blood at the mouth, convulsions and cessation of breathing, unconsciousness.

Treatment: Recompression in a recompression chamber to reduce the size of the bubble so it might return to the lungs for expiration.

Prevention: Exhale during ascent, plan dives so you have enough air for a safe, normal ascent. Check weight belt buckle periodically.

5.3.4 Pneumothorax

Pneumothorax is the presence of air in the pleural cavity between the lungs and chest wall.

Mechanism: Similar to air embolism. Air expands during ascent with no way of escaping the lungs. A leak or tear may develop; air gets into the pleural cavity. Air continues to expand and may collapse a lung. This generally occurs with air embolism but may occur separately as spontaneous pneumothorax.

Symptoms: Cyanosis of lips and under fingernails, pain in side, grimacing bent-over position, rapid shallow breathing.

Treatment: If it is uncomplicated with air embolism, do not recompress. Hypodermic needle must be inserted through chest wall to withdraw the trapped air. Very painful.

Prevention: Never hold breath while ascending. Ascend slowly. THINK.

5.3.5 Mediastinal Emphysema

The presence of air in the middle chest area. This occurs with air embolism.

Mechanism: The mechanism of injury is the same as for pneumothrax. If the breath is held during ascent, air expands causing a leak or tear in the lung. Air may leak into the middle chest area and exert pressure on the major blood vessels, heart, trachea, and lungs. An air pocket forms in the area.

Symptoms: Pain under breast bone (sternum), faintness, circulation impairment, cyanosis, difficulty in breathing, shock.

Treatment: Do not recompress unless air embolism is present. Seek medical help; generally this is not too severe.

Prevention: Do not hold the breath while ascending.

5.3.6 Subcutaneous Emphysema

The presence of air under the skin, usually in the area of the neck. Not a serious problem.

Mechanism: Expansion of air in the lungs with no means of escape. Air leaks through the lung membranes and forms an air pocket under the skin. This may be complicated with air embolism and pneumothorax.

Symptoms: Feeling of fullness in the neck area, change in the voice due to pressure on trachea, swelling in the neck, crepitant when neck is moved, difficulty in breathing.

Treatment: Not serious; seek medical attention promptly. Lung tears may be present. Hemorrhaging must be watched.

Prevention: Do not hold the breath while ascending.

5.3.7 Overexertion

Extending oneself, physically, beyond limitations. This is often found among treasure divers, and others whose urge to dive wins out over common sense.

Mechanism: Depleting the strength of the arms and legs, overloading the respiratory system.

Symptoms: Fatigue, shortness of breath, pain in side, extreme weakness, perspiration, dry mouth, mental fatigue.

Treatment: Immediate rest, inflate safety vest, small sips of water, seek Medical attention in extreme cases.

Prevention: Plan the dive to avoid long swims, plan entry points, use safety vest and floats, stay physically fit to dive.

5.3.8 Oxygen Poisoning

Oxygen poisoning results from exposure to increased oxygen partial pressures beyond acceptable limits. This can come through use of closed-circuit oxygen rebreather beyond depth and time limitations, using compressed air below about 132 feet, excessively high oxygen level in mixed gas diving.

Mechanism: Unknown. It is believed that high partial pressures of oxygen may have a toxic effect on the central nervous system.

Symptoms: Convulsion is the main and most dangerous symptom. Before convulsion sets in, some minor symptoms may be noticed: muscular twitching, nausea, dizziness, visual and auditory disturbances, difficulty in breathing, anxiety and confusion, unusual fatigue, uncoordination. The final and most serious symptom is convulsion. Convulsions make breathing impossible and cause the diver to drown.

Treatment: For minor symptoms, get to surface as fast as is feasible. For convulsions, surface (even though air embolism may be caused) and give artificial respiration, do not give oxygen. Recovery

is usually spontaneous but the victim will be extremely tired and confused for many hours. He will require a great deal of sleep and rest.

Prevention: Carefully observe specified depth-time limts for rebreathing units. Do not dive to 132 feet, 125 feet is a safe and sane limit. Some people are very susceptible to oxygen sickness: if the opportunity arises, get an O_2 check.

5.3.9 Oxygen Deficiency (Anoxia)

Many situations give rise to oxygen deficiency. It may occur as a result of oxygen deficiency in the breathing media (as in mixed gas diving), or simply by exhaustion of the air supply.

Mechanism: Simply not enough oxygen to carry on the life processes. Either not enough oxygen in breathing gas, or simply nothing to breathe.

Symptoms: Loss of concentration, impaired muscular functions, cyanois, extreme fatigue, irregular pulse, bloodshot eyes, cold clammy lips, heavy panting, unconsciousness and cessation of breathing.

Treatment: Get the victim to the surface and give him fresh air or oxygen, start artificial respiration.

5.3.10 Carbon Dioxide Poisoning

Carbon dioxide poisoning is simply an interference with normal body functions by the high partial pressures of CO_2.

Mechanism: Excessive carbon dioxide in the lungs or the breathing gas. This can be accomplished by using impure air, a faulty rebreathing unit, or by holding the breath or skip-breathing, after hyperventilation and diving too deep.

Symptoms: Generally unnoticed by the victim. Dizziness, perspiration, headaches, fatigue, nausea, heavy breathing, cyanosis to lips and fingers, unconsciousness. Convulusion - "Decerebrate Fits".

Treatment: Fresh air, rest, give oxygen if available, if unconscious, start artificial respiration.

Prevention: Use only certified air, rest and/or surface when breathing becomes labored, reduce depth when any unusual feelings overcome you.

5.3.11 Carbon Monoxide Poisoning

The effect of a foreign gas on body functions.

Mechanism: Breathing air that has been contaminated with carbon monoxide. CO binds preferentially with hemogloblin at expense of O_2 and the gas seems to affect the central nervous system.

Symptoms: No warning to the victim; tightness across the forehead, headache, dizziness, nausea, weakness, confusion, cessation of breathing.

Treatment: Fresh air and oxygen if available. In extreme cases a transfusion may be necessary because CO is taken up by the blood 200 times easier than O_2.

Prevention: Use only certified pure compressed air. Do not put compressor exhaust near intake.

5.3.12 Squeeze Injuries

Simple pressure injuries caused by the direct effects of pressuring during descent. The classical pressure situation giving rise to squeeze injuries is a pressure difference across a membrane.

Mechanism: When pressure on one side of a membrane becomes greater than that on the other side of the membrane. The membrane may be an ear drum, lining tissue, or a blood vessel. In order to avoid such injuries the pressure which is lowest must be "equalized" with that which is greatest.

Symptoms: Pain, a compressed tight feeling; very noticeable to the diver, vertigo.

Treatment: If pressure is equalized before injury there are no "after effects." However, for broken ear drums, bleeding sinuses and tissues around the eyes, consult a doctor.
NOTE: the five areas affected by squeeze are the ears, sinuses, stomach and intestine, lungs, and external air spaces applied to the surface of the body.

Prevention: Equalized pressure during the descent. Do not continue the descent of pain persists. Care in ascent, if vertigo occurs.

5.4 DIVING FIRST AID AND EMERGENCY PROCEDURES

Problem	Symptoms	First Aid
Air Embolism	Cerebral - Blurry vision, blindness, unconsciousness, sensory disturbances i.e., spotty vision, speech disortions, abrupt change change in personality.	Place on tilt board - 30 degree incline with head down and body on left lateral side. Give resuscitation or CPR if required. possible, administer fluids (1 glass every half hour) such as Gatorade. Administer O_2 if available. DO NOT administer any type of pain reliever. Contact Coast Guard, Emergency Fire Rescue, or Sheriff's Department to arrange transportation to nearest chamber.
Mediastinal Emphysema	Shortness of breath, feeling of heartburn (not relieved by belching) pain under breastbone radiating towards shoulder - possible cyanosis.	If available, give O_2 and place on tilt board until certain air embolism is not associated with it. If no other symptoms develop, have patient seek medical attention and X-ray. If other symptoms start to develop suspect air embolism.
Subcutaneous Emphysema	Fullness in neck region, difficulty in swallowing and breathing, change in voice, crackling in skin at neck.	As in mediastinal emphysema, observe that no other symptoms develop. If not complicated, have patient seek medical attention.
Pneumothorax	Shortness of breath, severe chest pain, cough, cyanosis, possible cardiac arrest.	Administer O_2 - observe for further symptoms, initially place on tilt board. Contact Coast Guard, Emergency Fire Rescue, or Sheriff's Department and have patient taken to hospital for further medical treatment. (Recompression not recommended.) May have to administer CPR.
Decompression Sickness	Neurological - Dizziness, pins and needles, nausea, weakness, paralysis, unconsciousness, visual difficulty, loss of motor function, convulsions, possible shock. Extreme fatigue, violent muscle spasms.	Administer O_2 and fluids. It is also recommended, but not required, to place patient on tilt board. Often neurological decompression sickness is the result of explosive decompression. Use of the tilt board adds a safety factor when one considers that air embolism may be contributing to the symptoms; especially if symptoms developed soon after exiting water.

5.4 DIVING FIRST AID AND EMERGENCY PROCEDURES (Cont'd)

Problem	Symptoms	First Aid
Decompression Sickness (Cont'd)	Respiratory - Shallow breathing, burning sensation on inhalation and coughing spasm.	Administer O_2.
	Skeletal System - Pain and possible swelling in joints.	For all symptoms of decompression sickness, contact Coast Guard, Emergency Fire Rescue or Sheriff's Department and arrange transportation to a recompression facility.
Squeezes	Pain in affected area; e.g., face, sinuses, ears.	Ascend until pain goes away. If pain persists, do not dive. In event of remaining discomfort or dizziness, seek medical attention. If ear or sinus is ruptured take decongestant and seek medical advice.
Barnacle Cuts	Pain and bleeding, high infection risk.	Stop bleeding, clean wound, apply antibiotic ointment and if swelling or infection persist, seek medical attention.
Fire Coral	Irritation, stinging sensation, rash swelling.	Clean, apply acid compound; e.g., ammonia and water (strong base), papaya juice, vinegar, or if nothing else available, urine. Can soak in mild alcohol solution. Antihistamine, ointment or oral. If a reaction is severe seek medical attention.
Fire and Other Sponges	Itching, rash, stinging and burning sensation.	Apply antihistamine ointment, papaya juice, or ammonia and water, (strong base), or if nothing else available, urine (acid for breaking down protein of sting).
Man-O-War Sea Wasp	Pain, stinging, welts, possible shock, respiratory distress.	Again, use an acid such as previously mentioned. Take oral antihistamine and seek medical attention. Both of these animals may produce severe reactions, even death - prompt medical attention is mandatory.
Common Jellyfish	Stinging sensation, if anything.	Use acid ointment or soak in ammonia and water (strong base), papaya juice, etc.

5.4 DIVING FIRST AID AND EMERGENCY PROCEDURES (Cont'd)

Problem	Symptoms	First Aid
Sea Urchin	Prickling sensation, burning, local pain, possibly high allergic reaction, paralysis to develop.	Soak with acid or apply baking soda allow spine to dissolve, do not attempt to remove. Seek medical advice if severe reactions occur.
Venomous Fish	Various symptoms, swelling, redness, muscle spasm, respiratory problems, possible convulsions.	Soak in hot water after cleaning with cold water. Epsom salt or ammonia. Seek medical attention.
Sting Rays	Pain, weakness, nausea, fainting.	Remove barb, wash with clean salt solution. Soak in hot water for half hour or apply hot compresses. If necessary seek medical attention.
Cone Shells	Stinging, paralysis, possible death, cardiac arrest, respiratory distress.	Control pain, CPR if needed, Rush to medical attention; i.e., call Coast Guard, Emergency Fire Rescue or Sherrif's Department.
Bites (Shark, Moray, etc.)	Severe bleeding, shock.	Control bleeding and perform first aid for shock - CPR if needed. Seek medical emergency evacuation source.
Octopus	Rare to be bitten, but can produce swelling, redness, and bleeding.	Cold compress, observe for shock, control bleeding. Seek medical attention.

5.5 EMERGENCY PROCEDURES FOR ABORTED OR OMITTED DECOMPRESSION

Certain emergencies may interrupt or prevent specified decompression. Blowup, complete loss of communication without a standby diver, exhausted air supply, bodily injury, and the like are among such emergencies. If there are symptoms of decompression sickness or air embolism, immediate treatment by recompression is essential. Even without evidence of any ill effects, omitted decompression must be made up in some manner to avert later difficulty.

5.5.1 Use of Surface Decompression Tables

It may appear that surface decompression schedules offer an immediate solution to the problem of interrupted decompression because they provide for a surface interval. Such schedules shall only be used, however, if the emergency surface interval occurs at such a time that water stops are not required or have already been completed in accordance with whichever surface decompression table is considered most appropriate.

5.5.2 Surface Decompression Tables Not Applicable

When the conditions above are not fulfilled, the diver's decompression has been compromised. Special care shall be taken to detect signs of decompression sickness regardless of what action is initiated. The diver must be returned to pressure as soon as possible. The use of a recompression chamber shall always be preferred to water decompression. Water decompression shall only be used as a last resort.

5.5.3 When a Recompression Chamber is Available

Even if the diver shows no ill effects from his omitted decompression, he needs immediate recompression. Take him to 100 feet in the chamber and keep him at that depth for 30 minutes. If he still shows no ill effects after that period of time, bring him out of the chamber in accordance with Treatment. Consider any decompression sickness during or after the procedure as a recurrence.

5.5.4 When No Chamber is Available (Under the Direction of Medical Diving Officer)

Recompress the diver in the water, following as nearly as possible the procedure in 5.5.3, above. Keep the diver at rest, provide two standby divers, and maintain good communication and depth control.

When the course of action outlined in the above paragraph is impossible, use the following procedure, which is based on the Standard Air Decompression Table with 1 minute between stops:

- Repeat any stops deeper than 40 feet.
- At 40 feet, remain for one-fourth of the 10-foot stop time.
- At 30 feet, remain for one-third of the 10-foot stop time.

- At 20 feet, remain for one-half of the 10-foot stop time.
- At 10 feet, remain for one and one-half times the scheduled 10-foot stop time.

5.6 EMERGENCY PROCEDURE FOR BRINGING AN UNCONSCIOUS DIVER TO THE SURFACE

An unconscious diver must be brought to the surface as soon as possible so that emergency first aid can be rapidly administered. The concern with bringing an unconscious diver to the surface is that he may embolize on the way up. However, breath holding takes a conscious, forced effort. As long as the airway is open the air will take the path of least resistance and escape through the diver's mouth. The victim may commence to breathe on his own as soon as his airway is open. For this reason his regulator (or your regulator if he is out of air) should be inserted into his mouth. Open the airway. Bring the diver to the surface keeping his head tilted back so that his airway remains open. Keep the mouthpiece in place while ascending. If it is your mouthpiece you may remove it to buddy breathe and then reinsert it in the unconscious diver's mouth. Upon reaching the surface, if the unconscious diver is still not breathing, begin mouth-to-mouth immediately.

5.7 FIRST AID KIT SUPPLIES (REQUIRED)

6	2" Bandage compress
6	3" Bandage compress
8	4" Bandage compress
4	4" x 4" Plain gauze pads
4	3" Gauze roller bandage
2	Eye dressing packet #1
8	Triangular bandages 40"
2	Eye dressing packet #5
2	Snake bite kits
2	Forceps
8	Petrolatum gauze dressings 3" x 36"
1	Pen light
4	4" Gauze roller bandage
4	1/2" Adhesive tape 180"
1	Stethoscope
1	Pressure cuff (Sphygmomanometer)
1	Manual O_2 Resuscitator with transparent mask and tubing
2	Ace Bandage 3"
1	Bottle merthiolate
2	Bottle rubbing alcohol 2-1/2 oz. or 3 oz.
12	Safety pins
4	Sephiren towelettes
2	Zinc oxide ointment
2	Xylocaine 1% solution
2	Adhesive tape 1" x 1 yd.
2	Band-Aids, #70
3	Butterfly closures, #25 assorted
2	Eye pads #2
2	Eye patch

5.7 FIRST AID KIT SUPPLIES (Cont'd)

2	Gauze bandage, 2" roll
2	Ice packs #2
1	Q Tips #54
1	Scissors, blunt tip
4	Telfa pads, self-adhesive #20 2" x 3"
1	Thermometer, Oral
4	Tongue blades #5
1	Afrin nasal spray
1	Aromatic spirits of ammonia, 2 oz.
1	Aspirin tablets, #100
1	Bonine tablets, #16
1	Caladryl lotion, 75 ml.
1	Chloraseptic lozenges, #18
1	Chlotrimenton tables, #24
1	DiGel tablets, 4 x 7's
1	ExLax tablets #6
1	Neosporin ointment, 1 oz.
1	Sunstick
1	T.H. and D. Elixer, 4 oz.
1	Tanac lotion
1	Vaseline ointment, 1 oz. tube
1	Visine drops, 15 cc plastic
1	Xylocaine ointment, 35 gm 2.5%
2	Ace bandage 2"
1	Auralgan ear drops
1	Mycolog cream (Rx)
1	Neocortef eye ointment (Rx)
1	Pliers, needle nose
1	Razor blades (1 doz.)
1	Chamber procedural text
1	Ear exam kit
1	Paramedic's first aid book
2	Tourniquets
1	Hydrogen peroxide (12 oz.)
1	Analzong (100 tablets)
1	Matches Box
1	Ear Plugs
1	Decompression Table
1	Empirin Compound (with cod/gr)
1	Tetracycline 250 mg
1	Ampicillin 250 mg
1	Lomotil
1	Nembutal 100 mg
1	Neocortef 0.5%
1	Adrenalin Amps.
1	Demerol 100 mg
6	Syringes
1	Ethylchloride
4	Surgical Silk

These supplies shall only be used in emergency situations and by properly trained individuals under the direction of a Medical Doctor.

