



# **Diving Safety Manual**

## **Revision 3.1**

**Original Document: June 22, 1983**  
**Revision 1: January 1, 1991**  
**Revision 2: May 15, 2002**  
**Revision 3: September 1, 2010**  
**Revision 3.1: September 15, 2014**

**WOODS HOLE OCEANOGRAPHIC INSTITUTION**

## DIVING SAFETY MANUAL, REVISION 3.1

Revision 3.1 of the Woods Hole Oceanographic Institution Diving Safety Manual has been reviewed and is approved for implementation. It replaces and supersedes all previous versions and diving-related Institution Memoranda.

Dr. George P. Lohmann  
Chair, Diving Control Board  
MS#23  
[glomann@whoi.edu](mailto:glomann@whoi.edu)

Edward F. O'Brien  
Diving Safety Officer  
MS#28  
[eobrien@whoi.edu](mailto:eobrien@whoi.edu)

Ronald Reif  
Institution Safety Officer  
MS#48  
[rreif@whoi.edu](mailto:rreif@whoi.edu)

David Fisichella  
Diving Control Board  
MS#17  
[dfisichella@whoi.edu](mailto:dfisichella@whoi.edu)

Dr. Laurence P. Madin  
Diving Control Board  
MS#39  
[lmadin@whoi.edu](mailto:lmadin@whoi.edu)

John D. Sisson  
Diving Control Board  
MS#18  
[jsisson@whoi.edu](mailto:jsisson@whoi.edu)

Dr. Ann Tarrant  
Diving Control Board  
MS# 33  
[atarrant@whoi.edu](mailto:atarrant@whoi.edu)

Diving Control Board  
[\\_\\_\\_\\_\\_@whoi.edu](mailto:_____@whoi.edu)

Dr. Steve Elgar  
Diving Control Board  
MS#11  
[selgar@whoi.edu](mailto:selgar@whoi.edu)

Melissa Moulton  
Diving Control Board  
MS #12  
[mmoulton@whoi.edu](mailto:mmoulton@whoi.edu)

# WOODS HOLE OCEANOGRAPHIC INSTITUTION DIVING SAFETY MANUAL

REVISION 3.1, September 15, 2014

## INTRODUCTION

Scuba diving was first used at the Institution in the summer of 1952. At first, formal instruction and proper information was unavailable, but in early 1953 training was obtained at the Naval Submarine Escape Training Tank in New London, Connecticut and also with the Navy Underwater Demolition Team in St. Thomas, U.S.V.I. The link to the pioneer Scripps research diving program also began in 1953 with a series of correspondence between W.H.O.I. chief diver David M. Owen and Conrad Limbaugh, chief diver at Scripps. "A Manual for Free Divers, With Especial Reference to the Aqua-Lung," written by Mr. Owen, first appeared as an Institution technical report in December, 1953, and later was published in book form. Institution Memorandum #14-55, dated August 2, 1955, established a formal set of regulations for W.H.O.I. divers based, in large part, on the Scripps rules. These regulations were later updated as Institution Memoranda #19-55, "Additional Safety Requirements for Self-Contained diving off Institution Docks, #4-71, "Safety and Training Regulations for Underwater Diving", #3-71, "Institution Diving Policy", and #7-77, "OSHA Standard for Commercial Diving Operations." The Institution Diving Control Board accepted the first version of the W.H.O.I. Diving Safety Manual (DSM) in June 1983.

As an organizational member of the American Academy of Underwater Science, the Institution must adhere to the AAUS Standards for Scientific Diving. This major revision is intended to bring the Institution's DSM into compliance with the most current version of the AAUS standards while allowing for the continuation of some local procedures. Surface-supplied diving minimum personnel requirements conform to the Association of Diving Contractors (ADC) Consensus Standards. Special thanks are given to the National Association of Underwater Instructors for granting permission to reproduce their dive tables.

---

Edward F O'Brien  
**Diving Safety Officer**

## TABLE OF CONTENTS

SECTION	PAGE
<b>1.00 GENERAL POLICY</b> .....	<b>1</b>
<b>1.10 THE SCIENTIFIC DIVING STANDARDS</b> .....	<b>1</b>
1.11 Purpose .....	1
1.12 Scientific Diving Definition .....	1
1.13 Scientific Diving Exemption .....	1
1.14 Review of Standards .....	2
<b>1.20 OPERATIONAL CONTROL</b> .....	<b>2</b>
1.21 Institution Auspices Defined .....	2
1.22 Diving Safety Manual .....	2
1.23 Diving Safety Officer (DSO) .....	3
1.24 Diving Control Board (DCB) .....	4
1.25 Instructional Personnel .....	5
1.26 Lead Diver .....	5
1.27 Surface Support Team Members .....	6
1.28 Standby Diver .....	7
1.29 Waiver of Requirements .....	7
<b>1.30 CONSEQUENCES OF VIOLATION OF REGULATIONS</b> .....	<b>7</b>
1.31 Consequence of Violation of Regulations by Scientific Divers .....	7
1.32 Consequence of Violation of Regulations by Organizational Members .....	7
<b>1.40 RECORD MAINTENANCE</b> .....	<b>7</b>
1.41 Availability of Records .....	7
<b>2.00 DIVING REGULATIONS FOR SCUBA (OPEN CIRCUIT, COMPRESSED AIR)</b>	<b>8</b>
<b>2.10 INTRODUCTION</b> .....	<b>8</b>
<b>2.20 PRE-DIVE PROCEDURES</b> .....	<b>8</b>
2.21 Approval .....	8
2.22 Dive Plans .....	8
2.23 Diving from Vessels or Facilities Not Controlled by WHOI .....	9
2.24 Pre-dive Safety Checks .....	9
<b>2.30 DIVING PROCEDURES</b> .....	<b>10</b>
2.31 Solo Diving Prohibition .....	10
2.32 Refusal to Dive .....	10
2.33 Termination of Dive .....	11
2.34 Emergencies and Deviations from Regulations	
<b>2.40 POST-DIVE PROCEDURES</b> .....	<b>11</b>
2.41 Post-Dive Safety Checks .....	11
2.42 Equipment .....	11
<b>2.50 DIVING AT HIGH ALTITUDES</b> .....	<b>12</b>
<b>2.60 FLYING AFTER DIVING</b> .....	<b>12</b>



3.71	Design and Location .....	21
3.72	Maintenance .....	21
3.73	Air Quality Standards ò ò ò ò ò ò ò ò ò ò ò ò ò ò ò ò ò ò ..	21
<b>3.80</b>	<b>OXYGEN SAFETY.....</b>	<b>21</b>
3.81	Equipment Design .....	21
3.82	Oxygen Cleaning .....	22
<b>3.90</b>	<b>BORROWING PRIVILEGES FOR INSTITUTION DIVERS.....</b>	<b>22</b>
3.91	Personal Equipment Requirements .....	22
3.92	Regulations .....	22
<b>4.00</b>	<b>ENTRY LEVEL DIVER TRAINING.....</b>	<b>23</b>
<b>4.10</b>	<b>TRAINING POLICY.....</b>	<b>23</b>
4.11	Training and Experience Requirement .....	23
4.12	Limitation by Auspices .....	23
<b>4.20</b>	<b>PREREQUISITES.....</b>	<b>23</b>
4.21	Application .....	23
4.22	Medical Requirements .....	23
4.23	Age .....	23
4.24	Waiver .....	23
4.25	Swimming Evaluation .....	23
<b>4.30</b>	<b>MINIMUM STANDARDS FOR SCUBA TRAINING.....</b>	<b>24</b>
4.31	Standard of Evaluation .....	24
4.32	Pool (Confined Water) Training Requirements .....	24
4.33	Written Examination .....	25
4.34	Open Water Evaluation .....	25
<b>5.00</b>	<b>SCIENTIFIC DIVER CERTIFICATION .....</b>	<b>27</b>
<b>5.10</b>	<b>REQUIREMENTS FOR SCIENTIFIC DIVER CERTIFICATION .....</b>	<b>27</b>
5.11	Eligibility .....	27
5.12	Provisional Scuba Permit (Diver-in-Training) .....	27
5.13	Documents .....	27
5.14	Training .....	27
<b>5.20</b>	<b>DEPTH CERTIFICATIONS.....</b>	<b>28</b>
5.21	Certification Advancement.....	28
5.22	Forty (40) Foot Depth Certification.....	28
5.23	Seventy (70) Foot Depth Certification .....	28
5.24	One Hundred (100) Foot Depth Certification.....	28
5.25	One Hundred Thirty (130) Foot Depth Certification.....	29
5.26	Dives in Excess of 130 Feet.....	29
5.27	Exceptions to the Depth Limitation..... ò ò .....	29
<b>5.30</b>	<b>CERTIFICATION PROCEDURE FOR CANDIDATES WITH PREVIOUS DIVING EXPERIENCE .....</b>	<b>29</b>
5.31	Minimum Eligibility Requirements.....	29