5.8 EMERGENCY PROCEDURES FOR DAM DIVING

U.S. Air Force planes frequent many parts of the world. The hyperbaric unit duty officer at Brooks AFB, San Antonio, Texas knows where they all are. Call (512) 536-3278 (that's (512) RED FAST). He can give expert advice for managing the emergency, and can sometimes divert a plane, possibly even one with cabin pressurized to sea level, to take a victim to the nearest functional chamber as he knows where those are too.

Medically certified chambers in the Northeastern United States include:

1. Portsmouth Naval Shipyard, Portsmouth, NH 03801
   (207) 439-1000, ext. 1740

2. Submarine Base New London, Groton, CT 06349
   (203) 449-3666 24 hr/hosp
   (203) 449-3805

3. Norwalk Hospital, Norwalk, CT 06856
   (203) 852-2000
   (203) 852-2479

4. U.S. NAVAL UNDERWATER SYSTEMS CENTER, Newport, RI 02840
   (401) 841-3776

It may be advisable to contact the State Troopers to assist with evacuation from the dive site.

6.1 EQUIPMENT REQUIREMENTS

Most diving in the New England Division shall be accomplished with self-contained/demand-type open-circuit (SCUBA) gear, but, for certain tasks, surface air-supplied diving apparatus may also be used, along with specialized gear.

The Diving Officer shall approve all equipment for New England Division use, and only approved equipment and accessories shall be used. A list of currently approved equipment is contained in Section 6.3.

Periodic maintenance and inspection procedures shall be specified by the Diving Officer to ensure that equipment is in good condition at all times. Procedures for routine equipment maintenance are given in Section 6.4. Each dive team member is responsible for maintaining his own equipment records which shall include: the date each item was purchased, its cost, when it was replaced, dates and a time of repairs, and name of certified repair person. A sample of an equipment maintenance form is given in section 7.2. The equipment form shall be submitted annually to the Diving Officer.

The minimum equipment for any New England Division diver shall consist of breathing apparatus, mask, snorkle, flippers, wet suit, buoyancy compensator, weight belt, knife, depth gauge, and compass.

6.2 OSHA REGULATIONS ON EQUIPMENT

6.2.1 Air Compressor Systems

1. Compressors used to supply air to the diver shall be equipped with a volume tank with a check valve on the inlet side, a pressure gauge, a relief valve, and a drain valve.

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

3. Respirable air supplied to a diver shall not contain:

   (i) A level of carbon monoxide (CO) greater than 20 ppm;

   (ii) A level of carbon dioxide (CO_2) greater than 1,000 ppm;

   (iii) A level of oil mist greater than 5 milligrams per cubic meter; or

   (iv) A noxious or pronounced odor.

4. The output of air compressor systems shall be tested for air purity every 6 months by means of samples taken at the connection to the distribution system, except that nonoil-lubricated compressors need not be tested for oil mist.

6.2.2 Breathing Gas Supply Hoses

1. Breathing gas supply hoses shall:

   (i) Have a working pressure at least equal to the working pressure of the total breathing gas system;

   (ii) Have a rated bursting pressure at least equal to four times the working pressure;

   (iii) Be tested at least annually to 1.5 times their working pressure;

   (iv) Have their open ends taped, capped or plugged when not in use; and

   (v) Shall be free of excessive wear and be within time limits.

2. Breathing gas supply hose connectors shall:

   (i) Be made of corrosion-resistant materials;

   (ii) Have a working pressure at least equal to the working pressure of the hose to which they are attached; and

   (iii) Be resistant to accidental disengagement.

3. Umbilicals shall:

   (i) Be marked in 10-foot increments to 100 feet beginning at the diver's end, and in 50-foot increments thereafter;

   (ii) Be made of kink-resistant materials; and

   (iii) Have a working pressure greater than the pressure equivalent to the maximum depth of the dive (relative to the supply source) plus 100 psi.

6.2.3 Buoyancy Control

1. Helmets or masks connected directly to the dry suit or other buoyancy-changing equipment shall be equipped with an exhaust valve.

2. A dry suit or other buoyancy-changing equipment not directly connected to the helmet or mask shall be equipped with an exhaust valve.

3. When used for SCUBA diving, a buoyancy compensator shall have at least one inflation source separate from the breathing gas supply and shall have a lifting capacity of at least 35 pounds.

4. An inflatable flotation device used for SCUBA diving shall: be capable of maintaining an unconscious diver at the surface in a face-up position, have at least one manually activated inflation source independent of the breathing supply, and have an oral inflation device and an exhaust valve.

6.2.4 Compressed Gas Cylinders

1. Compressed gas cylinders shall:

   (i) Be stored in a ventilated area and protected from excessive heat;

   (ii) Be secured from falling; and

   (iii) Have shut-off valves recessed into the cylinder or protected by a cap, except when in use or manifolded, or when used for SCUBA diving.

6.2.5 Recompression Chambers

1. Each recompression chamber manufactured after the effective date of this standard shall be built and maintained in accordance with the ASME Code or equivalent.

2. Each recompression chamber manufactured prior to the effective date of this standard shall be maintained in conformity with the code requirements to which it was built, or equivalent.

3. Each recompression chamber shall be equipped with:

   (i) Means to maintain the atmosphere below a level of 25 percent oxygen by volume;

   (ii) Mufflers on intake and exhaust lines, which shall be regularly inspected and maintained;

   (iii) Suction guards on exhaust line openings; and

   (iv) A means for extinguishing fire, and shall be maintained to minimize sources of ignition and combustible materials.

6.2.6 Gauges and Timekeeping Devices

1. Gauges indicating diver depth which can be read at the dive location shall be used for all dives except SCUBA.

2. Each depth gauge shall be dead-weight tested or calibrated against a master reference gauge every 6 months, and whenever there is a discrepancy greater than 2 percent of full scale between any two equivalent gauges.

3. A cylinder pressure gauge capable of being monitored by the diver during the dive shall be used by each SCUBA diver.

4. A timekeeping device shall be available at each dive location.

6.2.7 Masks and Helmets

1. Surface-supplied air masks and helmets shall have:

   (i) A non-return valve at the attachment point between helmet or mask and hose which shall close readily and positively; and

   (ii) An exhaust valve.

2. Surface-supplied air masks and helmets shall have a minimum ventilation rate capability of 4.5 acfm at any depth at which they are operated or the capability of maintaining the diver's inspired CO_2 partial pressure below 0.02 ATA when the diver is producing CO_2 at the rate of 1.6 standard liters per minute.

6.2.8 Oxygen Safety

1. Equipment used with oxygen or mixtures containing over 40 percent by volume oxygen shall be designed for oxygen service.

2. Components (except umbilicals) exposed to oxygen or mixtures containing over 40 percent by volume oxygen shall be cleaned of flammable materials before use.

3. Oxygen systems over 125 psig and compressed air systems over 500 psig shall have slow-opening shut-off valves.

6.2.9 Weights and Harnesses

1. Except when heavy gear is worn, dive team members shall be equipped with a weight belt (or assembly) capable of quick release.

2. Except when heavy gear is worn or in SCUBA diving, each dive team member shall wear a safety harness with:

   (i) A positive buckling device;

   (ii) An attachment point for the umbilical to prevent strain on the mask or helmet; and

   (iii) A lifting point to distribute the pull force of the line over the diver's body.

6.3 APPROVED EQUIPMENT

Item	Stock Number/Requirement	Manufacturer's Name	Manufacturer's Designation
SCUBA, OPEN CIRCUIT, DEMAND			
Belt, Weight Quick Release, Single Pull	Commercially Available (CA)	Diver Preference	
Buoyancy Compensator with LP Inflator	CA	Seatec	
	Sunfish	10396-01	
	Tuff Tiger	10396-02	
		10396-03	
		10396-04	
	Swimaster	GBC-1	
	U.S. Divers	7700-BC 700	
Buoyancy Compensator without LP Inflator	CA	Fenzee	
Compass, Wrist	CA	Dacor	Model DCP
	Under Sea Industries	Scubapro LS 1	
	Ikelite	Pro #2500	
	Farallon	#04-1010	
	AMF Voit	#DC-300	
Cylinders, Scuba Single or Twin Steel or Aluminun (steel cylinders) or SP-6498/3000 (Aluminum cylinders)	CA Must conform to D.O.T. Specification Type 3AA		
Fins, Swim	CA	Diver Preference	
Harness,	CA only positive screw type bands	Diver Preference	
Knife, Divers'	CA	Diver Preference	
Light, Divers Hand-held, Self-contained, Integral Power Source	CA	Divers Preference	

6.3 APPROVED EQUIPMENT (Cont'd)

Item	Stock Number/Requirement	Manufacturer's Name	Manufacturer's Designation
Light, Umbilical Powered	CA	Underwater Service	HQI-500
	Hydro Products	HQ-250	
		HQ-500	
Manifold, Double	CA with J Valve	Diver Preference	
Manifold, Single	CA with J Valve	Diver Preference	
Mask, Face, Tempered Glass Faceplate	CA	Diver Preference	
Regulator, Demand Double Hose	CA	Dacor	C3-N
U.S. Divers Royal Aquamaster			
Regulator, Demand Single Hose	CA	AMF	Swimmaster
		MR-12-II	
		MR-12	
Dacor	Olympic 100		
		Olympic 200	
		Olympic 400	
		Olympic 800	
	Sherwood	SRB-4100J	
	Selpac Corp	SRB-4100K	
	U.S. Divers Aquarius	Calypso J	
		Conshelf XII	
		Conshelf XIV	
	Poseidon	Cyklon 300	
	Scuba Pro Air	I MK V (4 port swivel)	
		I MK V (5 port swivel)	
	Scubamaster	7687	
	Tekna	T-2100B	
	Under Sea Industries	Scubapro	
		MK I	
		MK V	
		MK V Pilot	

6.3 APPROVED EQUIPMENT (Cont'd)

Item	Stock Number/Requirement	Manufacturer's Name	Manufacturer's Designation
Strap, Wrist Watch NSN 1H-6645-00-679-0614	CA	Diver Preference	
Suit, Neoprene Wet	CA O'Neil	Poseidon/Parkways Supersuit Bluewater Blueglove	Unisuit
Suit, Wet	CA	Local Procurement	Diver Preference
Watch, Wrist submersible (Must have rotating Bezel, sweep second hand, and less than $300)	CA	Diver Preference	
OTHER DIVING EQUIPMENT			
Amplifier	CA	Helle 3315	WP-14
Bell, Open Diving Steel Acrylic Top	 GMI DR #00-137-1000 NAVSEA DR #468-4707	 (Rev D) (Rev C)	 NA NA
Buoy, marker, inflatable	CA	Dacor	IDF
Booster, pump, gas + O_2 (Not for shipboard use with 40% or greater O_2)	CA	Haskel	26968
Clamps/Air Hose (New hose 1/2" ID x 1" OD)	NA MIL-H2815F	Band-It Co. clamp No.4	No. J504 Silicone bronze
Coupling/Air Hose (New hose 1/2" ID x 1" OD) Female Male	NA MIL-H2815F	DESCO Cat No. 23065 Cat No. 23066	

Item	Stock Number/Requirement	Manufacturer's Name	Manufacturer's Designation
NOTE 1: H.P., M.P., and L.P. should not be procured with a purification system but must have an approved filter, a moisture separator, and a back pressure regulator installed.			
Compressor, H.P.	3000 psig, 15 SCFM (Note 3)	Ingersoll Rand 4R15	10T2
3000 psig, 4 SCFM NSN 1H-4310-00-165-4865	NA	NA	
3000 psig, 4 SCFM	Bauer (Note 3)	KA-51-DF	
3000 psig, 9.2 SCFM	Bauer (Note 3)	KA-14	
3000 psig, 90 SCFM	Rix (Note 3)	2J-4B-150	
3000 psig, 5 SCFM	Rix	1S3B-6G (SA-6G)	
3000 psig, 8 SCFM	Hardie-Tynes (Note 1)	3M-133	
3000 psig, 24 SCFM & 60 SCFM MIL-C-18419	NA (Note 1)	NA	
Compressors, M.P. 250 psig, 97 SCFM	400 psig, 150 SCFM Quincy	Rix 5120W	2JS2B-300
Compressors, L.P.	125 psig, 25 SCFM (Only with NAVSEA permission)	Aqua Air (Note 1)	AA1325
Filters, Divers' Air up to 300 psi service	CA CA	Pall Trinity Micro (Pall) VCS3002G160 Elements	Housings VCS3001G160
CA CA	Pall	MDC1001SUM MDS1001SUM	

6.3 APPROVED EQUIPMENT (Cont'd)

Item	Stock Number/Requirement	Manufacturer's Name	Manufacturer's Designation
CA	Filterite	REV-DUO-FIN-10	
CA	FACET (Bendix)	Housing 173530	
CA	FACET	(3 req.)045800-10	
CA	FACET	(6 req.)041315-15	
CA	Zurn	Housing 77104	
CA	Zurn	Element 74635-29	
CA	Balston	Housing 20/35A	
CA	Balston	Element 200-35-CX	
CA	Balston	Housing 20/80A	
CA	Balston	Element 200-80-CX	
up to 500 psi service	CA	Filterite LMOVS10S-3/4	Housing 913563:
CA	Filterite	Elements REV-DUO-FIN-10	
CA	Pall	MDC1001SUM	
CA	Pall	MDS1001SUM	
CA	Keene	Housing 950-2A	
CA	Keen	Element 60L22	
up to 800 psi service	CA	Balston	Housing 20/35A-801
CA	Balston	Element 200-35-CX	
up to 3000 psi service	CA	Filterite 3LHIO-3/4	Housing 913328:
CA	Filterite	Element REV-DUO-FIN-10	
CA	Pall	MDC1001SUM	
CA	Pall	MDS1001SUM	
CA	Norman Equip. Co.	Housing 4535A-03PL-DRI NSWC	
		Element 535A-03PL	
up to 6000 psi service	CA	Pall	Housing MEN9001G240
CA	Pall	Element MDC1001SUM	
CA	Pall	MDS1001SUM	
CA	Filterite	REV-DUO-FIN-10	

Item	Stock Number/Requirement	Manufacturer's Name	Manufacturer's Designation
NOTE 2: The following filters are approved as previously installed but should not be purchased for new filter installations.			
Filters, Divers' Air	CA	Pall	Housing MCC1001G160
up to 150 psi service (Note 4)	CA	Pall	Element MDC1001SU
CA	Pall	MDS1001SU	
CA	Filterite	REV-DUO-FIN-10	
CA	Deltech	Housing Delguard 450	
CA	Deltech	Element 450E	
CA	King	Housing 2260-1	
CA	King	Element (1 req.) 9326A-241	
CA	King	Element (5 req.) 2430-5-6	
CA	Dollinger	Housing GP-11-105	
CA	Dollinger	Element 2-34	
CA	Consler	Housing CCP-3-3	
CA	Consler	Element 11714	
up to 200 psi service (Note 2)	CA	Facet	Housing 056800
CA	Facet	Element (18 req.)041315-15 (12 req.)045800-06	
up to 250 psi service (Note 2)	CA	Arrow	Housing 3315
CA	Arrow	Element 39070	
CA	Monnier	Housing 203-6299-8	
CA	Monnier	Element 25640	
CA	Balston	Housing 62A	
CA	Balston	Element 150-19-CX	
up to 3000 psi service (Note 2)	CA	NSWC	Housing CUNO 1H1 MOD
CA	Pall	Element MDC1001SUM	
CA	Pall	MDS1001SUM	