5.32	Evaluation Procedure for Experienced Candidates . . . . .	30
5.33	Certification Level Assignment . . . . .	30
5.34	Reciprocity with AAUS Accredited Diving Programs. . . . .	30
5.35	Temporary Diving Permit . . . . .	31
5.36	Waiver of Specific Requirements for Special Circumstances/Urgent Needs . . . . .	31
<b>5.40</b>	<b>MAINTENANCE OF CERTIFICATION . . . . .</b>	<b>31</b>
5.41	Term of Certification . . . . .	31
5.42	Minimum Diving Activity . . . . .	31
5.43	Medical Examination . . . . .	32
5.44	Other Recertification Requirements . . . . .	32
5.45	Requalification of Depth Certificate . . . . .	32
<b>5.50</b>	<b>SUSPENSION, RESTRICTION, AND REVOCATION OF CERTIFICATION. . . . .</b>	<b>32</b>
5.51	Cause . . . . .	32
5.52	Procedure for Suspension, Restriction, or Revocation . . . . .	33
5.53	Consequences of Suspension, Restriction, or Revocation. . . . .	33
5.54	Recertification After Expiration or Revocation. . . . .	33
<b>6.00</b>	<b>MEDICAL STANDARDS. . . . .</b>	<b>34</b>
<b>6.10</b>	<b>MEDICAL REQUIREMENTS. . . . .</b>	<b>34</b>
6.11	General. . . . .	34
6.12	Frequency of Medical Evaluations . . . . .	34
6.13	Information Provided Examining Physician . . . . .	34
6.14	Content of Medical Evaluations . . . . .	34
6.15	Conditions Which May Disqualify Candidates From Diving. . . . .	34
6.16	Laboratory Requirements For Diving Medical Examination and Intervals . . . . .	35
<b>6.20</b>	<b>MEDICAL EXAMINATION PROCEDURES. . . . .</b>	<b>36</b>
<b>7.00</b>	<b>NITROX DIVING GUIDELINES . . . . .</b>	<b>37</b>
<b>7.10</b>	<b>PREREQUISITES . . . . .</b>	<b>37</b>
7.11	Eligibility. . . . .	37
7.12	Application and Documentation . . . . .	37
<b>7.20</b>	<b>REQUIREMENTS FOR AUTHORIZATION TO USE NITROX. . . . .</b>	<b>37</b>
7.21	Training. . . . .	37
7.22	Examinations . . . . .	37
7.23	Minimum Activity to Maintain Authorization. . . . .	37
<b>7.30</b>	<b>NITROX TRAINING GUIDELINES. . . . .</b>	<b>38</b>
7.31	Classroom Instruction. . . . .	38
7.32	Practical Training. . . . .	38
7.33	Written Examination. . . . .	38
7.34	Openwater Dives. . . . .	39
7.35	Surface-Supplied Training. . . . .	39
<b>7.40</b>	<b>SCIENTIFIC NITROX DIVING REGULATIONS . . . . .</b>	<b>39</b>
7.41	Dive Personnel Requirements . . . . .	39



9.60	Semi-Closed Circuit Rebreathers	57
9.70	Closed-Circuit Rebreathers	57
<b>10.00</b>	<b>DIVING EMERGENCY PROCEDURES</b>	<b>58</b>
<b>10.10</b>	<b>GENERAL POLICY</b>	<b>58</b>
10.11	Introduction	58
10.12	Preparedness	58
<b>10.20</b>	<b>ON-SITE ACCIDENT MANAGEMENT</b>	<b>58</b>
10.21	Rescue/First Aid	58
10.22	Summoning Aid	59
10.23	On-Site Care of Diving Casualty	60
10.24	Additional On-Site Procedures While Awaiting Aid/Transport	60
<b>10.30</b>	<b>EMERGENCY EVACUATION GUIDELINES</b>	<b>60</b>
10.31	General Guidelines	60
10.32	Evacuation by Air	61
<b>10.40</b>	<b>LEGAL CONSIDERATIONS</b>	<b>62</b>
10.41	Responsibility	62
10.42	Guidelines for Serious Accidents	62

**APPENDICIES**

A	Emergency Assistance Checklist for the Woods Hole Area	
B	Lead Diver Checklist Guidelines	
C	NAUI Dive Table	
D	Diving Accident First Aid Manual	
E	AAUS Diving Injury/Incident Report Form	
F	Dive Plan	
G	Medical Forms	
	Diving Medical Exam Overview for the Examining Physician	G-1
	Medical Evaluation of Fitness for Scuba Diving Report	G-3
	Diving Medical History Form	G-5
	Recommended Physicians with Expertise in Diving Medicine	G-7
H	Statement of Understanding	
I	Application for Diver Training/Certification	
J	WHOI/AAUS Reciprocity Letter of Reference	
K	AAUS Checkout Dive and Training Evaluation	
L	Safe Ascent Recommendations	
M	Guidelines for Use of Dive Computers	
N	UNOLS Research Vessel Operating Committee Shipboard Diving Regulations	
O	Definition of Terms	
P	Dive Log Form	

**SECTION 1.00  
GENERAL POLICY**

**1.10 THE SCIENTIFIC DIVING STANDARDS**

1.11 Purpose

1. Rationale

- a. Scuba and other forms of underwater diving are widely used at the Institution as effective research tools.
- b. Institution research diving requires competent underwater operations.
- c. Personnel engaged in diving are exposed to special risks.
- d. The risks associated with diving can be minimized by appropriate management of diving operations.
- e. An employer must accept responsibility for protecting staff and students from work-related hazards.

2. Objectives:

- a. To ensure that all diving under the auspices of Woods Hole Oceanographic Institution is conducted in a manner that will maximize protection of its divers from accidental injury and/or illness;
- b. To set forth regulations, procedures, and standards for selection, training, and certification of Institution divers;
- c. To allow reciprocity between the Institution diving program and organizational members of the American Academy of Underwater Sciences (AAUS).

1.12 Scientific Diving Definition

Scientific diving is defined (29 CFR 1910.402) as diving performed solely as necessary part of a scientific, research, or educational activity by employees whose sole purpose for diving is to perform scientific research tasks.

1.13 Scientific Diving Exemption

OSHA has granted an exemption for scientific diving from commercial diving regulations under the following guidelines (Appendix B to Subpart T):

1. The Diving Control Board consists of a majority of active scientific divers and has autonomous and absolute authority over the scientific diving program's operation.
2. The purpose of the project using scientific diving is the advancement of science; therefore, information and data resulting from the project are non-proprietary.
3. The tasks of a scientific diver are those of an observer and data gatherer. Construction and trouble-shooting tasks traditionally associated with commercial diving are not included within scientific diving.
4. Scientific divers, based on the nature of their activities, must use scientific expertise in studying the underwater environment and therefore, are scientists or scientists-in-training.

5. In addition, the scientific diving program shall contain at least the following elements:
  - a. Diving safety manual which includes at a minimum: Procedures covering all diving operations specific to the program; including procedures for emergency care, recompression and evacuation; and the criteria for diver training and certification.
  - b. Diving control (safety) board, with the majority of its members being active scientific divers, which shall at a minimum have the authority to: approve and monitor diving projects, review and revise the diving safety manual, assure compliance with the manual, certify the depths to which a diver has been trained, take disciplinary action for unsafe practices, and assure adherence to the buddy system (a diver is accompanied by and is in continuous contact with another diver in the water) for scuba diving.

#### 1.14 Review of Standards

As part of each organizational member's annual report, any recommendations for modifications of these standards shall be submitted to the AAUS for consideration.

### 1.20 OPERATIONAL CONTROL

#### 1.21 Institution Auspices Defined

The regulations and procedures specified in this manual will apply to all persons who use Institution-owned diving equipment or facilities, and all persons engaged in Institution-sponsored diving activities, including employees acting within the scope of their employment, students participating in Institution-sponsored activities, and any persons engaged in Institution authorized research.

##### 1. Equipment

All diving under Institution auspices shall be done only with equipment which conforms to the standards set forth in this manual.

##### 2. Location

The regulations herein shall be observed at all locations where diving is carried out under Institution auspices.

#### 1.22 Diving Safety Manual

The regulations herein provide for the development and implementation of policies and procedures that will enable the Institution to meet the requirements of local environments and conditions as well as to comply with the AAUS scientific diving standards.

1. These scientific diving standards shall include:
  - a. The AAUS Standards (<http://www.aaus.org/>) are the minimal guidelines for the Institution's scientific diving safety manual.
  - b. Emergency evacuation and medical treatment procedures.
  - c. The criteria for diver training and certification.
  - d. Standards for each diving mode utilized which include the following:
    - (1) Safety procedures for the diving operation.

- (2) Responsibilities of the dive team members.
- (3) Equipment use and maintenance procedures.
- (4) Emergency procedures.

## 2. Diving Safety Manual Review

The Diving Safety Manual will be reviewed periodically and revised as necessary by the Diving Control Board, with particular emphasis on revisions to the AAUS Standards.

## 3. Diving Safety Memoranda

It is impossible to develop a set of diving standards to cover all imaginable situations. When necessary, the DSO will promulgate supplementary Diving Safety Memoranda with additional procedures to cover unusual situations or special projects. The Diving Safety Manual is, however, basic and shall be adhered to whenever diving is being conducted under Institution auspices.

## 4. Distribution

The current revision of the Diving Safety Manual and Diving Safety Memoranda shall be supplied to all active status divers and shall be available at the dive location.

## 5. Precedence

Material contained in this revision of the Diving Safety Manual and subsequent Diving Safety Memoranda shall supersede all previous editions.

### 1.23 Diving Safety Officer (DSO):

#### 1. Qualifications

- a. shall be appointed by the Director, with the advise and counsel of the DCB;
- b. shall be an active underwater instructor from a nationally recognized agency;
- c. shall be trained as a scientific diver;
- d. shall be a full member as defined by the AAUS;
- e. shall have had varied diving experience and qualifications, including at least four (4) years of diving experience and one hundred (100) hours underwater using scuba and surface supplied equipment; shall exhibit a thorough knowledge of diving theory, safety practices, operational procedures and diver training;

#### 2. Duties and Responsibilities

- a. shall have operational authority for the diving program, including enforcement of diving safety regulations, conduct of all diver training and certification, approval of all dive plans and equipment, and the maintenance of Institution owned diving equipment and records, and shall be responsible to the Director, through the Diving Control Board, for the conduct of the diving program at the Institution;
- b. shall restrict or suspend diving operations or individuals which he considers to be unsafe or which are in violation of these regulations.
- c. shall compile an annual report of diving activities for the DCB.

d. may designate a qualified person to carry out portions of the diving program, although the DSO may not delegate responsibility for the safe conduct of the local diving program

#### 1.24 Diving Control Board

##### 1. Qualifications of Members

- a. The Diving Control Board (DCB) shall consist of a majority of active scientific divers.
- b. Voting members shall include the Diving Safety Officer and representatives from the major diving activities at the Institution.
- c. Members shall be appointed by the Director.

##### 2. Duties and Responsibilities

- a. shall select a chairperson and secretary;
  - (1) the chairperson will convene meetings at least annually; extraordinary meetings of the DCB may be convened in response to requests from the staff or student body;
  - (2) the secretary will be responsible for recording the business of the DCB and for providing written copies to the Director and to members of the DCB;
- b. has autonomous and absolute authority over the scientific diving program's operation;
- c. shall approve and monitor diving projects;
- d. shall review and revise the diving safety manual;
- e. shall assure compliance with the manual;
- f. shall certify the depths to which a diver has been trained;
- g. shall take disciplinary action for unsafe practices;
- h. shall assure adherence to the buddy system for scuba diving;
- i. shall advise and inform the Director on matters of diving policy and shall act as the official representative of the Institution in matters concerning the scientific diving program;
- j. shall act as a board of appeal to consider diver-related problems;
- k. shall recommend the issue, reissue, or the revocation of diving certifications;
- l. shall recommend changes in policy and amendments to the AAUS and the Institution's scientific diving manual as the need arises;
- m. shall establish and/or approve training programs through which the applicants for certification can satisfy the requirements of the Institution's diving safety manual;
- n. shall suspend diving programs which it considers to be unsafe or unwise;
- o. shall establish criteria for equipment selection and use;
- p. shall recommend new equipment or techniques;

- q. shall establish and/or approve facilities for the inspection and maintenance of diving and associated equipment;t
- r. shall ensure that the Institution's diving air station(s) meet air quality standards as described in Sec. 3.73 of this manual;
- s. shall periodically review the Diving Safety Officer's performance and program;
- t. shall sit as a board of investigation to inquire into the nature and cause of diving accidents and violations of the standards set forth in this manual;
- u. shall convey an annual report of diving activities to the Director.

#### 1.25 Instructional Personnel

##### 1. Qualifications

All personnel involved in diving instruction under the auspices of the organizational member shall be qualified for the type of instruction being given.

##### 2. Selection

Instructional personnel will be selected by the responsible administrative officer, or his/her designee, who will solicit the advice of the DCB in conducting preliminary screening of applicants for instructional positions.

#### 1.26 Lead Diver

1. For each dive a certified diver shall be designated as the Lead Diver.

2. The Lead Diver, under the DSO, has complete authority and full responsibility for the dive operation.

3. Responsibilities:

a. Plan the operation as completely as possible, and file a dive plan, as required by the DSO;

b. Designate the members of the dive team, ensuring that:

(1) the divers possess current and sufficient certification;

(2) no person shall be permitted to dive for the duration of any known physical impairment or condition which is likely to affect adversely the safety and health of the diver or of other dive team members;

(3) the surface crew possess the knowledge and skill necessary.

c. Coordinate diving operations with other known activities in the vicinity which are likely to interfere with diving operations;

d. Ensure that all divers have the required equipment with them before departing the staging area (see Section 3.20) and that safety and emergency equipment is in working order and at the dive site;

e. Evaluate the environmental conditions and dive site, and ensure that a means of supporting the divers for entering and exiting the water exists;

f. Brief divers and support crew as fully as possible regarding:

- (1) dive objective;
  - (2) any unusual hazards or environmental conditions likely to affect the safety of the diving operation;
  - (3) any modifications to diving or emergency procedures necessitated by the specific nature of the diving operation;
  - (4) immediate reporting of any physical problems or symptoms of pressure related injuries.
- g. brief Master of the support vessel concerning the dive plan and emergency procedures;
  - h. supervise and direct all phases of the diving operation;
  - i. ensure that the operation is conducted in compliance with all existing regulations, and that all safety precautions are followed;
  - j. ensure that pre-dive inspections are made, that each diver fully understands the instructions before entering the water, and that buddy teams enter the water together;
  - k. check with the divers for equipment malfunctions at the dive site and tag all malfunctioning equipment (see Section 2.24.2d);
  - l. supervise cleaning and stowage of all equipment, and ensure that it is properly maintained as outlined in Section 2.42;
  - m. ensure that the record of dive form is completed and filed with the DSO as soon as possible upon completion of the dive or operation;
  - n. during any diving emergency, ensure that proper action is taken (see appendix D Emergency Procedures), and ensure that a detailed report is submitted to the DSO.
4. The Lead Diver may also assume the role of diver on simple or limited scuba diving operations, and under favorable environmental or operational conditions, at the discretion of the DSO.
  5. The Lead Diver may be required by the DSO to be in charge at the surface platform during complex or surface supplied operations or under unfavorable environmental or operational conditions. The Lead Diver:
    - a. must be in a position to direct personnel and take charge in an emergency;
    - b. may enter the water in an emergency.

#### 1.27 Surface Support Team Members

1. All tenders, boat operators, and other surface support personnel shall possess the necessary qualification, experience, and/or training to effectively and safely assist the diving operation, and shall be thoroughly briefed by the lead diver regarding the operational and emergency procedures.
2. Certified divers shall be used for tending unless specifically waived by the DSO.
3. Emergency medical training (CPR, first aid) is strongly recommended for all surface support personnel and may be a requirement for approval of the dive plan, at the discretion of the DSO.

## 1.28 Standby Diver

1. A standby diver may be required, at the discretion of the DSO, for any diving operation.
2. The standby diver must possess sufficient certification for the depth and mode of the operation.
3. The standby diver shall be sufficiently equipped, positioned, and dressed to rapidly render effective in-water assistance (less than 3 minutes) to the divers in an emergency.

## 1.29 Waiver of Requirements

The organizational Diving Control Board may grant a waiver for specific requirements of training, examinations, depth certification, and minimum activity to maintain certification.

## 1.30 CONSEQUENCES OF VIOLATION OF REGULATIONS

### 1.31 Consequences of Violation of Regulations by Scientific Divers

Failure to comply with the regulations of the organizational member's diving manual may be cause for the revocation or restriction of the diver's scientific diving certificate by action of the organizational member's Diving Control Board.

### 1.32 Consequences of Violation of Regulations by Organizational Members

Failure to comply with the regulations of the AAUS Standards for Scientific Diving may be cause for the revocation or restriction of the organizational member's recognition by the AAUS.

## 1.40 RECORD MAINTENANCE

The DSO shall maintain permanent records for each individual scientific diver certified. The file shall include evidence of certification level, dive logs, results of current physical examination, waivers granted, reports of disciplinary actions by the DCB, and other pertinent information deemed necessary.

### 1.41 Availability of Records:

1. Medical records shall be available to the attending physician of a diver or former diver when released in writing by the diver.
2. Records and documents required by this standard shall be retained for the following period:
  - a. Physician's written reports of medical examinations for dive team members - 5 years.
  - b. Diving Safety Manual - indefinitely for historical purposes
  - c. Records of dive - indefinitely for historical purposes
  - d. Pressure-related injury assessment - 5 years.
  - e. Equipment inspection and testing records - current entry or tag, or until equipment is withdrawn from service.