6.3 APPROVED EQUIPMENT (Cont'd)

Item	Stock Number/Requirement	Manufacturer's Name	Manufacturer's Designation
Full Face Mask (NOTE: Used with AMF/VOIT NR12 or Conshelf XII, XIV for special use with SUBCOM Model 2-30)	CA	U.S. Divers	Model 5204
Gauge, Pressure Caisson	NSN 9G-6685-00-431-4895	3D Instruments (Formerly Roylyn)	
Exterior	NSN 1H-66-5-00-009-7470		
Gauge, Depth wrist mounted	CA DACOR	U.S. Divers LPG 300	Depthmaster II
Gauge, Tank, Pressure 3000 psi	CA DACOR	U.S. Divers 7003, 7004	PGR Delux
Gauge, Submersible, tank pressure	CA	Diver Preference	
Hot Water Boots	CA Int.	Diver Unlimited (Soft Sole) Part No. 35009-02 (Hard sole)	Part No. 35009-01
Hot Water Gloves	CA Int.	Diver Unlimited	Part No. 35008-01
Hot Water Heater	CA Int.	Diver Unlimited Eccono Gulf Part No. 32007-00	Part No. 31020-01
Hot Water Hood	CA Int.	Diver Unlimited	Part No. 35000-11
Hose Fittings	CA Int.	Diver Unlimited QD Part No. 310271-01	Part No. Diver
Weight Pockets (suit) Waist and legs set	CA	Diver Unlimited Int.	Part No. 35000-112

6.3 APPROVED EQUIPMENT (Cont'd)

Item	Stock Number/Requirement	Manufacturer's Name	Manufacturer's Designation
Hot Water Hose	CA Int.	Diver Unlimited Part No. 31027-000	Hot Water Diver
Hot Water Suit	CA Int.	Diver Unlimited Diver Part No. 35002-000	Deep Diver, Industrial
Hot Water Suit Liner	CA Int.	Diver Unlimited 35006000	Model 23-01, Part No.
Mask, MK 1 MOD S	KMB-9 as modified by NAVSEA	NA	NA
Mask, MK 1 MOD T	KMB-9 as modified by NAVSEA	NA	NA
Integrated Divers Vest (IDV)	NSN 1H-4220-01-045-2194	NA	NA
Pump O_2 Transfer	CA PPI	Aminco 1040-A	AOC 250
Scuba (Emerson) O_2 CID #990010013	SPCC Mechanicsburg	NA	NA
Snorkel, Scuba	CA	Diver Preference	
Suitcase Console/Filter Assy	CA	NA Filter #5020819	Console #5020805
Through Water Communications	CA Systems, Inc.	Sound Wave	WPV-02
Vehicle, Diver Propulsion	CA	Farallon	MK V, MK VI

DIVER TOOLS

NOTE 3: NAVSEA Drawing includes hose assembly and accessories.
NOTE 4: Model 1 should be upgraded to Model 2; Contact NCSC, Code 710, for particulars on this, and all tools with NCSC modifications.

6.3 APPROVED EQUIPMENT (Cont'd)

Item	Stock Number/Requirement	Manufacturer's Name	Manufacturer's Designation

NOTE 5: Diver required to wear 1/2" neoprene wet suit hood. Model 1-A use the tool a maximum of 1 hour to every 24 hours; Model 1-B use the tool a maximum of 2-1/4 hours in every 24.
NOTE 6: Special training required.
NOTE 7: 2 sets of AEROQUIP, 5600-12-10S Hydraulic Disconnects Per Hose Assembly are not included in the above assemblies and must be procured separately.

Hydraulic Power Supply Hydraulic)	NAVSEA Model 1 (Diesel	NA	NA (Note 6)
NAVSEA Model 2 NAVSEA 56366557 (Diesel Hydraulic)	NA	NA	
NAVSEA Model 3 NCSC 22265 (Diesel Hydraulic)	NA	NA	
NAVSEA Model 4 NAVSEA 5366558 (Diesel Hydraulic)	NA	NA	
Hydraulic Grinder	CA NAVSEA 5366565	Stanley	GR24 (Note 3)
Hydraulic Impact Wrench CA NAVSEA 5366563	CA NAVSEA 5366562 Stanley	Stanley IW13 340 (Note 3)	IW06 (Note 3)
Sump/Jetting Pump	CA NAVSEA 5366572	Stanley	SM22 501 (Note 3)
Jack Ram	CA NAVSEA 5366573	Enerpac	RC106 OR RC10 (Note 3)
Pull Cylinder	CA NAVSEA 5366575	Enerpac	1610-1 (Note 3)
Come-A-Long	CA NAVSEA 5366561	Griphoist 1 ton	TU-28H-SS-2 (Note 3)
Portable Hydraulic Bandsaw NA	CEL Design NAVSEA 6255658	NA	

6.3 APPROVED EQUIPMENT (Cont'd)

Item	Stock Number/Requirement	Manufacturer's Name	Manufacturer's Designation
Barstock Cutter	CA NAVSEA 5366579	H.K. Porter	Model 36274 (Note 3)
Wire Rope Cutter	CA NAVSEA 5366567	H.K. Porter	Model 36262 (Note 3)
Hydraulic Hose storage reels NAVSEA 22258	CA 3/4" Twin lined with	Synflex 2400 Twin lined hydraulic	3R8H-12-112
	Dayco	3W0637 Twin lined hydraulic (Note 3&7)	
Underwater Hydraulic Pile Cutter	CEL Design	NA	NA
Nut Splitter	CA	H.K. Porter	1780 PQ
1/4" High Pressure Hydraulic Hose	CA	Synflex	3R8H-04-106-106-1200
High-flow High Pressure Hydraulic Coupler with Dust Cap	CA	Enerpac	6H-604 with dust cap CD-415
Hull Scrubbing Brush Pneumatic	CA	Underwater Tools & Equip. Co. drawings 715-80-1, 715-80-2-Rev A and 715-80-B) (Note 3)	Aqua Kleen MK 1 MOD IV (modified by NCSC
Cavitating Water Jet Cleaning Tool	CA	Seaco Inc. Model 1-B (Note 3)	Model 1-A
Hydraulic Chain Saw	CA	Stanley as per NAVSEA drawing 5366590) (Note 3)	Model CS-11 (modified
Nut Splitter Cutter Head	CA	H.K. Porter per NAVSEA drawing 5366579)	1713 PQ (modified as

6.4 EQUIPMENT MAINTENANCE

6.4.1 What To Do After Diving

1. Rinsing thoroughly with fresh water is the best possible maintenance for diving equipment. The criteria for overhauling are that the equipment is not functioning or it is a scheduled for overhauling (e.g. regulator annual).

2. There are three means of flushing with freshwater:

   a. With fresh water available at the dive site. If water is scarce, fill large trash cans with fresh water. If possible, use two cans, one for the initial rinse and one for a secondary rinse.

   b. Rinsing with fresh water after returning from dive site.

   c. When diving is stopped for a period of time, soak the diving equipment in warm water for a period of 2 hours. This dissolves the salt from the equipment.

6.4.2 Methods of Rinsing the Dive Equipment

1. Whenever it is convenient, leave the regulator attached to the tank (with the tank valve open) and flush thoroughly.

2. If regulator is removed from tank, place the dust cap on, making sure there is no moisture or salt crystals on it.

   a. Flush thoroughly without depressing the purge button so as not to allow water into the intermediate chamber.

   b. Drain hoses and mouthpiece completely after washing.

3. Buoyancy compensator

   a. Rinse thoroughly both inside and outside and between the bladder and outer bag if it is a two-bag system.

   b. Thoroughly rinse all mechanical and moving parts.

   c. Remove CO_2 cartridge (if equiped) and spray silicone lubricant on the firing mechanism.

   d. Spray silicone lubricant on zipper and any moving parts.

4. Wet suits

   a. Rinse thoroughly both inside and outside, especially the zippers.

   b. Spray silicone lubricant on the zippers.

5. Associated diving equipment: mask, snorkel, fins, gauges, compass. etc.

   a. Rinse thoroughly with freshwater.

   b. Spray silicone lubricant on rubber parts.

   c. Gauges should be protected against rough handling and dropping.

   d. Depth gauge should periodically be tested for accuracy.

6.4.3 Storage

1. Make sure all of your equipment is thoroughly dry before you store or pack it away for any length of time.

2. Do not dry your equipment, especially the wet suit, in the wind or direct rays of the sun.

3. Store in a cool dry place.

4. Tank should be stored upright in a rack (to prevent it from falling). If the tank is to be unused for a long period of time, store with less than 300 psi to avoid excessive metal fatigue.

5. Keep regulator dry and avoid kinking hoses. Use hose protectors where hoses insert into the 1st stage.

6. Fins should be placed so as not to distort the blades.

7. When your wet suit is to be stored in excess of 1 month, wash thoroughly in freshwater and dry out of the wind and sun. It is recommended that the neoprene of the suit should be powdered lightly with a nonscented talcum powder or with corn starch. The suit should preferably be stored unfolded and laying on a flat surface. The zippers should be lubricated with silicone or graphite and the entire wet suit placed in a plastic bag, not hanging on a wire hanger.

8. After diving, especially if the diving equipment is to be stored for a great length of time, make sure the rubber products, such as the mask, fins and snorkel are not bent or stored near a heated object or left lying in the sun or near excessive heat. Straps should be released from their holders.

9. If an air compressor is to be stored in excess of 3 months, the filter mechanism should be drained and dried thoroughly. The oil should be drained from the crank case of the engine or, if it is an oil-lubicated air compressor, the oil should be drained from the crank case of the air compressor.

   WARNING: If the oil is drained from the driving engine and/or the air compressor, make sure a tag is placed conspicuously back on the engine or air compressor to assure that neither is started before the oil is

replaced. WARNING: Do not use a petroleum-based lubricant in the air compressor itself.

6.4.4 Regulator Overhaul

The regulator is to be overhauled annually by an authorized professional.

Authorized regulator repair services:

Diver's World INC.
195 Princeton Street
North Chelmsford, MA
(617) 251-4895

East Coast Divers
280 Worcester Road (Route 9)
Framingham, MA
(617) 620-1176

Other repair services must be approved in writing from the Diving Officer.

Section 7

RECORD KEEPING

7.1 RECORD KEEPING PROCEDURES

Pertinent records shall be maintained for each team member. These records include diving qualifications, training forms, annual medical examinations, dive logs, equipment acquisition, replacement, and maintenance records. The dive team member will keep personal copies of these records and will submit the originals to the Diving Officer. The Diving Officer is responsible for ensuring that each dive team member's records are maintained. The records shall be held and supplied by the Diving Officer.

In addition, at the conclusion of a diving operation, the Dive Master shall submit to the Diving Officer the written dive plan and Activity Job Hazards Analysis (AJHA). For routine dives involving the same operation, one dive plan may be submitted annually unless specialized procedures like decompression diving, surface-air supplied, or high altitude diving are involved.

In the event of a diving accident, a written report must be filled out as soon as possible by the Dive Master.

The Diving Officer shall submit, during the first quarter of each New Fiscal Year, to the Division Safety Office a record of all Division diving activities accomplished during the previous Fiscal Year.

7.2 TYPES OF RECORDS AND FORMS

7.2.1 Personal Records to be Maintained on Each Diver

7.2.1.1 Medical Records

- The results of the dive team member's annual medical.
- The examining physician's opinion of the dive team member's fitness to be exposed to hyperbaric conditions including any recommended restrictions to such exposure.

7.2.1.2 Training Records (Table 7-1)

In addition to his personal logs each dive team member shall keep a record of his diver training, continuing diver education, membership in diving-related organizations, and his experience in special conditions and different geographical areas.

Table 7-1 TRAINING RECORDS

DIVING TRAINING RECORD

List all diving courses attended such as..... Resort, Skin, Scuba, Advanced, Specialty, Instructor, Military, Commercial.

TYPE OF COURSE	LOCATION	DATES	TOTAL HOURS	CERTIFI-CATION	OPEN WATER	INSTRUCTOR
		start	lecture	agency	no. dives	print name, number
		finish	water	reg. no.	depth	instructor signature

RECORD OF CONTINUING EDUCATION

Additional diving related courses such as..... College Classes, Swimming, Lifesaving, First Aid, Boating and Seamanship, Environment, etc.

subject/class no.	finish date	sponsoring agency	print instructor name
location/school	units/hours	certification expires	instructor signature

RECORD OF MEMBERSHIP IN DIVING RELATED ORGANIZATIONS

Dive Clubs, Councils, Societies, Associations

ORGANIZATION_____

DATE JOINED_____ EXPIRES_____

RATING_____ DUES_____

ORAGNIZATION_____

DATE JOINED_____ EXPIRES_____

RATING_____ DUES_____

DIVING RELATED EXCURSIONS

Visits to Manufacturers, Aquariums, Oceanariums. Museums, Exhibits, Schools, Etc. (continued)

FACILITY	ACTIVITY	DATE(S)

DIVING AWAY FROM HOME

List all out-of-state/province, out-of-country diving experiences.

LOCATION/REMARKS	DATE(S)

ENVIRONMENTAL DIVING RECORD

Enter your first supervised open water experience and orientation under each condition. See details on entering previous experience under the heading "About the Record."

COND.	LOCATION	DATE(S)	VERIFIED: NAME, TITLE, ORGANIZATION
OCEAN			
LAKE			
QUARRY			
RIVER			
BOAT			
SHORE			
SURF (3 ft.+)			
ROCKY ENTRY			
ALTITUDE (2000'+)			
CURRENT (2 knots +)			
TURBID WATER (2' or less)			

COND.	LOCATION	DATE(S)	VERIFIED: NAME, TITLE, ORGANIZATION
WEEDS			
KELP			
CORAL			
ICE (under)			
COLD (full wet suit)			
NIGHT			
DEEP (60'-130')			
CAVE (100' penetration)			
WRECK (65'+ length)			
other			

7.2.1.3 Dive Logs (Table 7-2)

Each dive team member shall fill out his dive log at the end of the day's diving. He shall keep the original of each log and submit one copy to the Diving Officer.

7.2.1.4 Equipment Logs (Table 7-3)

Each dive team member shall maintain a record of his equipment acquisitions, replacements, and maintenance. He shall keep one copy of his equipment log form and submit the original to the Diving Officer who shall put it in the dive team memeber's personal file.

7.2.2 Records to be Maintained by Dive Master for Each Diving Operation

7.2.2.1 Dive Plan (Table 7-4)

A dive plan for all open-water diving operations shall be submitted by the Dive Master to the Diving Officer for approval prior to commencement of operations. An accident management procedure specifying particular action to be taken in the event of an emergency shall also accompany the diving plan. A copy of the completed and approved plan shall be available at the dive site. At the completion of operation, the dive plan, shall be turned in to the Diving Officer and maintained in the diving files in the Safety Office.

7.2.2.2 Activity Job Hazards Analysis (AJHA) (Table 7-5)

As part of the pre-dive conference the Dive Master, in conjunction with the dive team, shall conduct an AJHA. The AJHA shall be written down and should be turned into the Diving Officer along with the dive plan at the completion of diving operations.

7.2.3 Accident Reports (Table 7-6)

In the event of a diving accident, the Underwater Accident Report Form shall be filled out as soon as possible after the accident. This report shall be filled out by the Dive Master and submitted to the Diving Officer.

Table 7-2
DIVE LOG

Date_____

Diver_____ Conventional Dive Dive No._____
Location_____ Repetitive Dive Job No._____
Vessel_____ Repet Up

DIVING CONDITIONS

Wind_____ Weather_____ Waves_____ Current_____ Visibility_____
Bottom: °Sand °Sugar Sand °Shell °Soft °Medium °Beaumont Clay
Type of Equipment Used: °Air Hat °Mask °Deep Sea °SCUBA Other_____
Water Temperature_____ Diver's Dress: °Wet Suit °Dry Suit °Hot Suit Other_____
Severity of Work: °Light °Moderate °Heavy °Severe Diver's Condition: °Rested °Tired

DIVING INFORMATION

End Last Dive_____ Time_____ Sur. Int._____ Hrs._____ Min._____ Repeat Gp._____ to_____ RNT_____
Standby Diver_____ Timekeeper_____ Line Tender_____
LS_____ RB_____ LB_____ BT_____ RNT_____ TBT_____
Depth of Dive_____ft. Decompression Schedule Used_____ft. _____min. Repet Gp._____

REPET UP

REPET UP DEPTH	REPET GP.	RB	LB	BT	RNT	TBT	TIMEKEEPER
1st Repet up_____ft.	to						
2nd Repet up_____ft.	to						
3rd Repet up_____ft.	to						
4th Repet up_____ft.	to						

Table 7-2 (Continued)
WATER DECOMPRESSION

WATER DEPTH	TIME REACHED	MIN. AT STOP	TIME LEFT	ASCENT RATE	DIVER'S CONDITION	TIME KEEPER

1st Stop_____ft.
2nd Stop_____ft.
3rd Stop_____ft.
4th Stop_____ft.
5th Stop_____ft.
6th Stop_____ft.