**SECTION 2.00**  
**DIVING REGULATIONS FOR SCUBA (OPEN CIRCUIT, COMPRESSED AIR)**

**2.10 INTRODUCTION**

No person shall engage in diving activities under the auspices of the Institution unless he/she holds a current valid certification to the level of the proposed activity issued by the Diving Safety Officer or Diving Control Board, or is a candidate in a diver training or evaluation course as prescribed by the Diving Control Board.

**2.20 PRE-DIVE PROCEDURES**

2.21 Approval

All diving under the auspices of the Institution shall be approved in advance by the DSO.

2.22 Dive Plans

1. Dives should be planned around the competency of the least experienced diver.
2. Dive plans shall be filed with the DSO (Appendix F) by the Lead Diver before commencement of the diving operations, and shall include at least the following:
  - a. name, qualifications and the type of certificate or permit held by each diver;
  - b. emergency plan (see Section 9.00, Appendix A) with the following information:
    - (1) name, telephone number, and relationship of person to be contacted for each diver in the event of an emergency;
    - (2) nearest operational recompression chamber or Divers Alert Network emergency number (919-684-9111);
    - (3) nearest accessible hospital;
    - (4) available means of transport;
3. approximate number of proposed dives;
4. location(s) of proposed dives, and vessels to be employed, estimated time of return (local dives);
5. estimated depth(s) and bottom time(s) anticipated;
6. decompression status and repetitive dive plans, if required, and the specific dive tables to be used if not the current U.S. Navy No-Decompression tables, or the specific model dive computer(s) if not borrowed from the Dive Locker;
7. a brief statement regarding the proposed purpose and procedures of the mission;
8. any hazardous conditions anticipated;

9. a list of any equipment required from the diving locker;
  10. requests for waivers for special procedures must be submitted in writing with enough lead time for consideration by the DSO and/or DCB;
- 2.23 Diving From Vessels or Facilities Not Controlled by W.H.O.I.

1. Every effort shall be made to coordinate the regulations of this manual with others which apply.
2. Woods Hole Oceanographic Institution regulations are the minimum requirements.
3. Prior agreement between the Institution DSO and other involved parties is necessary before a dive plan can be approved.

2.24 Pre-dive Safety Checks

1. Diver Rights and Responsibilities

- a. Each scientific diver shall conduct a functional check of his/her diving equipment in the presence of the diving buddy or tender (Section 2.24.2). The diver shall report any equipment malfunction or discrepancy to the Lead Diver and team members.
- b. No dive team member shall be required to be exposed to hyperbaric conditions against his/her will, except when necessary to prevent or treat a pressure-related injury. The diver shall report any injury or symptoms of diving disease to the Lead Diver.
- c. The diver shall act in a prudent manner under direction of the Lead Diver and DSO with particular regard for his/her own safety, and the safety of those around him/her, and shall conform to all regulations of this manual.
- d. No dive team member shall be permitted to dive for the duration of any known condition which is likely to adversely affect the safety and health of the diver or other dive members.

2. Equipment Evaluations

- a. Each diver shall insure that his/her equipment is in proper working order and that the equipment is suitable for the type of diving operation. Equipment to be inspected shall include, but not be limited to:
  - (1) all straps, hoses and soft items (rubber, nylon, etc.) for cuts, cracks, dry rot, and/or other signs of deterioration or damage;
  - (2) wet or variable volume dry suits for body or seal tears, zipper function;
  - (3) scuba cylinders for damage, sufficient air supply, and valve function;
  - (4) regulators for free-flow, breathing; hoses, fittings, accessories, mouthpiece, etc., for tightness, cracking, deterioration, damage
  - (5) weight belts and buckles for deterioration and damage;
  - (6) buoyancy control devices, low pressure or other mechanical inflator, and oral inflator;

- (7) diving knives for sharpness;
- (8) any accessory equipment such as dive lights, etc. for battery, filament function, damage
- (9) depth gauges for damage, dive computers for battery viability
- b. Each diver shall have the capability of achieving and maintaining positive buoyancy.
- c. Every reasonable effort shall be made to prevent damage to equipment during the diving operation.
- d. Any malfunctioning item shall be individually tagged giving the name of the user (or person who noticed the malfunction), date and nature of the malfunction. Tagged equipment shall be brought to the attention of the DSO.

### 3. Site Evaluation

The environmental conditions at the site will be evaluated.

## 2.30 DIVING PROCEDURES

### 2.31 Solo Diving Prohibition

1. A diving team shall consist of not less than two (2) members. Scuba diving shall be conducted in buddy pairs, unless the task being undertaken dictates the use of additional divers.
2. Scuba divers shall maintain close, continuous, contact and be in a position to render assistance in case of need.
3. If loss of effective communication occurs within a buddy team or between diver and tender, all divers shall surface and remain there until contact is reestablished visually or until the bubble trail is sighted, unless specific instructions for other procedures have been planned and approved.
4. The buddy system is based upon mutual assistance, especially in case of emergency.

### 2.32 Refusal to Dive

1. The decision to dive is that of the diver. A diver may refuse to dive, without fear of penalty, whenever he/she feels it is unsafe for them to make the dive.
2. Safety: The ultimate responsibility for safety rests with the individual diver. It is the diver's responsibility and duty to refuse to dive if in his/her own judgment:
  - a. conditions are unfavorable (e.g., environmental, personnel, planning, etc.);
  - b. he/she is not qualified for the diving depth, environmental conditions, equipment, or procedures designated for the operation;
  - c. he/she is not in proper physical or mental condition for diving (e.g., suffering from a nonreported disease, chest cold, hangover, recent emotional trauma, out of shape, etc.);

- d. the equipment provided for the dive is inadequate or malfunctioning;
- e. he/she would be violating the precepts of his/her training or the regulations in this manual.

### 2.33 Termination of the Dive

1. It is the responsibility of the diver to terminate the dive, without fear of penalty, whenever he/she feels it is unsafe to continue the dive, unless it compromises the safety of another diver already in the water (Sec. 2.32).
2. The scuba diver shall plan the dive and monitor his/her air supply so that he/she surfaces with a minimum of 300 p.s.i. cylinder pressure or can safely reach an additional air source at the decompression station
3. The dive shall be terminated when the first team member runs low on air.

### 2.34 Emergencies and Deviations from Regulations

#### 1. Waiver

A waiver for deviating from any of the regulations outlined in this manual may be granted by the DCB or DSO (with cognizance of the DCB) upon the receipt of a written request detailing the proposed diving plan and the special need to deviate from normal procedures.

#### 2. Emergencies

- a. Any diver may deviate from the requirements of this manual to the extent necessary to prevent or minimize a situation which is likely to cause death, serious physical harm, or major environmental damage. A written report of such actions must be submitted to the Diving Control Board explaining the circumstances and justifications.
- b. The Manager of Marine Operations or ship's Master may authorize diving operations from Institution vessels in emergency situations. Under these circumstances the diving regulations followed may be those of the authority involved (e.g., Fire Department, Coast Guard, Police).

## 2.40 POST-DIVE PROCEDURES

### 2.41 Post-Dive Safety Checks

1. After the completion of a dive, each diver shall report any physical problems, symptoms of decompression sickness, or equipment malfunctions.
2. When diving outside the no-decompression limits, the divers should remain awake for at least one hour after diving, and in the company of a dive team member who is prepared to transport him/her to a hyperbaric chamber if necessary.

### 2.42 Equipment

All diving gear used shall be properly rinsed, dried (if possible) and stowed (except tagged equipment, as noted above) by the dive team as soon as possible upon completion of the dive or operation.

2.43 Enter dive data into Record of Dive form (see Section 2.91)

## **2.50 DIVING AT HIGH ALTITUDES**

Decompression tables, depth of stops, rate of ascent and repetitive dive planning must be altered for safe diving at altitudes above 1,000 feet (305 m). Sea Level equivalent depths and rate of ascent should be computed based on dive site atmospheric pressure and density of water. Depth values for Bourdon tube and bellows depth gauges must be corrected for altitude and density of water. The DSO must approve plans for projects above elevations of 1000 feet.

## **2.60 FLYING AFTER DIVING**

The minimum preflight surface interval shall be as follows, provided there are no decompression sickness (DCS) symptoms presenting, omitted decompression, or other extra risk factors (based on Divers Alert Network workshop on flying after diving, May, 2002):

1. 12 hour wait after a single no-decompression dive;
2. 18 hour wait after multiple dives per day or multiple days of diving;
3. dives requiring staged (mandatory stops) decompression stops: There is little experimental or published evidence on which to base a recommendation for decompression dives. A preflight surface interval substantially longer than 18 hours appears prudent.+
4. after any recompression chamber treatment, as directed by hyperbaric physician.