Reached Surface: Time_____ Date_____

SURFACE DECOMPRESSION

Outside Tender_____ Inside Tender_____ ^{o} $^{o}2$ ^{o}Air
Left Surface_____ Time_____ Surface Interval_____ Min._____ Diver on $^{o}2$_____ Time_____ Depth_____

WATER DEPTH	TIME REACHED	MIN. AT STOP	TIME LEFT	MIN. ON $^{o}2$	DIVER'S CONDITION	TIME KEEPER

1st Stop_____ft.
2nd Stop_____ft.
3rd Stop_____ft.

Out of Chamber: Time_____ Date_____

SUMMARY INFORMATION

Work
Assigned_____

Work
Completed_____

I hereby certify that the decompression schedule utilized on this dive was known to me prior to decompression and that the decompression schedule was adequate and in conformance with current standards. I further certify that I have no symptoms of dysbarism or bends and that the decompression was successful.

Diver's Signature_____
Time_____ Date_____

Supervisor's Signature_____
Time_____ Date_____

Table 7-3

EQUIPMENT LOG

TYPE OF EQUIPMENT	SERIAL #	COST	WHEN REPLACED	WHEN MAINTAINED	NATURE OF SERVICE	REPAIR PERSON	REMARKS

Table 7-4
DIVISION DIVING PLAN

DATE:_____

1. Area Office/Field Activity:_____

2. Detailed Description of Dive Mission:_____

3. Diving Team: CONTRACT_____ or CORPS PERSONNEL_____
   a. (If Contractor, give name and address)_____

4. Names and Duties of Personnel on Dive Team:
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____

5. Description of Diving Apparatus Used:_____

6. Scheduled Date for Dive and Duration of Dive:
   a. Date:_____
   b. Duration:_____(Hrs: Mins)

7. Maximum Working Depth and Bottom Time:
   a. Depth (Max):_____
   b. Bottom Time (Mininum):_____

8. Diving Craft Used: YES_____ or NO_____. If "Yes", describe:

9. Has Emergency Assistance for divers (emergency telephone numbers, ambulance, doctors, chambers, etc.) been prepared? YES_____ NO_____

10. Brief Description of General Conditions to be Expected at Dive Site_____

The following requirements shall be strictly adhered to:

a. "If, for any reason, this Dive Plan, as approved, is altered in mission, depth, personnel, or equipment, the Diving Officer shall be contacted in order that he may review any revision prior to actual operation." (ER 385-1-93)

b. All diving operations shall be accomplished in accordance with the New England Division Diving Manual.

Submitted by:

DATE:_____

_____
Responsible Dive Master

Table 7-5
THE ACTIVITY JOB HAZARDS ANALYSIS

1. Objective of Dive: _____
2. Exact Location of Work: _____

3. Anticipated Conditions or Hazards:
   a. Weather: _____
      _____ Potential Problem: YES_____ NO_____
   b. Water Conditions: _____
      _____ Potential Problem: YES_____ NO_____
   c. Type of Bottom: _____
      _____ Potential Problem: YES_____ NO_____
   d. Expected Visibility Underwater: _____
      _____ Potential Problem: YES_____ NO_____
   e. Depth: _____ Potential Problem: YES_____ NO_____
   f. Current/Tide/Turbulance/Boils: _____
      _____ Potential Problem: YES_____ NO_____
   g. Temperature (Air): _____ Potential Problem: YES_____ NO_____
   h. Temperature (Water): _____ Potential Problem: YES_____ NO_____
   i. Obstructions and/or Underwater Hazards: _____
      _____ Potential Problem: YES_____ NO_____
4. Review of Dive Plan. Any Modifications or Comments? _____

5. Lock Crew Availability (If Applicable): _____
6. Sequence of Operation: _____

Table 7-6

FORWARD REPORT WITH PATIENT

UNDERWATER
ACCIDENT REPORT

Name of Victim _____
Last First Middle

Address: _____

_____ State _____

Victim's Sex _____ Age _____ Hgt _____ Wgt _____

Marital Status: M ___ S ___ D ___ W ___ UNK _____

Occupation _____

_____

Description of all dives within previous 12 hours including accident dive

Depth	Time Down	Surface Interval
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Night diving _____

At time of accident, activities engaged in: _____

Recreational	_____
Commercial	_____
Under instruction	_____
Instructing	_____
Cave diving	_____
Spear fishing	_____
Photography	

At time of accident, buddy record: _____

Diving alone	_____
Diving with buddy	_____
Buddy distance	_____
Diving with more than one	_____
Distance to next nearest diver	_____

Type of Diving: (Explain if Necessary)

Scuba _____ Skin _____ Other _____ Unknown _____

Others in accident _____ (Yes or No)

Separate report filed _____ (Yes or No)

Vessels involved _____ (Yes or No)

U.S. Coast Guard aid sought _____ (Yes or No)

(Give Details in "Description of Accident," Name, Captain, Address, Phone, etc.)

Next of Kin	Address	Phone	Function/Role
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

WITNESS ON SITE PHYSICAN/PARA-MEDIC:

Name _____

Address _____

City _____ Phone _____

Name _____

Address _____

City _____ Phone _____

Table 7-6 (Continued)

DETAILED DESCRIPTION OF ACCIDENT

Describe in detail how the accident happened, including what the person was doing, any specific marine life or objects and the action or movement which led to the event. Include details of first aid or resuscitation efforts. Describe any "Decompression" and/or "Recompression-Treatment" in description of accident. List previous known medical problems and/or allergies.

APPENDIX

A.1 MEDICALLY CERTIFIED CHAMBERS IN NORTHEASTERN UNITED STATES:

Listed below are the active double-lock hyperbaric chambers in the Northeastern United States. These facilities have trained personnel available on a 24-hour basis for the treatment of diving accidents. Please note that single-lock chambers, such as the small one-man chambers, are inadequate and dangerous for treatment of diving accidents and can only be used in special cases for transportation of a patient to a double-lock chamber. When calling the numbers below, please state that you have an emergency diving accident; otherwise, do not call these numbers.

Portsmouth Naval Shipyard
Code 104, Portsmouth, NH 03801
LTCDR James Fenner (207) 439-1000, ext.2200
CDR Bennett MD (207) 439-1000, ext.1740

Environmental Simulation Facility - NSMRL, Submarine Base New London
Groton, CT 06349
CAPT W.C. Milroy, CO (203) 449-3422
Drs. Knight, Margulies (203) 449-3666 24 hr/hosp, (203) 449-3805

U.S. NAVAL UNDERWATER SYSTEMS CENTER, Building 118 Range Dept.
Newport, RI 02840
LCDR Hatton (401) 841-2691, (401) 841-4594
Chamber phone (401) 841-3776

Norwalk Hospital, Norwalk, CT
24 Stevens St., P.O. Box 5050
Drs. Nair, Staw (203) 852-2000, (203) 852-2479

A.2 LISTING OF SUPPORT FACILITIES

Operational groups which will provide transportation and alert recompression facilities:

U.S. Coast Guard Rescue	(617) 223-6978
by radio :	Channel 16 or 2182
Navy Experimental Diving Unit	(904) 234-4351
National Naval Medical Center	(301) 295-0203
Air Force Hyperbaric Duty Officer	(512) 536-3278

A.3 REFERENCES

American Academy of Orthopedic Surgeon 1919. "Emergency Care and Transportation of the Sick and Injured." George Bata Co. Menussa, Wisconsin; 304pp.

American National Red Cross 1968. "Swimming and Water Safety." Washington D.C.; 141pp.

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Halstead, Bruce W. 1959. "Dangerous Marine Animals." Cornell Maritime Press, Cambridge, Maryland; 146pp.

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U.S. Department of the Navy, 1974. "Handbook, U.S. Navy Diving Operations." Washington, D.C.

A.4 NOTIFICATION LIST

A.4.1 Pre- and Post-Diving Operations

The Diving Officer.

A.4.2 Annually

The Safety Officer is notified of the diving activities of the previous fiscal year.

A.5 AUTHORITIES ON DIVING

Russell Bellmer — Research Diving
Diving Officer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, MA 02254
(617) 647-8142

Jimmy Stewart — Research Diving
Diving Officer
Scripps Institute of Oceanography
La Jolla, CA 92093
(714) 452-4445

Lloyd Austin — Research Diving
Diving Officer
University of California, Berkeley
Berkeley, CA 94501
(415) 642-1298

John Duffy — Research Diving
Diving Safety Board
California Department of Fish and Game
1350 Front Street
San Diego, CA 92101
(714) 237-7311

Jim Joiner — Surface-Supplied Diving
Executive Director
Commercial Diving Center
272 South Fries Avenue
Wilmington, CA 90744
(213) 834-2501

Andrew Pilmanis — Diving Physiology
Associate Director
University of Southern California
Catalina Marine Science Center
P.O. Box 398
Avalon, CA 90704
(213) 743-6793

Edward R. Roaf, M.D.
Medical Director
1560 Beacon Street
Brookline, MA 02146
(617) 566-6011

A.6 REGULATIONS

Department of the Army Corps of Engineers	ER 385-1-86	Safety-Underwater Diving
Department of the Army	AR 385-15	Safety-Underwater Safety
Department of the Army Corps of Engineers	EM 385-1-1	Safety-General Safety Requirements Manual
Department of the Army Corps of Engineers	CPR 532-1 (C5)	Paragraph (e) Divers and Tenders
Department of the Army Costal Engineering Research Center	CERCR 385-4	Safety-Diving Operations
Department of Labor	PL 91-596	Occupational Safety and Health Act of 1970
Department of Labor	Title 29 code of Part 1960	Safety and Health Provisions for Federal Employees
Department of Labor	Title 29 code of Part 1977	Commercial Diving Fed Regulations Operations Occupational Safety and Health Requirements, Provisions for Federal Employees

A.7 DIVING RESUMES OF AUTHORS

Russell J. Bellmer

Position: Marine Biologist (9 years)

Education: Master of Science, Marine Ecology

Diving Training: Basic skin and SCUBA 1969, Advance SCUBA 1970, Instructor skin and SCUBA 1971, Surface-supplied 1980

Experience: Research Diver: 1970 to present (e.g., physiology, marine biology, cave limnology, high altitude); salvage diver 1970-1972; photographer 1976 to present; instructor 1971 to present; Director Diving

Program YMCA 1973-1975; Director Diving Program LATTC 1976 to present; Los Angeles District Diving Officer 1977-present

Related Experience: Lifeguard 1967-1975; swimming instructor 1968 to present (e.g., beginning, advanced, handicapped, lifesaving); first aid instructor 1972 to present (e.g., basic, advanced, CPR); emergency medical technician 1974 to present; chamber operator 1980 to present

Diving: Over 90 percent of diving in California from Mexican border to Fort Bragg coastal, inland Lake Beoryessa, Clear Lake, Lake Tahoe, Yosemite; Seattle area; Belize; working depths from 10 feet to 210 feet; high altitude; decompression; repetitive; night diving; zero visibility; over 1,000 hours of bottom time.

Noel Davis

Position: Marine Biologist (4 years)

Education: Doctor of Philosophy, Biological Oceanography

Diving Training: Basic 1968, advanced 1970, instructor 1972 (outstanding Candidate)

Experience: Research Diver: 1970-present (Marine Biology); Scripps diving control board 1972-1978; research diver at Scripps 1971-1978; research diver at UCLA 1970-1971

Related Experience: Lifeguard and swimming instructor; first aid and CPR trained

Diving: Extensive diving in Southern California including all the Channel Islands, Central California, Puget Sound, Mexico (Acapulco, Gulf of California and Pacific Coast), Hawaii, British Honduras, Panama (both Caribbean and Pacific sides); over 1,800 dives.

A.8 RECIPROCAL AGENCIES AND INSTITUTIONS FOR DIVING

Federal

Department of the Interior

Department of Defense

Department of Commerce

Department of Transportation

States

Departments of Fish and Game

Institutions

University of Massachusetts

University of New Hampshire

University of Connecticut

University of Rhode Island

University of Maine

All dives with a single Division dive team member diving with other agencies require prior approval by Diving Officer. Dives may be made with other entities which demonstrate to Diving Officer programs in compliance with Division Diving requirements.

A.9 DECOMRESSION TABLES

This appendix contains the decompression tables, a repetitive dive worksheet, and a chart to be filled out if any decompression dives are made.

REPETITIVE DIVE WORKSHEET

I. PREVIOUS DIVE:

_____minutes Standard Air Table

_____feet No-Decompression Table

_____repetitive group designation

II. SURFACE INTERVAL:

_____hours_____minutes on surface.

Repetitive group from I_____

New repetitive group from surface

Residual Nitrogen Timetable_____

III. RESIDUAL NITROGEN TIME:

_____feet (depth of repetitive dive)

New repetitive group from II._____
Residual nitrogen time from
Residual Nitrogen Timetable _____

IV. EQUIVALENT SINGLE DIVE TIME:

_____minutes, residual nitrogen time from III.

+_____minutes, actual bottom time of repetitive dive.

=_____minutes, equivalent single dive time.

V. DECOMPRESSION FOR REPETITIVE DIVE:

_____minutes, equivalent single dive time from IV.

_____feet, depth of repetitive dive

Decompression from (check one):

- °Standard Air Table °No-Decompression Table

°Surface Table Using Oxygen °Surface Table Using Air

°No decompression required

Decompression Stops: _____feet_____minutes

_____feet_____minutes
_____feet_____minutes
_____feet_____minutes
_____feet_____minutes

Schedule used
Repetitive group

US NAVY DIVING MANUAL

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
	360	0:30					23	23:40	**
	480	0:30					41	41:40	**
	720	0:30					69	69:40	**
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
	240	0:40				2	79	82:00	**
	360	0:40				20	119	140:00	**
	480	0:40				44	148	193:00	**
	720	0:40				78	187	266:00	**
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

*** See No Decompression Table for repetitive groups**
****Repetitive dives may not follow exceptional exposure dives**

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	Totai ascent (min:sec)	Repeti-tive group
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	48	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
	180	1:00				35	85	121:20	**
	240	0:50			6	52	120	179:20	**
	360	0:50			29	90	160	280:20	**
	480	0:50			59	107	187	354:20	**
	720	0:40		17	108	142	187	455:20	**
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
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
	180	1:00		1	29	53	118	202:40	**
	240	1:00		14	42	84	142	283:40	**
	360	0:50	2	42	73	111	187	416:40	**
	480	0:50	21	81	91	142	187	503:40	**
	720	0:50	55	106	122	142	187	613:40	**
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	28	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	84	107:50	Z
	100	1:20			15	37	72	125:50	Z

* See No Decompression Table for repetitive groups
**Repetitive dives may not follow exceptional exposure dives

U. S. NAVY STANDARD AIR DECOMPRESSION TABLE

Depth (feet)	Bottom time (min)	Time to first stop (min:sec)	Decompression stops (feet) 70	60	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
	120	1:20				10	19	47	98	176:00	**
	180	1:10			5	27	37	76	137	284:00	**
	240	1:10			23	35	60	97	179	396:00	**
	360	1:00		18	45	84	93	142	187	571:00	**
	480	0:50	3	41	64	93	122	142	187	654:00	**
	720	0:50	32	74	100	114	122	142	187	773:00	**
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					18	24	61	105:10	Z
	80	1:30				3	19	35	72	131:10	Z
	90	1:30				8	19	45	80	154:10	Z

Depth (feet)	Bottom time (min)	Time to first stop (min:sec)	Decompression stops (feet) 90	80	70	60	50	40	30	20	10	Total ascent (min:sec)	Repetitive group
140	10										[illegible]	[illegible]	[illegible]
	15	2:10									2	4:20	G
	20	2:10									[illegible]	[illegible]	[illegible]
	25	2:00								2	14	18:20	J
	30	2:00								[illegible]	[illegible]	[illegible]	[illegible]
	40	1:50							2	16	26	46:20	N
	50	1:50							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	60	1:50							16	23	56	97:20	Z
	70	1:40						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	80	1:40						10	23	41	79	155:20	Z
	90	1:30					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	120	1:30					12	14	36	56	120	240:20	**
	180	1:20				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	240	1:10			8	28	34	50	78	124	187	511:20	**
	360	1:00		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	480	1:00		31	44	59	100	114	122	142	187	801:20	**
	720	0:50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* See No Decompression Table for repetitive groups
**Repetitive dives may not follow exceptional exposure dives

U. S. NAVY STANDARD AIR DECOMPRESSION TABLE

Depth (feet)	Bottom time (min)	Time to first stop (min:sec)	Decompression stops (feet) 90	80	70	60	50	40	30	20	10	Total ascent (min:sec)	Repetitive group
150	5										0	2:30	C
	10	2:20									1	3:30	E
	15	2:20									3	5:30	G
	20	2:10								2	7	11:30	H
	25	2:10								4	17	23:30	K
	30	2:10								8	24	34:30	L
	40	2:00							5	19	33	59:30	N
	50	2:00							12	23	51	88:30	O
	60	1:50						3	19	26	62	112:30	Z
	70	1:50						11	19	39	75	146:30	Z
	80	1:40					1	17	19	50	84	173:30	Z
160	5										0	2:40	D
	10	2:30									1	3:40	F
	15	2:20								1	4	7:40	H
	20	2:20								3	11	16:40	J
	25	2:20								7	20	29:40	K
	30	2:10							2	11	25	40:40	M
	40	2:10							7	23	39	71:40	N
	50	2:00						2	16	23	55	98:40	Z
	60	2:00						9	19	33	69	132:40	Z
	70	1:50					1	17	22	44	80	166:40	Z

Depth (feet)	Bottom time (min)	Time to first stop (min: sec)	Decompression stops (feet) 110	100	90	80	70	60	50	40	30	20	10	Total ascent (min: sec)	Repetitive group
170	5												0	2:50	D
	10	2:40											2	4:50	F
	15	2:30										2	5	9:50	H
	20	2:30										4	15	21:50	J
	25	2:20									2	7	23	34:50	L
	30	2:20									4	13	26	45:50	M
	40	2:10								1	10	23	45	81:50	O
	50	2:10								5	18	23	61	109:50	Z
	60	2:00							2	15	22	37	74	152:50	Z
	70	2:00							8	17	19	51	86	183:50	Z
	80	1:50						12	12	14	34	52	120	246:50	**
	120	1:30				2	10	12	18	32	42	82	156	356:50	**
	100	1:40			4	10	22	28	34	50	78	120	187	535:50	**
	240	1:20			18	24	30	42	50	70	116	142	187	681:50	**
	300	1:10		22	34	40	52	60	98	114	122	142	187	873:50	**
	480	1:00	14	40	42	56	91	97	100	114	122	142	187	1007:50	**
180	5												0	3:00	D
	10	2:50											3	6:00	F
	15	2:40										3	6	12:00	I
	20	2:30									1	5	17	26:00	K
	25	2:30									3	10	24	40:00	L
	30	2:30									6	17	27	53:00	N
	40	2:20								3	14	23	50	93:00	O
	50	2:10							2	9	19	30	65	128:00	Z
	60	2:10							5	16	19	44	81	168:00	Z

* See No Decompression Table for repetitive groups

**Repetitive dives may not follow exceptional exposure dives

U. S. NAVY STANDARD AIR DECOMPRESSION TABLE

190

Bottom time (min)	Time to first stop (min: sec)	Decompression stops (feet) 110	100	90	80	70	60	50	40	30	20	10	Total ascent (min: sec)	Repetitive group
5												0	3:10	D
10	2:50										1	3	7:10	G
15	**2:50**										**4**	**7**	**14:10**	I
20	2:40									2	6	20	31:10	K
25	**2:40**									**5**	**11**	**25**	**44:10**	M
30	2:30								1	8	19	32	63:10	N
40	**2:30**								**8**	**14**	**23**	**55**	103:10	O
50	2:20							4	13	22	33	72	147:10	Z
60	**2:20**							10	17	19	50	84	183:10	Z

200

Bottom time (min)	Time to first stop (min:sec)	Decompression stops (feet) 130	120	110	100	90	80	70	60	50	40	30	20	10	Total ascent (min:sec)
5	**3:10**													1	4:20
10	3:00												1	4	8:20
15	**2:50**											1	**4**	**10**	**18:20**
20	2:50											3	7	27	40:20
25	**2:50**											**7**	**14**	**25**	**49:20**
30	2:40										2	9	22	37	73:20
40	**2:30**									**2**	**8**	**17**	**23**	**59**	**112:20**
50	2:30									6	16	22	39	75	161:20
60	**2:20**								**2**	**13**	**17**	**24**	**51**	**89**	**199:20**
90	1:50					1	10	10	12	12	30	38	74	134	324:20
120	**1:40**				**6**	**10**	**10**	**10**	**24**	**28**	**40**	**64**	**98**	**180**	**473:20**
180	1:20		1	10	10	18	24	24	42	48	70	106	142	187	685:20
240	**1:20**		**6**	**20**	**24**	**24**	**36**	**42**	**54**	**68**	**114**	**122**	**142**	**187**	**842:20**
360	1:10	12	22	36	40	44	56	82	98	100	114	122	142	187	1058:20

210

Bottom time (min)	Time to first stop (min:sec)	Decompression stops (feet)	Total ascent (min:sec)
5	**3:20**	1	4:30
10	3:10	2	9:30
15	**3:00**	1 **5**	**13**	**22:30**
20	3:00	4 10	23	40:30
25	**2:50**	**2** 7	**17**	**27**	**56:30**
30	2:50	4 9	24	41	81:30
40	**2:40**	**4** **9**	**19**	**28**	**83**	**124:30**
50	2:30	1 9	17	19	45	80	174:30

220

Bottom time (min)	Time to first stop (min:sec)	Decompression stops (feet)	Total ascent (min:sec)
5	**3:30**	**2**	**5:40**
10	3:20	2 5	10:40
15	**3:10**	**2** **5**	**18**	**28:40**
20	3:00	1 3	11	24	42:40
25	**3:00**	**3** **8**	**19**	**33**	**66:40**
30	2:50	1 7	10	23	47	91:40
40	**2:50**	**6** **12**	**22**	**29**	**68**	**140:40**
50	2:40	3 12	17	18	51	86	190:40

U. S· NAVY STANDARD AIR DECOMPRESSION TABLE

Depth (feet)	Bottom time (min)	Time to first stop (min:sec)	Decompression stops (feet)													Total ascent time (min:sec)
			130	120	110	100	90	80	70	60	50	40	30	20	10	
230	5	3:40													2	5:50
	10	3:20											1	2	6	12:50
	15	3:20											3	6	18	30:50
	20	3:10										2	5	12	26	48:50
	25	3:10										4	8	22	37	74:50
	30	3:00									2	8	12	23	51	99:50
	40	2:50								1	7	15	22	34	74	156:50
	50	2:50								5	14	16	24	51	89	202:50
240	5	3:50													2	6:00
	10	3:30											1	3	6	14:00
	15	3:30											4	6	21	35:00
	20	3:20										3	6	15	25	53:00
	25	3:10									1	4	9	24	40	82:00
	30	3:10									4	8	15	22	56	109:00
	40	3:00								3	7	17	22	39	75	167:00
	50	2:50							1	8	15	16	29	51	94	218:00
250	5	3:50												1	2	7:10
	10	3:40											1	4	7	16:10
	15	3:30										1	4	7	22	38:10
	20	3:30										4	7	17	27	59:10
	25	3:20									2	7	10	24	45	92:10
	30	3:20									6	7	17	23	59	116:10
	40	3:10								5	9	17	19	45	79	178:10
	60	2:40					4	10	10	10	12	22	36	64	126	298:10
	90	2:10		8	10	10	10	10	10	28	28	44	68	98	186	514:10
260	5	4:00												1	2	7:20
	10	3:50											2	4	9	19:20
	15	3:40										2	4	10	22	42:20
	20	3:30									1	4	7	20	31	67:20
	25	3:30									3	8	11	23	50	99:20
	30	3:20								2	6	8	19	26	61	126:20
	40	3:10							1	6	11	16	19	49	84	190:20
270	5	4:10												1	3	8:30
	10	4:00											2	5	11	22:30
	15	3:50										3	4	11	24	46:30
	20	3:40									2	3	9	21	35	74:30
	25	3:30								2	3	8	13	23	53	106:30
	30	3:30								3	6	12	22	27	64	138:30
	40	3:20							5	6	11	17	22	51	88	204:30

U. S· NAVY STANDARD AIR DECOMPRESSION TABLE

Depth (feet)	Bottom time (min)	Time to first stop (min:sec)	Decompression stops (feet) 130	120	110	100	90	80	70	60	50	40	30	20	10	Total ascent time (min:sec)
280	5	4:20														
	10	4:00										1	2	5	13	25:40
	15	3:50														
	20	3:50									3	4	8	23	39	81:40
	25	3:40														
	30	3:30							1	3	7	13	22	30	70	150:40
	40	3:20						1								
290	5	4:30														
	10	4:10										1	3	5	16	29:50
	15	4:00														
	20	4:00									3	7	9	23	43	89:50
	25	3:50														
	30	3:40							1	5	6	16	22	36	72	162:50
	40	3:30														
300	5	4:40														
	10	4:20										1	3	6	17	32:00
	15	4:10														
	20	4:00								2	3	7	10	23	47	97:00
	25	3:50							1							
	30	3:50							2	5	7	17	22	39	75	172:00
	40	3:40														
	60	3:00		4	10	10	10	10	10	14	28	32	50	90	187	460:00

Extreme exposures—250 and 300 ft

Depth (ft)	Bottom time (min)	Time to first stop (min:sec)	Decompression stops (feet) 200	190	180	170	160	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	Total ascent time (min:sec)
250	120	1:50							5	10	10	10											
	180	1:30					4	8	8	10	22	24	24	32	42	44	60	84	114	122	142	187	931:10
	240	1:30																					
300	90	2:20																					
	120	2:00				4	8	8	8	10	14	24	24	24	34	42	58	66	102	122	142	187	890:00
	180	1:40	6	6	6	8	14	20	21														

No-Decompression Limits and Repetitive Group Designation Table for No-Decompression Air Dives 7.5.2 The No-Decompression Table serves two purposes. First it summarizes all the depth and bottom time combinations for which no decompression is required. Secondly, it provides the repetitive group designation for each no-decompression dive. Even though decompression is not required, an amount of nitrogen remains in the diver's tissues after every dive. If he dives again within a 12 hour period, the diver must consider this residual nitrogen when calculating his decompression.

Each depth listed in the No-Decompression Table has a corresponding **no-decompression limit** given in minutes. This limit is the maximum bottom time that a diver may spend at that depth without requiring decompression. The columns to the right of the no-decompression limits column are used to determine the repetitive group designation which must be assigned to a diver subsequent to every dive. To find the repetitive group designation enter the table at the depth equal to or next greater than the actual depth of the dive. Follow that row to the right to the bottom time equal to or next greater than the actual bottom time of the dive. Follow that column upward to the repetitive group designation.

Depths above 35 feet do not have a specific no-decompression limit. They are, however, restricted in that they only provide repetitive group designations for bottom times up to between 5 and 6 hours. These bottom times are considered the limitations of the No-Decompression Table and no field requirement for diving should extend beyond them.

Any dive below 35 feet which has a bottom time greater than the no-decompression limit given in this table is a decompression dive and should be conducted in accordance with the Standard Air Table.

Example—

Problem—In planning a dive, the Master Diver wants to conduct a brief inspection of the work site, located 160 feet below the surface. What is the maximum bottom time which he may use without requiring decompression? What is his repetitive group designation after the dive?

Solution—The no-decompression limit corresponding to the 160 foot depth in the No-Decompression Table is 5 minutes. Therefore, the Master Diver must descend to 160 feet, make his inspection and begin his ascent within 5 minutes without having to undergo decompression.

Following the 160 foot depth row to the 5 minute column, the repetitive group designation at the top of this column is D.

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
15		35	70	110	160	225	350									
25		20	35	55	75	100	125	160	195	245	315					
40	200	5	15	25	30	40	50	70	80	100	110	130	150	170	200	
60	60		10	15	20	25	30	40	50	55	60					
90	30		5	10	12	15	20	25	30							
110	20			5	10	13	15	20								
140	10			5	7	10										
160	5				5											
180	5				5											

Residual Nitrogen Timetable for Repetitive Air Dives 7.5.3 The quantity of residual nitrogen in a diver's body immediately after a dive is expressed by the repetitive group designation assigned to him by either the Standard Air Table or the No-Decompression Table. The upper portion of the Residual Nitrogen Table is composed of various intervals between 10 minutes and 12 hours, expressed in hours: minutes (2:21 = 2 hours 21 minutes). Each interval has two limits; a minimum time (top limit) and a maximum time (bottom limit).

Residual nitrogen times, corresponding to the depth of the repetitive dive, are given in the body of the lower portion of the table. To determine the residual nitrogen time for a repetitive dive, locate the diver's repetitive group designation from his previous dive along the diagonal line above the table. Read horizontally to the interval in which the diver's surface interval lies. The time spent on the surface must be between or equal to the limits of the selected interval.

Next, read vertically downwards to the new repetitive group designation. This designation corresponds to the present quantity of residual nitrogen in the diver's body. Continue downward in this same column to the row which represents the depth of the repetitive dive. The time given at the intersection is the residual nitrogen time, in minutes, to be applied to the repetitive dive.

If the surface interval is less than 10 minutes, the residual nitrogen time is the bottom time of the previous dive. All of the residual nitrogen will be passed out of the diver's body after 12 hours, so a dive conducted after a 12 hour surface interval is not a repetitive dive.

There is one exception to this table. In some instances, when the repetitive dive is to the same or greater depth than the previous dive, the residual nitrogen time may be longer than the actual bottom time of the previous dive. In this event, add the actual bottom time of the previous dive to the actual bottom time of the repetitive dive to obtain the equivalent single dive time.

Example–

Problem–A repetitive dive is to be made to 98 fsw for an estimated bottom time of 15 minutes. The previous dive was to a depth of 102 fsw and had a 48 minute bottom time. The diver's surface interval is 6 hours 28 minutes (6:28). What decompression schedule should be used for the repetitive dive?

Solution–Using the repetitive dive worksheet–

REPETITIVE DIVE WORKSHEET

I. PREVIOUS DIVE:

48 minutes ☑ Standard Air Table

102 feet ☐ No-Decompression Table

M repetitive group designation

II. SURFACE INTERVAL:

6 hours 28 minutes on surface.

Repetitive group from I M

New repetitive group from surface

Residual Nitrogen Timetable B

III. RESIDUAL NITROGEN TIME:

98 feet (depth of repetitive dive)

New repetitive group from II. B

Residual nitrogen time from

Residual Nitrogen Timetable 7

IV. EQUIVALENT SINGLE DIVE TIME:

7 minutes, residual nitrogen time from III.

15 minutes, actual bottom time of repetitive dive.

22 minutes, equivalent single dive time

V. DECOMPRESSION FOR REPETITIVE DIVE:

22 minutes, equivalent single dive time from IV

98 feet, depth of repetitive dive

Decompression from (check one):

☐ Standard Air Table ☐ No-Decompression Table

☐ Surface Table Using Oxygen ☐ Surface Table Using Air

☑ No decompression required

Decompression Stops: ____ feet ____ minutes

____ feet ____ minutes

____ feet ____ minutes

____ feet ____ minutes

Schedule used ____ ____ feet ____ minutes

Repetitive group ____

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

NEW → GROUP DESIGNATION	Z	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A
															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*
	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*
REPETITIVE DIVE DEPTH																
40	257	241	213	187	161	138	118	101	87	73	61	49	37	27	17	9
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	33	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	6	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	5	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	8	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)

TABLE 1A—RECOMPRESSION TREATMENT OF DECOMPRESSION SICKNESS AND GAS EMBOLISM USING AIR

TABLE 1A NOTES—

1. Use—treatment of pain-only decompression sickness when oxygen cannot be used and pain is relieved at a depth less than 66 feet.
2. Descent rate—25 ft/min.
3. Ascent rate—1 minute between stops.
4. Time at 100 feet—includes time from the surface.
5. If the piping configuration of the chamber does not allow it to return to atmospheric pressure from the 10 foot stop in the one minute specified, disregard the additional time required.