## **2.70 DIVING AT THE ISELIN MARINE FACILITY PIER**

### 2.71 Notification

1. No diving is permitted at the pier or near vessels at the pier without approval of the DSO or his designee.
2. The Port Office and watch officers of all vessels at the pier shall be notified before commencement of diving operations.
3. During normal working hours, the Mechanical Shop Supervisor and/or Dockmaster are to be notified before commencement of diving operations.

### 2.72 Pier Safety:

1. Divers shall ensure other activities and suspended equipment at the pier will not present a hazard during the duration of the dive.
2. The dive flag will be raised prior to divers entering the water from the mast at the head of the pier.

### 2.73 Site Survey:

1. Tidal currents can exceed 1.5 knots on full flood tide.
2. Some low areas under the pier deck (beneath utility conduits, under ships) may prevent direct access to the surface at times of high water.
3. Visibility is often limited to a few feet.
4. Lines, cables, and monofilament from fishing activity may present entanglement

## 2.80 DIVING FROM VESSELS

### 2.81 Coastal Operations Utilizing Small- to Intermediate-Sized Vessels

1. The vessel shall be of sufficient size and seaworthiness to accommodate divers, surface personnel, equipment, and the diving operations.
2. The vessel operator shall be qualified to operate the craft safely and effectively.
3. The vessel must be well maintained, in satisfactory operating condition, and equipped with proper safety equipment as required by Coast Guard regulations and other applicable federal, state, or local laws.
4. An adequate means of exiting the water shall be provided (e.g., a ladder or platform for boats with a high freeboard).
5. Additional requirements for boat diving more than 1/2 mile offshore, or more than 20 minutes from assistance, or as determined by the DSO are:
  - a. two-way radio communication;
  - b. a person in the boat at all times qualified to operate the boat and radio, and to assist the divers;
6. Fresh water and survival supplies may be needed.
7. A highly visible buoyed safety line no less than one hundred (100) feet in length trailed behind the boat and/or a "chase boat" may be required for diving from anchored vessels in currents or other situations where difficulty returning to the boat or surface hazards are anticipated.

### 2.82 Diving from a Non-Anchored Vessel (e.g., Drift Diving or Live Boating):

When possible, offshore diving operations shall be conducted from anchored vessels or platforms. In situations where it is prudent to maintain a support vessel in proximity to the diver, such as unsafe anchoring conditions, distances to be covered by divers is large, potentially hazardous boat traffic in the dive area, swift currents, etc., "live boat diving" may be conducted under the following procedures:

1. The engines of boat or ship shall be in neutral when divers are close or are entering/exiting the water.

2. The boat operator shall be continuously aware of the divers' location:
  - a. the divers will not enter the water until authorized by the vessel operator;
  - b. on entry, all divers will remain on the surface and visible to the vessel operator until the vessel moves away from the divers;
  - c. drift divers shall be buoyed at all times, towing a surface buoy of international orange color and sufficient size to be seen by the vessel operator;
  - d. during the dive, the boat will remain well clear of the divers' bubbles until all divers are visible on the surface and they have indicated to the vessel operator that they are ready for pickup;
  - e. divers awaiting pickup are to remain stationary and grouped on the surface. After the vessel has been maneuvered as close to the divers as is safe, the engines will be placed in neutral, and the vessel operator will indicate to the divers that it is safe to approach the vessel and exit the water;
3. If divers are tethered, precautions shall be taken to avoid entanglement in the propellers ("caging" the propeller, buoying the umbilical, etc.).
4. When using diver-to-surface communication, failure in communication shall require termination of the dive.

#### 2.83 Diving at Sea

1. The Master of the vessel has the authority to terminate all diving operations, if, in the Master's judgment, conditions endanger the vessel or personnel.
2. A safety boat is required for diving operations away from the mother ship.
  - a. A small power boat (e.g., a Zodiac inflatable with outboard motor), large enough to accommodate divers and their equipment shall be used. The boat shall also be equipped with a whistle, flares or flashing strobe, fresh water, and a first aid kit.
  - b. The boat shall be manned at all times by a qualified boat operator.
  - c. There shall be two-way radio communication with the ship and prearranged boat/diver recall utilizing ship's whistle, flares, or a flashing strobe light.
  - d. The boat operator shall have prearranged means to convey emergency information to submerged divers (e.g., weather, dangerous marine life).
  - e. The ship shall stand by while divers are out, keeping the dive boat in sight at all times. Concurrent work shall be planned at the discretion of the Chief Scientist and the Master.
3. The Master shall be thoroughly briefed regarding all aspects of the operation.

4. Because of the special environment of "bottomless," open sea diving and the remoteness from recompression chamber and other definitive medical facilities, the minimum qualification is a current 70 foot certification level, including the following:
  - a. All of the recertification requirements of Section 5.40 will be met before the cruise commences.
  - b. At least 24 dives meeting the criteria set forth in Section 5.20 must have been logged within two years of commencement of the cruise.

## **2.90 OPERATION RECORDKEEPING**

### **2.91 Record of Dive**

1. A record of dive for all dives under Institution auspices shall be submitted to the DSO as soon as possible after the event.
2. Standard forms provided by the DSO shall be used to log dives, and shall include at least the following:
  - a. full name of diver, buddy diver(s), and lead diver;
  - b. date and local time (use 24 hour clock) dive began and ended;
  - c. location (latitude and longitude at sea), type and name of vessel or platform (i.e., name of pier, beach, etc.);
  - d. approximate underwater and surface conditions (temperature, visibility, current);
  - e. maximum depth and bottom time (or underwater time for shallow dives) for each diver;
  - f. nature of diving activities and purpose;
  - g. diving modes used (scuba vs. surface-supplied, air vs. mixed gas, wet vs. dry suit) for each diver;
  - h. diving tables, dive computer models, or devices used if other than U.S. Navy no-decompression procedures for each diver;
  - i. detailed report of any incidents as stated in section 2.93.

### **2.92 Personal Diving Log**

1. A personal diving log is required for all divers in training and candidates for certification.
2. All certified Institution divers are strongly encouraged to document their diving careers by maintaining a personal diving log, including all dives whether Institution sponsored or recreational.
3. The recommended format is similar to that outlined in Section 2.91 with the following differences:

- a. may be more detailed and subjective;
- b. should be signed by the dive buddy or instructor for verification;
- c. should be compiled in a bound booklet (preferably with water resistant paper).

#### 2.93 Incident Reporting

1. Detailed reports of any accident, injury, emergency, potentially dangerous incident, deviation from the dive tables or violation of the regulations specified in this manual shall be reported in writing to the DSO as soon as possible after the event. The report will specify the circumstances of the incident, the extent of any injuries or illnesses, actions taken and treatment provided.
2. If pressure-related injuries are suspected, or if symptoms are evident, the following additional information shall be recorded and retained by the Diving Office, with the record of the dive:
  - a. Complete AAUS Incident Report Form (Appendix E).
  - b. Written descriptive report to include:
    - (1) Name, address, phone numbers of the principal parties involved.
    - (2) Summary of experience of divers involved.
    - (3) Location, description of dive site and description of conditions that led up to incident.
    - (4) Description of symptoms, including depth and time of onset.
    - (5) Description and results of treatment.
    - (6) Disposition of case.
    - (7) Recommendations to avoid repetition of incident.

**SECTION 3.00  
DIVING EQUIPMENT**

**3.10 GENERAL POLICY**

All diving equipment, regardless of ownership, used under the auspices of the Institution is subject to inspection and approval by the DSO and DCB.

It is the responsibility of the primary user (the diver) to regularly examine his/her equipment and verify that it is fit for use.

Equipment that is subjected to extreme usage under adverse conditions should require more frequent testing and maintenance than the schedules listed in this manual.

**3.20 MINIMUM REQUIRED INDIVIDUAL EQUIPMENT FOR SCUBA DIVING**

3.21 Exposure Suit:

1. shall be adequate to protect the diver from adverse effects of water temperature, harmful chemicals, sharp or stinging marine organisms, etc.;
2. variable volume dry suits require special training and must be equipped with an exhaust valve.
3. gloves should be worn for handling sharp objects as well as for thermal protection.

3.22 Mask, Fins, Snorkel:

1. fins are not required for surface supplied diving;
2. snorkels are required for any open water scuba dive where significant surface swimming is anticipated.

3.23 Knife:

required for any dive where the possibility of entanglement in lines, nets, or marine plants exists.

3.24 Time/Depth Instrumentation:

1. Instrumentation measuring depth and elapsed time (e.g., a depth gauge and watch/bottom timer or dive computer) is required to be worn by each diver.
2. Capillary gauges are not adequate for dives deeper than 30 feet (9 m).
3. Dive computer use shall conform to the guidelines listed in appendix M.