TABLE 1A

Depth (feet)	Time (minutes)	Breathing Media	Total Elapsed Time (minutes)
100	30	Air	30
80	12	Air	43
60	30	Air	74
50	30	Air	105
40	30	Air	136
30	60	Air	197
20	60	Air	258
10	120	Air	379
0	1	Air	380

TABLE 1A DEPTH/TIME PROFILE

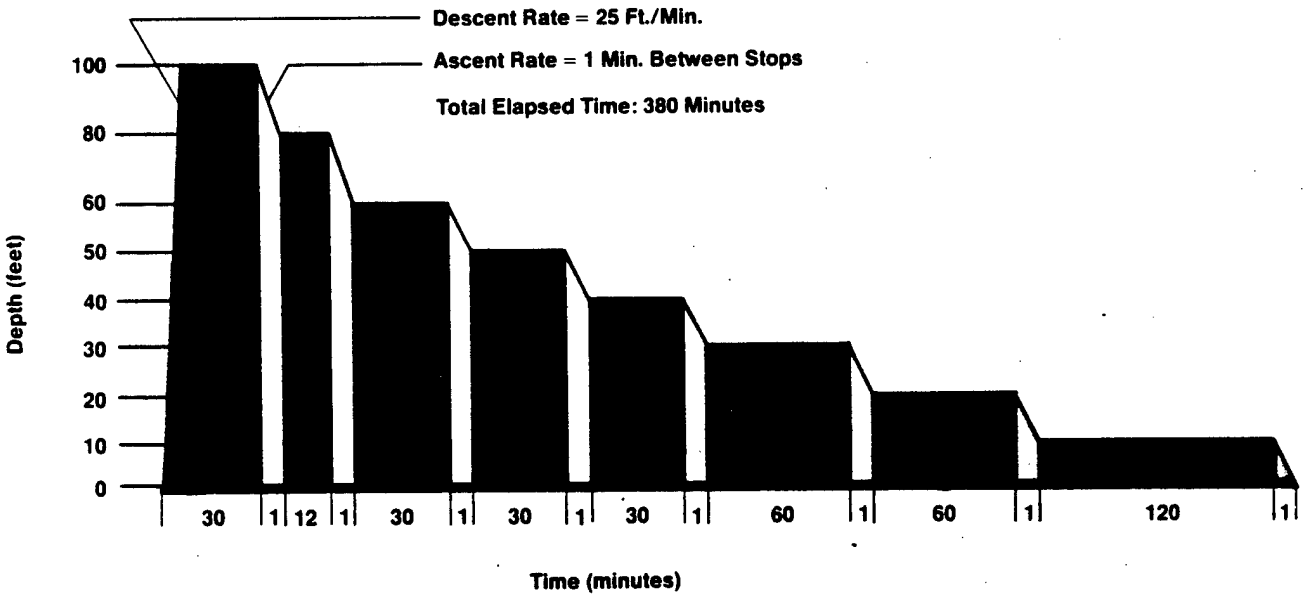

TABLE 2A–RECOMPRESSION TREATMENT OF DECOMPRESSION SICKNESS AND GAS EMBOLISM USING AIR

1. Use–treatment of pain-only decompression sickness when oxygen cannot be used and pain is relieved at a depth greater than 66 feet.
2. Descent rate–25 ft/min.
3. Ascent rate–1 minute between stops.
4. Time at 165 feet–includes time from the surface.
5. If the piping configuration of the chamber does not allow it to return to atmospheric pressure from the 10 foot stop in the one minute specified, disregard the additional time required.

Depth (feet)	Time (minutes)	Breathing Media	Total Elapsed Time (minutes)
165	30	Air	30
140	12	Air	43
120	12	Air	56
100	12	Air	69
80	12	Air	82
60	30	Air	113
50	30	Air	144
40	30	Air	175
30	120	Air	296
20	120	Air	417
10	240	Air	658
0	1	Air	659

TABLE 2A DEPTH/TIME PROFILE

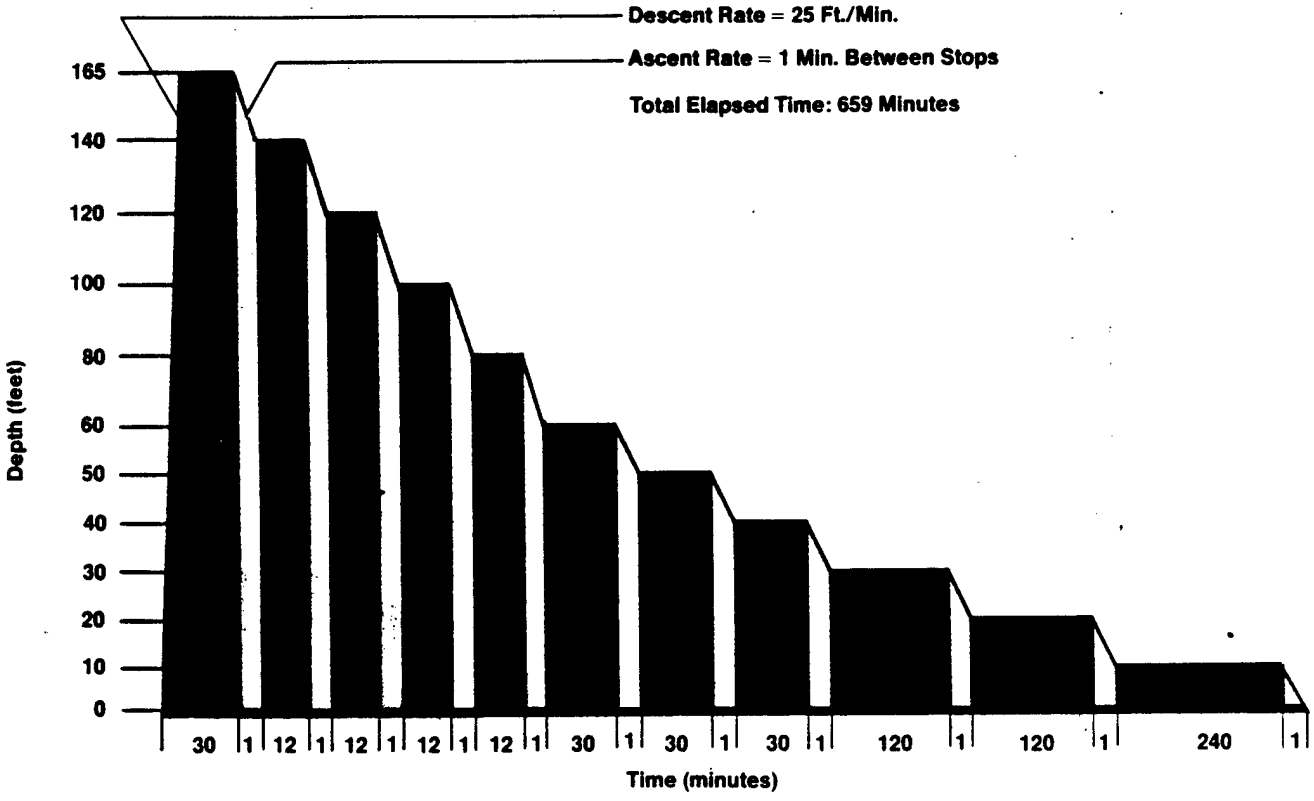

TABLE 3—RECOMPRESSION TREATMENT OF DECOMPRESSION SICKNESS AND GAS EMBOLISM USING AIR

1. Use—treatment of serious symptoms when oxygen cannot be used and symptoms are relieved within 30 minutes at 165 feet.
2. Descent rate—as fast as possible.
3. Ascent rate—1 minute between stops.
4. Time at 165 feet—includes time from the surface.
5. If the piping configuration of the chamber does not allow it to return to atmospheric pressure from the 10 foot stop in the one minute specified, disregard the additional time required.

Depth (feet)	Time	Breathing Media	Total Elapsed Time (hrs:min)
165	30 min.	Air	0:30
140	12 min.	Air	0:43
120	12 min.	Air	0:56
100	12 min.	Air	1:09
80	12 min.	Air	1:22
60	30 min.	Oxygen (or air)	1:53
50	30 min.	Oxygen (or air)	2:24
40	30 min.	Oxygen (or air)	2:55
30	12 hr.	Air	14:56
20	2 hr.	Air	16:57
10	2 hr.	Air	18:58
0	1 min.	Air	18:59

TABLE 3 DEPTH/TIME PROFILE

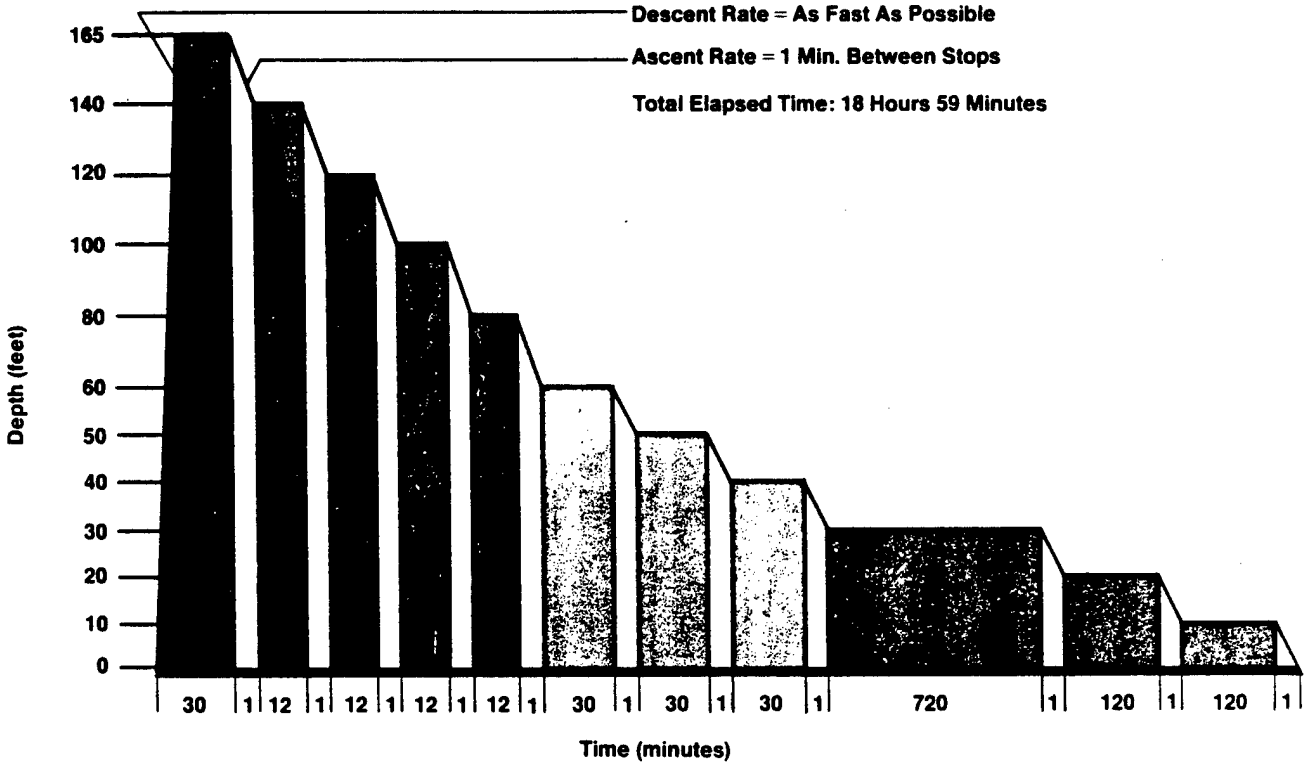

TABLE 4—RECOMPRESSION TREATMENT OF DECOMPRESSION SICKNESS AND GAS EMBOLISM USING AIR

1. Use—treatment of serious symptoms or gas embolism when oxygen cannot be used or when symptoms are not relieved within 30 minutes at 165 feet.
2. Descent rate—as fast as possible.
3. Ascent rate—1 minute between stops.
4. Time at 165 feet—includes time from the surface.
5. No modification or extension of this table is permitted except by a Diving Medical Officer.
6. If the piping configuration of the chamber does not allow it to return to atmospheric pressure from the 10 foot stop in the one minute specified, disregard the additional time required.

Depth (feet)	Time	Breathing Media	Total Elapsed Time (hrs:min)
165	½ to 2 hr.	Air	2:00
140	½ hr.	Air	2:31
120	½ hr.	Air	3:02
100	½ hr.	Air	3:33
80	½ hr.	Air	4:04
60	6 hr.	Air	10:05
50	6 hr.	Air	16:06
40	6 hr.	Air	22:07
30	11 hr.	Air	33:08
30	1 hr.	Oxygen (or air)	34:08
20	1 hr.	Air	35:09
20	1 hr.	Oxygen (or air)	36:09
10	1 hr.	Air	37:10
10	1 hr.	Oxygen (or air)	38:10
0	1 min.	Oxygen	38:11

TABLE 4 DEPTH/TIME PROFILE

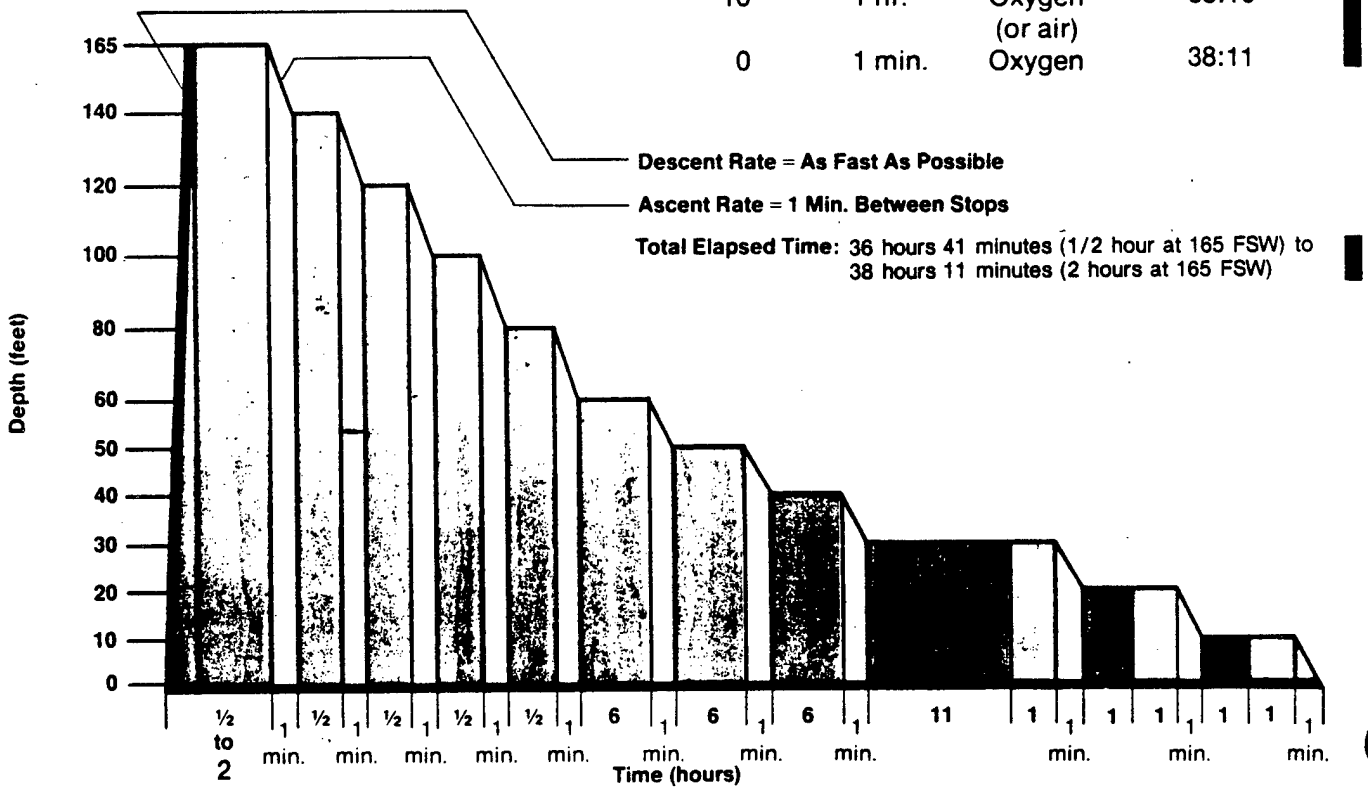

TABLE 5—MINIMAL RECOMPRESSION, OXYGEN BREATHING METHOD FOR TREATMENT OF DECOMPRESSION SICKNESS AND GAS EMBOLISM

1. Use—treatment of pain-only decompression sickness when oxygen can be used and symptoms are relieved within 10 minutes at 60 feet. Patient breathes oxygen from the surface.
2. Descent rate—25 ft/min.
3. Ascent rate—1 ft/min. Do not compensate for slower ascent rates. Compensate for faster rates by halting the ascent.
4. Time at 60 feet begins on arrival at 60 feet.
5. If oxygen breathing must be interrupted, allow 15 minutes after the reaction has entirely subsided and resume schedule at point of interruption.
6. If oxygen breathing must be interrupted at 60 feet, switch to TABLE 6 upon arrival at the 30 foot stop.
7. Tender breathes air throughout. If treatment is a repetitive dive for the tender or tables are lengthened, tender should breathe oxygen during the last 30 minutes of ascent to the surface.