3.25 Quick Release Devices:

1. All weight belts and scuba harnesses worn by the diver shall be equipped with quick release devices designed to permit jettisoning of entire gear.

2. The quick release device must operate easily with a single motion of either hand.

#### 3.26 Buoyancy Compensator:

1. Each diver shall have the capability of achieving and maintaining positive buoyancy;
2. must be equipped with an exhaust valve, an oral and a mechanical inflation device (low pressure inflator);
3. is required for variable volume dry suit scuba diving for ascent control and emergency flotation;
4. is not required for umbilical surface supplied diving.

#### 3.27 Submersible Pressure Gauge must be worn by each diver

#### 3.28 Regulators will consist of both a primary second stage and an alternate air source (e.g., an 'octopus' second stage or a redundant air supply)

#### 3.29 Scuba cylinders shall be designed, constructed, and maintained in accordance with the applicable provisions of the Unfired Pressure Vessel Safety Orders.

### **3.30 REQUIRED SUPPORT EQUIPMENT AT THE DIVE SITE**

#### 3.31 First Aid Supplies

1. First aid kit appropriate for the diving operation.
2. An approved emergency oxygen administration kit appropriate to the dive site.

#### 3.32 Warning Signals

One or more of the following is required, depending on the location of the dive site:

1. U.S. sport diver flag must be displayed at least 3 feet (1 m) in height above the surface for inshore and inland waterways (required by Massachusetts state law);
2. The international signal flag "Alpha" or shape signal (vertical black ball-diamond-ball) is required to be displayed in inshore waters from a vessel which cannot maneuver due to diving operations (U.S. Coast Guard) and in international waters or areas frequented by international ship traffic;
3. Lights (vertical red-white-red) are required to be displayed from a vessel supporting diving operations at night.

#### 3.33 Communication Devices for Summoning Emergency Assistance

1. May be required at the discretion of the DSO, depending on the reasonable estimate of distance or time from assistance, or the nature of the dive site environment (See Section 5.20).
2. Channel 16 (VHF frequency) is monitored by the USCG and upon notification, by the Institution.
3. CB band, Channel 9, may only be used with special permission (See Section 9.22).

4. Flares, lights, whistles, etc., may be required.

#### 3.34 Decompression Tables

1. A set of diving tables, approved by the DCB, must be available at the dive location.
2. Dive computers may be utilized in place of diving tables, and must be approved by the DCB.

#### 3.35 Emergency Assistance List

1. Telephone or radio call numbers appropriate to the dive location of the most accessible operational recompression chamber facility (if not available at the dive site);
2. Numbers and locations of available physicians and hospitals;
3. Available means of emergency transportation (Coast Guard, Emergency Medical Services (EMS));
4. Divers Alert Network Emergency Number (D.A.N.):  
(919) 684-9111  
Duke University Medical Center

#### 3.36 Woods Hole Oceanographic Institution Diving Safety Manual.

### 3.40 AUXILIARY EQUIPMENT

#### 3.41 Hand Held Underwater Power Tools.

1. Electrical tools and equipment used underwater shall be specifically approved for this purpose.
2. Electrical tools and equipment supplied with power from the surface shall be de-energized before being placed into or retrieved from the water. Hand held power tools shall not be supplied with power from the dive location until requested by the diver.

### 3.50 BREATHING MASKS AND HELMETS

1. Shall have a non-return valve at the attachment point between helmet or mask hose, which shall close readily and positively;
2. an exhaust valve;
3. a minimum ventilation rate capable of maintaining the diver at the depth to which he/she is diving.

### 3.60 EQUIPMENT MAINTENANCE

#### 3.61 Repair Technician/Facilities

All inspections (except divers' routine pre and post dive), tests and repairs referred to in this section shall be accomplished by a qualified technician or authorized dive shop or repair facility approved by the DSO.

#### 3.62 Scuba Regulators

Scuba regulators shall be inspected and tested prior to first use and every twelve months thereafter.

### 3.63 Scuba Cylinders & Other Refillable Compressed Gas Cylinders

1. shall be designed, constructed and maintained according to Department of Transportation (D.O.T.) regulations, including hydrostatic testing at intervals not exceeding 5 years;
2. shall be visually inspected both externally and internally prior to first use and at intervals not to exceed 12 months or whenever internal pressure has been reduced to ambient;
3. scuba cylinder valves shall be functionally tested at intervals not to exceed 12 months;
4. shall be inspected and tested prior to initial use and at intervals not to exceed 12 months thereafter.

### 3.64 Buoyancy Control Devices

shall be functionally inspected and tested at intervals not to exceed twelve months.

### 3.65 Recordkeeping

1. Each equipment modification, repair, test, calibration or maintenance service shall be logged, including the date, nature of the work performed, serial number and nomenclature of the item, and the name of the person or facility performing the work for the following equipment:
  - a. scuba regulators;
  - b. submersible pressure gauges;
  - c. depth gauges;
  - d. scuba cylinders;
  - e. cylinder valves;
  - f. diving helmets;
  - g. submersible breathing masks;
  - h. compressors;
  - i. gas control panels;
  - j. air storage cylinders;
  - k. air filtration systems;
  - l. analytical instruments
  - m. buoyancy control devices;
  - n. dry suits;
2. The DSO may require documentation of outsourced maintenance for the listed types of equipment used under Institution auspices, regardless of ownership.

### 3.70 AIR COMPRESSORS (FOR SUPPLYING BREATHING AIR)

#### 3.71 Design and Location

1. Low pressure compressors used to supply air to the diver if equipped with a volume tank shall have a check valve on the inlet side, a relief valve, and a drain valve.
2. Compressed air systems over 500 psig shall have slow-opening shut-off valves.
3. All air compressor intakes shall be located away from areas containing exhaust or other contaminants.

#### 3.72 Maintenance

1. Maintenance shall be performed by personnel authorized by the DSO in accordance with the manufacturer's specification.
2. Routine operation shall be performed only by personnel authorized by the DSO.
3. Gas analyses and air tests shall be performed on each breathing air compressor at regular intervals of no more than 100 hours of operation or six months, whichever occurs first. The results of these tests shall be entered in a formal log and be maintained.
4. A formal maintenance and operations log shall be maintained for each compressor showing operation, repair, overhaul, oil change, filter maintenance, temperature adjustment, results of gas analyses and air tests; each entry shall include name of operator/technician, date, cumulative run time, and a description of the procedure performed.

#### 3.73 Air Quality Standards

Breathing air for scuba shall meet the following specifications as set forth by the Compressed Gas Association (CGA Pamphlet G-7.1) and referenced in OSHA 29 CFR 1910.134

##### CGA Grade E

##### Component Maximum

Oxygen	20 - 22%/v
Carbon Monoxide	10 PPM/v
Carbon Dioxide	500 PPM/v
Condensed Hydrocarbons	5 mg/m <sup>3</sup>
Water Vapor	NS
Objectionable Odors	None

### 3.80 Oxygen Safety

#### 3.81 Equipment Design and Maintenance

Equipment used with pure oxygen or mixtures containing over forty percent (40%) by volume oxygen shall be designed and maintained for oxygen service;

### 3.82 Cleaning

Components exposed to pure oxygen or mixtures containing over forty percent (40%) by volume oxygen shall be cleaned for oxygen service before being placed into service.

## **3.90 BORROWING PRIVILEGES FOR INSTITUTION DIVERS**

### 3.91 Personal Equipment Requirements

Certified divers are expected to acquire their own wetsuit, fins, mask, snorkel, gloves, booties, hood, and weight belt, and are encouraged to purchase other personal scuba equipment as well. A limited inventory of equipment is available for loan from the Diving Locker.

### 3.92 Regulations

Institution owned diving equipment and/or facilities may be used by certified Institution divers for work, recertification or training during or outside of normal working hours, subject to the following regulations:

1. Permission from the DSO must be obtained prior to removing anything from the Diving Locker or Diving Office.
2. All safety and other regulations of this manual must be followed.
3. All borrowed equipment shall be properly logged out and in using forms supplied by the DSO, which shall include the borrower's name, phone number (extension), lab/office location and a list of all borrowed items, with serial or W.H.O.I. numbers, as applicable (such that the item can be identified).
4. Equipment must be maintained as outlined in Section 2.42 and returned on time.
5. Equipment and facilities shall be used entirely on the borrower's responsibility; the person signing shall be responsible for loss or damage, pre dive inspection, pre and post dive care, cleaning and proper stowage, and for tagging all malfunctioning or damaged equipment.
6. Equipment borrowed is for the specific use of the person signing and shall not be loaned to others without specific permission of the DSO.
7. Only currently certified Institution divers may use or borrow Diving Locker equipment unless specifically authorized by the DSO. Divers whose certifications have lapsed or have been revoked are prohibited from using Institution owned equipment or facilities until their certification has been reinstated (see Section 5.54)

**SECTION 4.00  
ENTRY LEVEL DIVER TRAINING**

**4.10 TRAINING POLICY**

4.11 Each dive team member shall have the training and/or experience necessary to perform tasks assigned in a safe and effective manner.

4.12 Institution diver training is limited to persons diving under Institution auspices. Non-Institution trainees may be admitted to the training program with permission of the DCB and the instructor.

**4.20 PREREQUISITES**

4.21 Application

To apply for diver training, the candidate shall fill out an application form provided by the DSO and route this for permission and signature to the project supervisor and Department Chairman. This application must include:

1. personal information and experience questionnaire;
2. a statement of the need for training;
3. signatures of the Project Supervisor, Department Chairman, Diving Safety Officer and Diving Control Board Chairman.

4.22 Medical Requirements

The applicant for training shall fill out a Medical History Questionnaire and shall be certified by a licensed physician to be medically qualified for diving before proceeding with the training as designated in Sec. 6.00 and Appendix G).

4.23 Age

Candidates younger than eighteen (18) years of age must present a consent form signed by his/her parent or legal guardian.

4.24 Waiver

The candidate must sign a waiver, release, and indemnity agreement.

4.25 Swimming Evaluation

Each candidate must demonstrate the following skills in a pool or confined water, without using fins, mask, snorkel or flotation device or exhibiting signs of unusual fatigue. Rest periods are allowed between tests, however, all should be completed within 90 minutes.

1. Swim underwater without swim aids for a distance of 25 yards (23 m) without surfacing.
2. Swim 400 yards (366 m) in 12 minutes or less without swim aids.
3. Tread water for 10 minutes.
4. Without the use of swim aids, transport another person of equal size a distance of 25 yards (23 m) in the water.

## 4.30 MINIMUM STANDARDS FOR SCUBA TRAINING

### 4.31 Standard of Evaluation

1. At the completion of training the candidate must demonstrate to the satisfaction of the DSO, through written examination(s) and physical performance, thorough knowledge and skill of the requirements of this section.
2. The candidate is not assured of certification merely by attending the course or even by completing all of the training requirements. The DSO will make a decision ("will this person make a safe and reliable diver?"), based on the candidate's total performance, judgment, attitude towards safety, and conformance to the standards of this section.
3. All certified Institution divers are expected to maintain the minimal fitness, knowledge and skill requirements of this section throughout their diving careers.

### 4.32 Pool (Confined Water) Training Requirements:

1. demonstrate safe entering and exiting of the water while wearing full scuba equipment using several techniques;
2. clear flooded face mask;
3. demonstrate air sharing, including both with a single mouthpiece ("buddy breathing") and with an alternate air source (e.g. "octopus") while submerged, both as donor and receiver, with and without a face mask;
4. demonstrate ability to alternate between snorkel and scuba while surface swimming;
5. correctly give and receive standard underwater signs and signals for divers;
6. swim efficiently with snorkel and fins, with and without face mask;
7. at the surface, with face submerged: breathe through snorkel while resting and swimming, and breathe through water in the snorkel without choking;
8. demonstrate proficiency with buoyancy including performing surface buoyancy checks, making necessary adjustments with weights and buoyancy compensator to achieve neutral buoyancy at diving depth, and orally inflating at the surface own and buddy's BC;
9. independent operational assembly, functional inspection, donning, adjustment, use, operational disassembly, and routine maintenance of all equipment used for open water scuba diving;
10. recover a passive simulated victim of an accident from a depth of 10 feet (3 m), administer simulated mouth-to-mouth resuscitation at the surface while towing, using an acceptable carry 50 yards (45 m) while continuing resuscitation;
11. remove and replace skin and scuba equipment while submerged; at the surface, remove and replace (in turn) masks, fins, weight belt;
12. swim underwater using scuba without a mask;
13. demonstrate skills necessary to make a controlled emergency swimming ascent;
14. relieve a simulated leg cramp from self and buddy;
15. demonstrate watermanship ability which is acceptable to the instructor.

#### 4.33 Written Examination

1. function, care, use and maintenance of diving equipment;
2. physics, physiology and medical qualifications as they relate to diving;
3. the Institution's diving regulations as outlined in this manual, and applicable governmental laws pertaining to diving, such as local, (town of Falmouth), state (Massachusetts), and federal (Coast Guard, OSHA);
4. diving environment: physical and biological aspects of the marine environment, with particular emphasis on the Southern New England area, including:
  - a. near shore currents and waves;
  - b. hazardous marine organisms;
  - c. aspects of freshwater and altitude diving;
5. emergency procedures, including out-of-air emergencies, self-rescue, rescue, buoyant ascent, ascent by air sharing, and activation of emergency medical system;
6. currently accepted "no decompression", repetitive "no decompression" and decompression procedures (air diving);
7. demonstrate proper use of dive tables and dive computers;
8. underwater communications;
9. hazards of breath-hold diving and ascents;
10. planning and supervision of diving operations;
11. diving hazards;
12. diving medicine: cause, symptoms, treatment and prevention of the following diving injuries: near drowning, pulmonary overpressure injuries (gas embolism, etc.), hypercapnia, squeezes, oxygen poisoning, nitrogen narcosis, exhaustion and panic, respiratory fatigue, motion sickness; decompression sickness, hypo- and hyperthermia, hypoxia/anoxia, and carbon monoxide poisoning

#### 4.34 Open Water Evaluation

1. surface dive to a depth of 10 feet (3 m) without scuba;
2. demonstrate proficiency in sharing air with a single mouthpiece ("buddy breathing") and with an alternate air source ("octopus" ) as both donor and receiver;
3. demonstrate proper entry and exit techniques representative of the Woods Hole area while wearing scuba gear, including shore, small boats, and pier ladders;
4. kick on the surface 400 yards (366 m) while wearing scuba gear, but not breathing from the scuba unit;
5. demonstrate sufficient skill, endurance and judgment at all times, both above and below the surface, for safe diving;

6. demonstrate, where appropriate, the ability to maneuver efficiently in the environment, at and below the surface;
7. perform a relaxed, controlled, simulated emergency ascent from a depth of 15-25 feet (5 - 8 m) using proper technique;
8. repeatedly flood and clear mask of water while breathing from scuba underwater; remove, replace and clear facemask;
9. repeatedly remove, replace, and clear regulator of water using two methods; regain a regulator which has fallen behind shoulder;
10. demonstrate the ability to use the buoyancy compensator, weight system, and breath control to make a controlled descent, achieve neutral buoyancy at any depth ("hovering"), make a controlled ascent, and achieve comfortable positive buoyancy at the surface;
11. demonstrate techniques of self-rescue and buddy rescue;
12. demonstrate proficiency in underwater navigation using compass and environmental navigation techniques;
13. at a depth of 15 to 20 feet (5 - 6 m), remove and replace scuba equipment as directed by the instructor;
14. plan and execute a dive;
15. calculate and record air consumption for self in P.S.I./minute (or similar units) using a submersible pressure gauge, depth gauge, and timing device. Demonstrate ability to use this data to plan a safe no-decompression dive leaving adequate air for descent, time at depth, ascent, safety stop and safety margin;
16. successfully complete a minimum of eight (8) open water ocean scuba dives for a minimum cumulative underwater time of 160 minutes and one open water skin dive accompanied by the DSO or a qualified instructor designated by the DSO. No more than 3 training dives may be made in any one day.

**SECTION 5.00  
SCIENTIFIC DIVER CERTIFICATION**

**5.10 REQUIREMENTS FOR SCIENTIFIC DIVER CERTIFICATION**

5.11 Eligibility

Only a person diving under the auspices of an organization that subscribes to the practices of the AAUS is eligible for a scientific diver certification.

5.12 Provisional Scuba Permit (Diver-in-Training)

1. Upon satisfactory completion of the requirements outlined in section 4.20 and the entry-level scuba training course outlined in section 4.30 the candidate will be issued a Provisional scuba Diver Permit.
2. The diver-in-training status is not regarded as a certification for Institution purposes: the trainee may not be lead diver.
3. A permit holder is authorized to continue his/her training through working dives or others at the discretion of the DSO.
4. The depth limit is 40 feet (12 m) without specific authorization from the DSO.
5. The permit holder must be accompanied on all dives by a person certified to 40 feet (12 m) or greater.

5.13 Documents

1. Application (Section 4.21)
2. Medical Approval (Section 4.22)
3. Waiver (Section 4.24)

5.14 Training

1. Emergency Care Training
  - a. Cardiopulmonary Resuscitation (CPR) equivalent to the American Heart Association Heartsaver course given by the Institution Safety Office;
  - b. Standard First Aid equivalent to the National Safety Council Advanced course given by the Institution Safety Office;
  - c. Emergency Oxygen Administration equivalent to the Divers Alert Network Oxygen Administration Course given by the Institution Safety Office;
2. The diver must complete additional theoretical aspects and practical training beyond the diver-in-training permit level for a minimum cumulative time of 100 hours. At the discretion of the DSO, mentorship and/or home study may be substituted for formal coursework.
  - a. Theoretical aspects shall include emergency care training (5.13.1) and principles and activities appropriate to the intended area of scientific study.
  - b. Practical training shall include additional supervised ocean or open water dives beyond the Diver-in-Training level, in a variety of dive sites and differing diving conditions, for a cumulative total of 12 dives for a cumulative total in-water time of approximately 6 hours.