Depth (feet)	Time (minutes)	Breathing Media	Total Elapsed Time (minutes)
60	20	Oxygen	20
60	5	Air	25
60	20	Oxygen	45
60 to 30	30	Oxygen	75
30	5	Air	80
30	20	Oxygen	100
30	5	Air	105
30 to 0	30	Oxygen	135

TABLE 5 DEPTH/TIME PROFILE

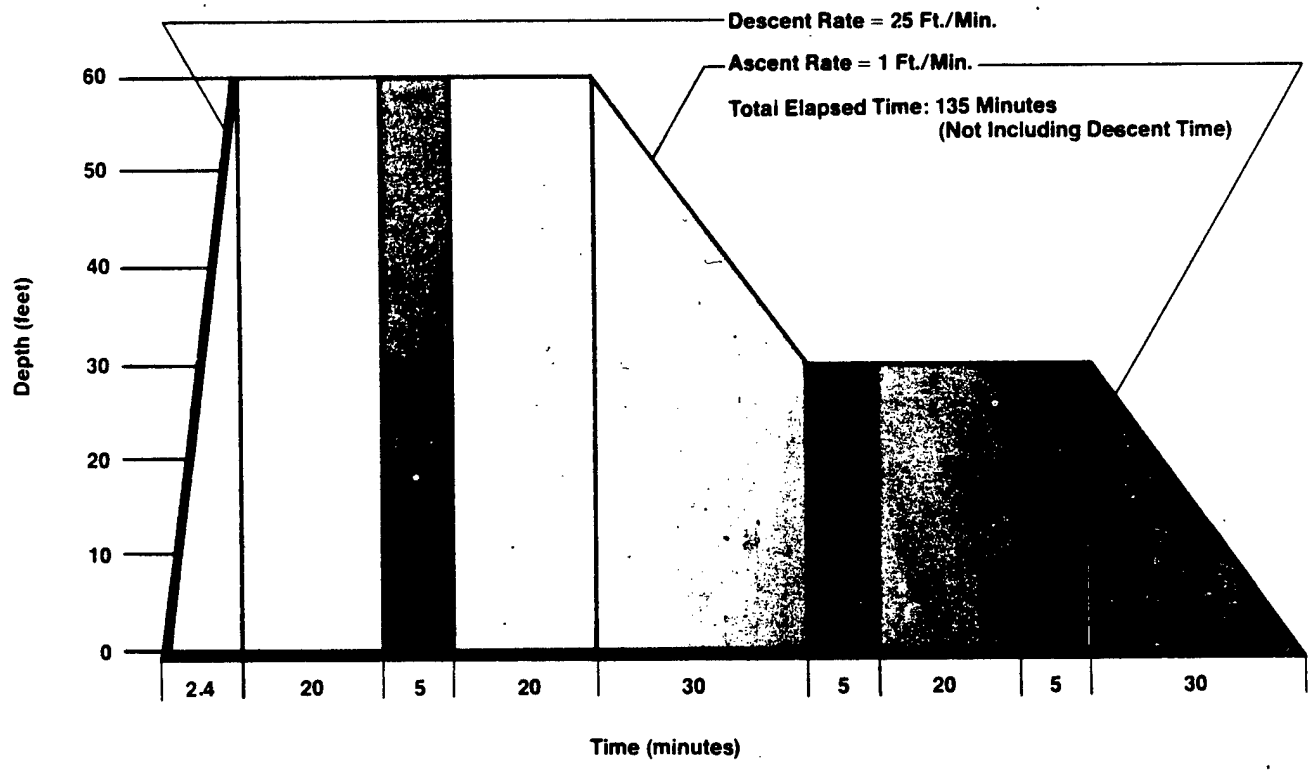

TABLE 5A—MINIMAL RECOMPRESSION, OXYGEN BREATHING METHOD FOR TREATMENT OF DECOMPRESSION SICKNESS AND GAS EMBOLISM

1. Use—treatment of gas embolism when oxygen can be used and symptoms are relieved within 15 minutes at 165 feet.
2. Descent rate—as fast as possible.
3. Ascent rate—1 ft/min. Do not compensate for slower ascent rates. Compensate for faster ascent rates by halting the ascent.
4. Time at 165 feet—includes time from the surface.
5. If oxygen breathing must be interrupted, allow 15 minutes after the reaction has entirely subsided and resume schedule at point of interruption.
6. Tender breathes air throughout. If treatment is a repetitive dive for the tender or tables are lengthened, tender should breathe oxygen during the last 30 minutes of ascent to the surface.

Depth (feet)	Time (minutes)	Breathing Media	Total Elapsed Time (minutes)
165	15	Air	15
165 to 60	4	Air	19
60	20	Oxygen	39
60	5	Air	44
60	20	Oxygen	64
60 to 30	30	Oxygen	94
30	5	Air	99
30	20	Oxygen	119
30	5	Air	124
30 to 0	30	Oxygen	154

TABLE 5A DEPTH/TIME PROFILE

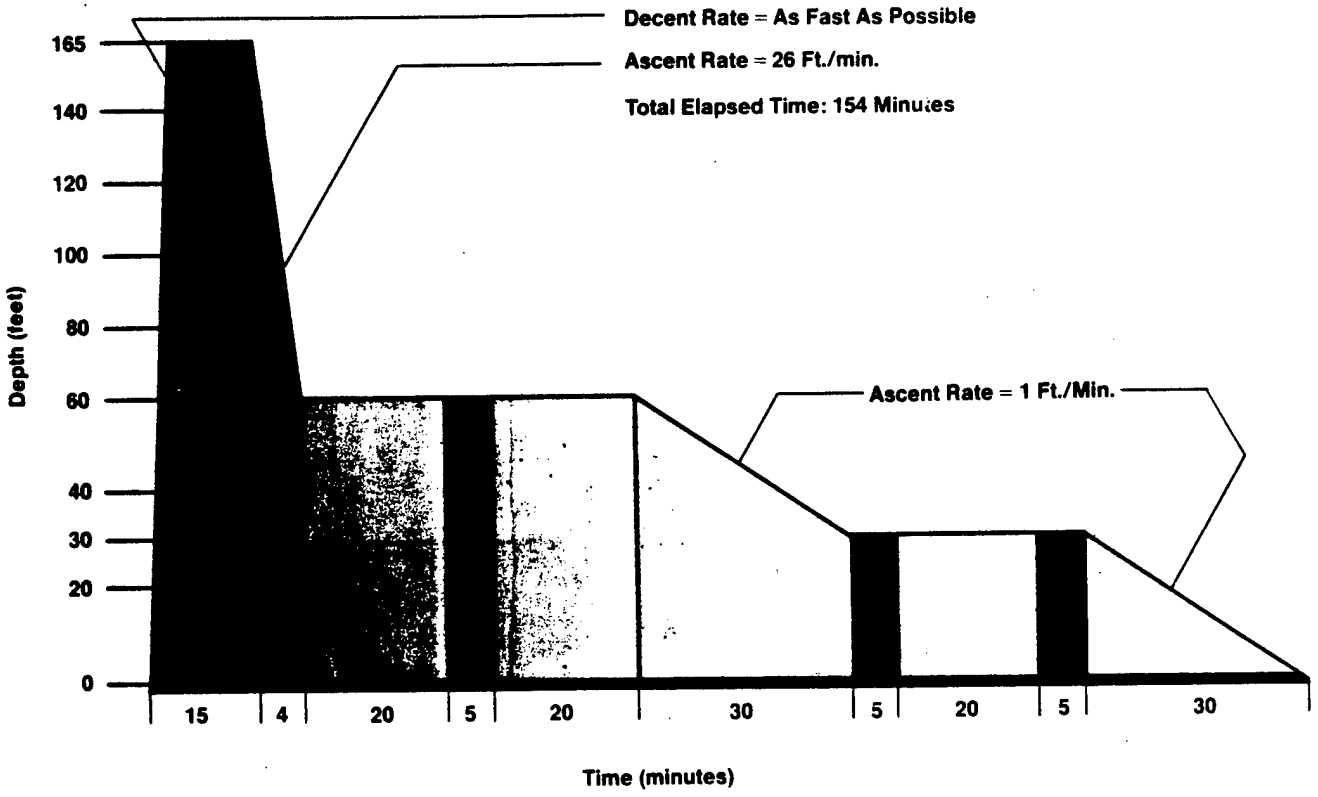

TABLE 6—MINIMAL RECOMPRESSION, OXYGEN BREATHING METHOD FOR TREATMENT OF DECOMPRESSION SICKNESS AND GAS EMBOLISM

1. Use—treatment of decompression sickness when oxygen can be used and symptoms are not relieved within 10 minutes at 60 feet. Patient breathes oxygen from the surface.
2. Descent rate—25 ft/min.
3. Ascent rate—1 ft/min. Do not compensate for slower ascent rates. Compensate for faster rates by halting the ascent.
4. Time at 60 feet—begins on arrival at 60 feet.
5. If oxygen breathing must be interrupted, allow 15 minutes after the reaction has entirely subsided and resume schedule at point of interruption.
6. Tender breathes air throughout. If treatment is a repetitive dive for the tender or tables are lengthened, tender should breathe oxygen during the last 30 minutes of ascent to the surface.
7. Table 6 can be lengthened by an additional 25 minutes at 60 feet (20 minutes on oxygen and 5 minutes on air) or an additional 75 minutes at 30 feet (15 minutes on air and 60 minutes on oxygen), or both.

Depth (feet)	Time (minutes)	Breathing Media	Total Elapsed Time (minutes)
60	20	Oxygen	20
60	5	Air	25
60	20	Oxygen	45
60	5	Air	50
60	20	Oxygen	70
60	5	Air	75
60 to 30	30	Oxygen	105
30	15	Air	120
30	60	Oxygen	180
30	15	Air	195
30	60	Oxygen	255
30 to 0	30	Oxygen	285

TABLE 6 DEPTH/TIME PROFILE

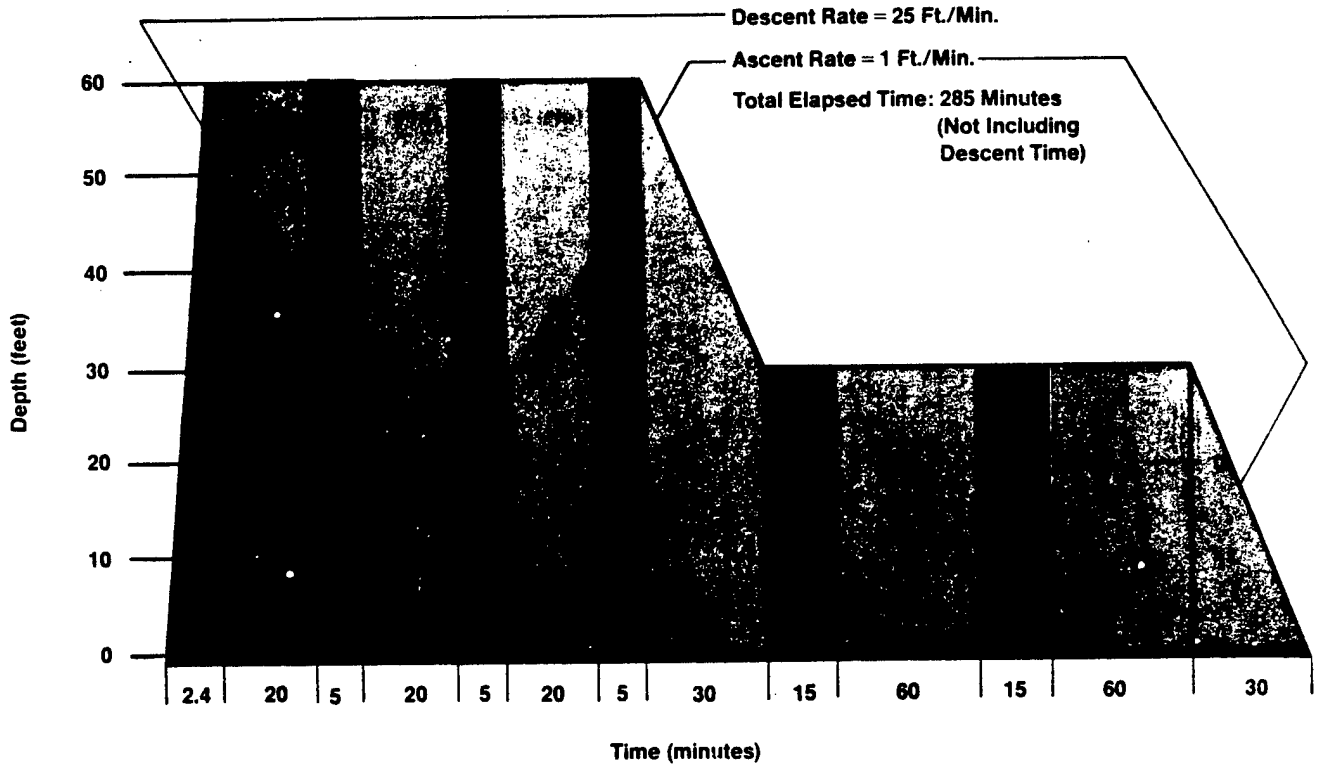

TABLE 6A – MINIMAL RECOMPRESSION, OXYGEN BREATHING METHOD FOR TREATMENT OF DECOMPRESSION SICKNESS AND GAS EMBOLISM

1. Use – treatment of gas embolism when oxygen can be used and symptoms moderate to a major extent within 30 minutes at 165 feet.
2. Descent rate – as fast as possible.
3. Ascent rate – 1 ft/min. Do not compensate for slower ascent rates. Compensate for faster ascent rates by halting the ascent.
4. Time at 165 feet – includes time from the surface.
5. If oxygen breathing must be interrupted, allow 15 minutes after the reaction has entirely subsided and resume schedule at point of interruption.
6. Tender breathes air throughout. If treatment is a repetitive dive for the tender or tables are lengthened, tender should breathe oxygen during the last 30 minutes of ascent to the surface.
7. Table 6A can be lengthened by an additional 25 minutes at 60 feet (20 minutes on oxygen and 5 minutes on air) or an additional 75 minutes at 30 feet (15 minutes on air and 60 minutes on oxygen), or both.

Depth (feet)	Time (minutes)	Breathing Media	Total Elapsed Time (minutes)
165	30	Air	30
165 to 60	4	Air	34
60	20	Oxygen	54
60	5	Air	50
60	20	Oxygen	79
60	5	Air	84
60	20	Oxygen	104
60	5	Air	109
60 to 30	30	Oxygen	139
30	15	Air	154
30	60	Oxygen	214
30	15	Air	229
30	60	Oxygen	289
30 to 0	30	Oxygen	319

TABLE 6A DEPTH/TIME PROFILE

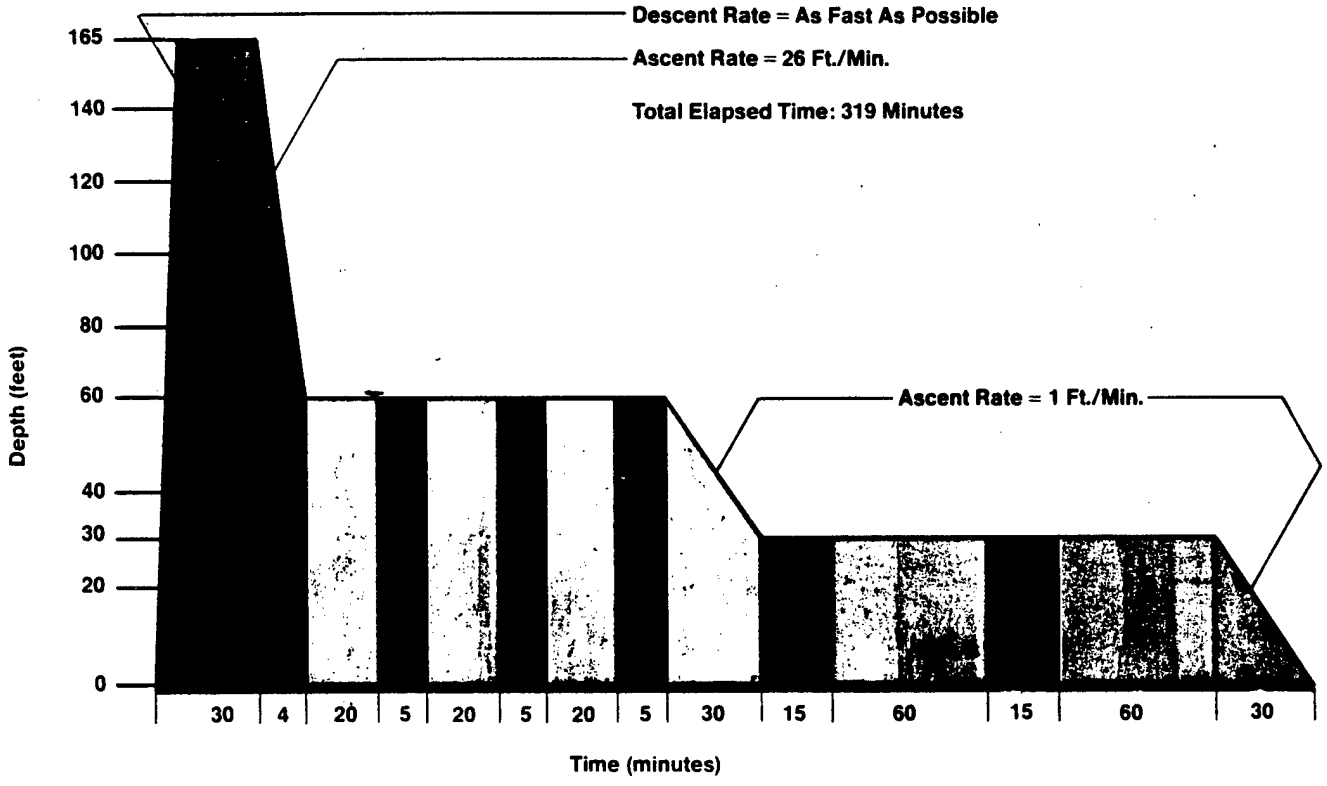

Chart for Decompression Dives

NAME OF DIVER	RATE	TABLE USED	DATE
NAME OF DIVER	RATE	TENDER (Sign name)	
PURPOSE OF DIVE			
LEFT SURFACE	REACHED BOTTOM	DESCENT TIME	LEFT BOTTOM	TIME TO FIRST STOP	TBT
DEPTH IN FEET	PRESSURE IN POUNDS		TOTAL DECOMPRESSION TIME		TBD

DIVE RECORD	DEPTH OF STOP	LBS PRESSURE	TIME
	130	58	REACHED
			LEFT
	120	54	REACHED
			LEFT
	110	49	REACHED
			LEFT
	100	44.5	REACHED
			LEFT
	90	40	REACHED
			LEFT
	80	36	REACHED
			LEFT
	70	32	REACHED
			LEFT
	60	27	REACHED
			LEFT
	50	22	REACHED
			LEFT
	40	18	REACHED
			LEFT
	30	13	REACHED
			LEFT
	20	9	REACHED
			LEFT
	10	4.5	REACHED
			LEFT

REACHED SURFACE
NEW GROUP
AIR DECOMPRESSION

DIVER'S CONDITION
REMARKS

A.11 NEUROLOGICAL CHECKS FOR DIVING ACCIDENT VICTIMS AND SELECTION OF TREATMENT TABLES

A.11.1 Objective --To introduce the diver to a methodology for determining the seriousness and extent of any specific decompression accident.

A.11.2 The Medical Examination.

A. History.

- Current medical history.
- Dive profiles.
- Sex.
- Age.
- Time prior to arriving at the chamber.
- Recorded symptoms and time to their onset.

B. Visual.

- Can patient stand or walk without assistance?
- Speech.
- Stand on tip toes.
- Knee bends.
- Hands at side, close eyes, see if balance is maintained.
- Check with buddies for personality changes.

C. Tests.

- Eye control.
- Pupil contraction/dilation
- Facial muscle.
- Reflex test: Elbow, Wrist, Ankle, Knee.
- Stroke stomach for response.
- Stroke bottom of foot.
- Cross hand grip, check strength.

- Raise foot against hand.
- Raise leg against hand
- Push hand with foot.
- Forearm strength.
- Check coordination.

A.11.3 Selection of Treatment Tables.

A. Treat air embolism on Table 5A (compress to 165 ft.) if symptoms clear in 15 minutes or less; if not, switch to Table 6A.

B. Treat serious neurological problems same as air embolism.

C. Treat simple bends on Table 5.

D. Recurrence of symptoms or persistent weakness, etc.

- Switch to next greater table.
- If symptoms persist, go to the extended Table 6 and consider use of Dextran and Decadron.

A.11.4 Follow up.

A. Medical exam.

B. Observe for 24 hours.

C. If indicated, hospitalize patient and keep on oxygen and steroids if needed.

D. Treat in chamber if necessary - once a day, Table 5, for up to five days.

E. Time lapse before returning to active diving status.

- Simple bends - two weeks.
- Neurological problems - 90 days and then only after a complete neurological exam.

A.12 EXAMINATION OF A DIVING CASUALTY

A.12.1 Vital Signs

These are of primary importance.

Breathing:

- Is the chest moving?
- How many breaths per minute? Compare to pre-dive check.

Heart:

- Check pulse rate: Compare to pre-dive check.

Hemorrhage:

- Stop massive bleeding.

A.12.2 CAUTION:

When chamber treatment is clearly required, this exam shall not delay recompression and should only determine that the victim's life is not in jeopardy regarding vital body functions.

A.13.3 Examination.

A. Mental condition or status. Because less interference is required to impair the function of higher mental and thought processes, test first for an organic brain syndrome by tests of:

1. Orientation.

- Time (the first function to be impaired).
- Place (the second function to be impaired).
- Person (indicating severe impairment).

2. Memory.

- Immediate (test using number series - i.e., 3+3=6).
- Recent (happening in the past twenty-four hours - e.g., what was supper last night?)
- Remote (background - e.g., are you married?)

3. Mentation (Smarts).

- Test by using the serial 7's (i.e., subtract 7 from 100, then 7 from the answer, etc. If an error is repeated, for example, 93 - 90 - 83 - 80, this is referred to as perseveration and generally indicates an impairment.)

4. Consciousness.

- Be alert for any fluctuation.

5. Seizures.

   - These are obvious to the most casual observer.

B. Cranial nerves. Test left against right if possible.

1. Smell (olfactory nerves).

   - Use coffee, oil or any other readily available substance. Pinch off one nostril at a time.

2. Sight (optic nerves).

   - Use your fingers for victim to count, cover one eye at a time.

3. Eye movement (oculomotor nerves).

   - Using your finger, have victim follow it up-down-left-right, keeping the head still and moving only the eyes.

4. Chewing (trigeminal nerves).

   - Can he grit his teeth?

5. Mouth (facial nerves).

   - Can the victim smile?

   - Do both corners of the mouth react?

6. Hearing (acoustic nerves).

   - Cover one ear at a time. Do not be mislead by a diver who is hard of hearing for other reasons (e.g., loud machinery).

7. Talking (glossopharyngeal, vegas nerves).

   - Listen for proper enunciation or possible gagging.

8. Shoulder muscles (spinal accessory nerves).

   - Can he shrug his shoulders while you press down on them?

9. Tongue (hypoglossal nerves).

   - Can he stick his tongue straight out? (Not to the side.)

10. Forehead.

- Can he wrinkle his forehead?

C. Sensory nerves.

1. Sharp versus dull (left versus right).

- Can the victim distinguish between sharp and dull objects in the following? Back of the hand? Base of thumb? Base of little finger?

D. Motor nerves.

1. Muscle strength.

- Can the victim grip two or four fingers with equal squeeze?

- Can the victim lift both legs against your light pressure? Do this just above the ankles. Is the lift equal?

2. Range of motion.

- Does the victim have normal movement of both arms and legs?

3. Muscle tone.

- Are the muscles contracted or relaxed?

E. Coordination.

- Point in space: Can the victim touch your finger tip with his finger tip?

- Finger to nose: Can the victim touch his nose and then come back to your finger tip?

- Gait: Are the victim's legs unsteady or rubbery? Is the victim staggering? Does the victim walk heel-to-toe?

- Balance: Can the victim stand erect, feet together, arm extended in front palms down, thumbs touching and his eyes closed?

F. Reflexes. The confines of a chamber may preclude all but the knee reflex.

1. Basic reflexes (left versus right).

- Biceps.

- Triceps.

o Forearm.

o Knee.

o Ankle.

2. Babinski reflex. Pass a blunt instrument from heel to toe on the foot. If the toes curl forward, a normal Babinski is indicated. If nothing occurs, no conclusion can be drawn; however, if the toes flex backwards and spread, this is s a reliable sign of spinal impairment or long nerve involvement.

3. Scrotum reflex. Pass a pointed instrument from the base of the scrotum toward the knee about three inches. If the testicle contracts within the scrotum, this is a reliable indication of central nervous system involvement.

G. Language problem.

1. Aphasia condition.

o Listen for speech mistakes (e.g., wrong word selection or order; misplaced or repeated words).

H. Location of the heart.

1. The heart should be located approximately three fingers to the left of the breastbone.

I. Chest expansion.

1. With both hands on the chest, fingers spread and thumbs touching, have him expand his chest (thumbs should spread between 1/2 and one inch).

J. Unequal breath.

1. Using the stethoscope, listen below the breast, on the side of the ribcage, and below the shoulder blade. Do both sides and compare for equal sounds.

A.13.4 EXAMINATION CHECK LIST

PATIENT _____ DATE _____

VITAL SIGNS:
1. Breathing _____
2. Heart _____
3. Hemorrhage _____
4. Shock _____

MENTAL CONDITION:
1. Orientation: Time _____
Place _____
Person _____
2. Memory: Immediate _____
Recent _____
Remote _____
3. Mentation _____
4. Consciousness _____
5. Seizures _____

SENSORY NERVES:
1. Sharp v. dull R_____ L _____

MOTOR NERVES:
1. Muscle strength R_____ L _____
2. Range of motion R_____ L _____
3. Muscle tone R_____ L _____

COORDINATION:
1. Point in space R_____ L _____
2. Finger to nose R_____ L _____
3. Gate-Unsteady _____
Staggering _____
Heel to toe _____
4. Balance _____

CRANIAL NERVES:
1. Smell R_____ L_____
2. Sight R_____ L_____
3. Eye movement R_____ L_____
4. Chewing R_____ L_____
5. Mouth (smile) R_____ L_____

REFLEXES - Cont.
6. Hearing R_____ L_____
7. Talking R_____ L_____
8. Shoulders R_____ L_____
9. Tongue R_____ L_____
10. Forehead _____

2. Babinski reflex R_____ L_____
3. Scrotum reflex R_____ L_____

LANGUAGE:
1. Aphasia condition:
_____

REFLEXES:
COMMENTS OR CONSTRUCTION: _____
1. Basic: Biceps R_____ L _____
Triceps R_____ L _____
Forearm R_____ L _____
Knee R_____ L _____
Ankle R_____ L _____

_____
_____
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_____
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A.14
REGULATION ER 385-1-93

A.15
CONTRACT DIVING

GENERAL SPECIFICATIONS AND SPECIAL PROVISIONS FOR CONTRACT OR PURCHASE ORDER DIVING ACTIVITIES

A.15.1 All Diving activities performed under any Division contract or purchase order shall comply with: U.S. Navy Diving Manual (Volumes I and II, NAVSEA 0994-LP-001-9010, NAVSEA 0994-LP-001-9010); Chapter XVII Occupational Safety and Health Administration, Department of Labor-Commercial Diving Operations (Federal Register Friday, July 22, 1977 Part III); Corps' Regulations Safety-Underwater Diving (ER 385-1-93); Division Diving Officer Specific Written Instructions to the Contracting Officer. If there exists a contradiction in requirements, the Written Instructions from the Diving Officer to the Contracting Officer, shall take precedence.

A.15.2 Prior to the undertaking of any Diving activities a detailed Diving Operational Plan shall be submitted five (5) work days in advance to the Diving Officer and written acceptance by the Contracting Officer with concurrence of the Division Diving Office is received by contractor. This plan shall include a detailed implementable (recently checked) Emergency Management Plan (e.g., Evacuation, Communications, Recompression Requirements, First Aid Kits). This plan shall be given to the Contracting Officer five (5) working days prior to any mobilization. This plan shall contain as a minimum the following items:

A.15.2.1 Detailed description of mission (including location, maps, drawing, environmental conditions, emergency assitance locations, relevant diver instructions).

A.15.2.2 Contact list with addresses and phone numbers (including at dive site, at contractor's office, company doctor).

A.15.2.3 Scheduled dates (including estimated daily duration times).

A.15.2.4 Description of Diving activities (including equipment, maximum depths, maximum bottom times, work to be undertaken, apparatus being used).

A.15.2.5.1 All members of the dive team including support personnel shall submit a list of qualifications, certificates, classes which include the issuing organization, the date of the most recent renewal, and which demonstrate their ability and qualifications to undertake the proposed underwater task safely and efficiently. Such documentation includes, but is not limited to, certificates of training from a recognized national diving organization, commercial dive school, college or trade school or Military training program. Properly completed, verifiable evidence of Diving experience may also be submitted.

A.15.2.5.2 In addition, Diving personnel shall submit written clearance from a medical doctor that the subject personnel are in good health and able to undertake the physical and mental stress of Diving. This clearance shall be the result of a thorough Diving medical exam such as that outlined in OSHA regulations, which has been administered by a qualified Hyperbaric Physician (doctor name and phone number), no longer than one year prior to the proposed Diving activity. Additionally all personnel shall submit evidence of current certification in a Red Cross First Aid and CPR course or its equivalent.

A.15.2.6 Description of Diving craft and boat handling equipment on-board.

A.15.2.7 Activity hazard analysis plan (including water conditions, working conditions, sequence of operations); address these concerns in the Emergency Management Plan.

A.15.3 If the Dive Plan, as approved by the Contracting Officer, is altered, the Contracting Officer shall be contacted prior to undertaking any Diving activities. All Diving activities shall proceed only after receipt of written approval by the Contracting Officer, with Diving Officer concurrance.

A.15.4 Daily Diving logs shall be furnished the Contracting Officer within 24 hours of all Diving activities.

A.16
GLOSSARY

GLOSSARY

Activity Job Hazards Analysis (ASHA): Written description of conditions and potential hazards in accomplishing the diving work - prepared at the dive site.

contract diver: A diver who is not an employee of the Corps of Engineers, but who is hired by the Corps to perform work as a contractor.

dive log: Written record of a diver's diving activities.

Dive Master: Responsible for diving operations at the location of the dive.

dive plan: Written description of planned diving operation, includes work plan, expected conditions, and emergency numbers.

Diving Medical Officer: Conducts annual diving medical exams to determine the medical fitness for diving operations of each diver and aids in determinations of emergency medical supply needs, equipment needs, procedures, and medical care of divers.

Diving Officer: Responsible for coordination of all Division diving activities.

Diving Training Officer: Responsible for diver training procedure by making sure that requirements for new dives are enforced.

emergency assitance checklist: A list to be kept at the dive site of an operational recompressing chamber, accessible hospitals, available physicians, available means of transportation and the nearest U.S. Coast Guard Rescue Coordinating Center.

high altitude diving: Diving at elevation greater than 1,000 feet. Problems arise because physical laws concerning absolute pressures and gas partial pressure are affected as altitude increases.

pre-dive conference: Conducted at the dive site prior to the dive to review the plan of operation, expected hazards, expected depths and if applicable, decompression schedules.

senior diver: Leader for the buddy team while they are in the water.

standby diver: Completely suited diver who remains on the surface to be prepared to assist in a diving emergency.

surface-air supplied diving: Diving with an air supply that is located at the surface.

tender: In surface-air supplied diving, the individual who handles the umbilicals, maintains communication with the diver, keeps time, and monitors the diver's air supply. He also aids the diver in dressing.