Dives made in connection with section 4.34 may count toward the 12-dive total. No more than 3 of these dives shall be made in one day.

## **5.20 DEPTH CERTIFICATIONS**

### **5.21 Certification Advancement**

1. Certification advancement is based on accumulation of supervised diving experience and training at progressively deeper depths, and the recommendation of the DSO.
2. For the purpose of certification advancement or recertification, dives are defined as a water entry, an underwater working or training activity breathing compressed air (scuba or surface-supplied) for a minimum average time of twenty (20) minutes, and an exit from the water.
3. Dive durations may be shorter for the 100 foot (30 m) and 130 foot (40 m) depth levels or in extreme environmental conditions in order to stay within the no decompression limits.
4. No more than three (3) dives per day may be credited toward certification advancement or recertification. There must be a surface interval of at least ten minutes between dives.

### **5.22 Forty (40) Foot Depth Certification**

1. A diver holding a Provisional Permit who has completed the requirements of Section 5.10 may be eligible to advance to a 40 foot certification.
2. A 40 foot certified diver may dive to depths not exceeding 40 feet, accompanied by any Institution certified diver or permit holder, and may act as lead diver.
3. Forty feet may be exceeded to a maximum depth of 70 feet (21 m) provided that the diver is accompanied and supervised by a diver certified to at least 70 feet.

### **5.23 Seventy (70) Foot Depth Certification**

1. A diver holding a 40 foot certification who has completed a cumulative, supervised underwater time of 4 hours at depths between 41 and 70 feet in a minimum of 12 satisfactory logged open water dives, including at least one dive to a depth of 70 feet, may be eligible to advance to the 70 foot certification level.
2. A 70 foot certified diver may dive to depths not exceeding 70 feet accompanied by an Institution diver certified to the appropriate depth, and may act as lead diver.
3. A 70 foot diver may exceed 70 feet to a maximum depth of 100 feet (30 m) provided that he/she is accompanied and supervised by a diver certified to at least 100 feet.

### **5.24 One Hundred (100) Foot Depth Certification**

1. A diver holding a 70 foot certification who has completed a cumulative supervised time of 1 hour at depths between 71 and 100 feet in a minimum of 4 satisfactory logged open water dives, including at least one dive to a depth of 100 feet, may be eligible to advance to a 100 foot certification.
2. A 100 foot certified diver may dive to depths not exceeding 100 feet accompanied by a diver certified to 70 feet and greater.
3. A 100 foot diver may exceed 100 feet to a maximum depth of 130 feet (40 m) provided that he/she is accompanied by a diver certified to 130 feet.

#### 5.25 One Hundred Thirty (130) Foot Depth Certification

1. A diver holding a 100 foot certification who has completed and logged at least 4 supervised, satisfactory open water dives between 101 and 130 feet, including at least one dive to a depth of 130 feet, may be eligible to advance to a 130 foot certification.
2. The diver must demonstrate a thorough knowledge of the special problems and safety requirements associated with deep diving.
3. A 130 foot diver may dive to depths not exceeding 130 feet accompanied by a diver certified to at least 100 feet.

#### 5.26 Dives in Excess of 130 Feet

1. Dives in excess of 130 feet require specific authorization from the DCB.
2. Authorization is granted only to those highly qualified individuals who have a specific need to dive beyond 130 feet.
3. The diver must demonstrate a thorough knowledge of the special problems and safety requirements associated with deep diving.
4. Diving is not permitted beyond a depth of 190 feet.

#### 5.27 Exceptions to the Depth Limitation

1. Provisional Permit holders may exceed 40 feet only with specific permission of the DSO.
  - a. A statement of need must be submitted to the DSO with the dive plan.
  - b. The Permit holder must have logged at least 5 open water scuba dives and have exhibited adequate judgment and ability.
  - c. The permit holder must be accompanied by the DSO or another highly experienced certified diver appointed by the DSO.
  - d. This waiver is limited to the specific purpose requested.
2. Certified divers may exceed their maximum limit only with specific permission of the DSO.
  - a. Parts a, b, and c of section 5.18 - 1. shall apply.
3. Divers shall not exceed the limit of the next greater certification.
4. In an extreme emergency (life or death situation) divers of all levels are permitted to exceed their depth certification to render assistance. A written detailed report of the incident must be submitted to the DSO and DCB as soon as possible after the event.

### **5.30 CERTIFICATION PROCEDURE FOR CANDIDATES WITH PREVIOUS DIVING EXPERIENCE**

#### 5.31 Minimum Eligibility Requirements

1. Previous training through a nationally or internationally recognized diver training agency which meets or exceeds the course requirements of Section 4.0.
2. Recent diving experience: at least 24 open water dives logged within two years of commencement of evaluation. At least 6 of these dives shall have been performed in marine environmental conditions similar to the Woods Hole area.

3. Candidates will be rejected from evaluation if training, diving experience, and documentation are not satisfactory to the DSO.

#### 5.32 Evaluation Procedure for Experienced Candidates

1. If the applicant has limited experience (i.e. <24 dives), or has no diving experience in cold water (50 degrees F.), then the applicant should enroll in the basic WHOI Scientific Diving Class Diving. This course satisfies the requirements for WHOI Scientific Diver Certification. If the applicant meets the criteria above, then the following steps must be completed:
2. Complete the requirements specified in Sections 5.12 and 5.13.
3. Submit a certificate of training ("C-card") from a nationally or internationally recognized diver training agency (e.g., NAUI, PADI, YMCA)
4. Submit a log book of diving activity.
5. The standard evaluation procedure is as follows:
  - a. attend a class on Institution scientific diving regulations, procedures, and local diving conditions;
  - b. examination of personal equipment;
  - c. pool evaluation: May be required depending on experience. The candidate should be prepared to demonstrate any of the swim evaluation or pool skills outlined in Sections 4.25 and 4.32);
  - d. pass a written examination as outlined in section 4.33;
  - e. successfully complete the open water skill evaluation as outlined in section 4.34.

#### 5.33 Certification Level Assignment

1. Upon completion of the evaluation procedure of section 3.22, the DSO will assign a status based on the candidate's prior training, experience (log book review of past two years), performance during evaluation, and conformance to the standard outlined in section 4.30.
2. The candidate may:
  - a. be certified to a depth level;
  - b. not be certified but be placed in a class for further training;
  - c. be rejected for diving duty.

#### 5.34 Reciprocity with American Academy of Underwater Sciences Accredited Diving Programs

1. Two or more AAUS Organizational Members engaged jointly in diving activities, or engaged jointly in the use of diving resources, shall designate one of the participating Diving Control Boards to govern the joint dive project.
2. For purposes of reciprocity, an AAUS Diver-in-Training with less than 12 open water dives is equivalent to a Provisional Permit, an AAUS 30 foot diver who has logged 12 open water dives is equivalent to a 40 foot level, and an AAUS 60 foot diver who has logged 24 open water dives is equivalent to a 70 foot level.

3. A scientific diver from one Organizational Member shall apply for permission to dive under the auspices of another Organizational Member by submitting to the Diving Safety Officer of the host Organizational Member a document containing all the information described in Appendix J. (letter of reciprocity) signed by the Diving Safety Officer or Chairperson of the home Diving Control Board.
4. The DSO may require attendance at a class on Institution regulations and local diving conditions and/or one or more local orientation dives.
5. A visiting scientific diver may be asked to demonstrate his/her knowledge and skills for the planned diving. An example of items to be demonstrated is presented in Appendix K (checkout dive).
6. If a host Organizational Member denies a visiting scientific diver permission to dive, The host DCB shall notify the visiting scientific diver and his/her DCB with an explanation of all reasons for the denial.

#### 5.35 Temporary Diving Permit

1. A temporary diving permit may be issued at the discretion of the DSO in cases where it may be deemed impractical to issue a permanent diving certificate. This permit may be issued to:
  - a. authorized visitors whose diving participation in a research project has been requested by the Principal Investigator;
  - b. part time or temporary Institution employees or students.
2. A statement of the temporary diver's qualifications and supporting documentation shall be submitted to the DSO as part of the dive or cruise plan.
3. The temporary permit shall be restricted to the planned diving operation.

#### 5.36 Waiver of Specific Requirements for Special Circumstances/Urgent Needs

1. At the discretion of the DSO, specific Experienced Diver Evaluation Procedure requirements may be waived for very experienced divers. The requirements for medical examination, application form, training/experience documentation, "Release and Waiver," and at least one evaluation/orientation dive with the DSO or his designate shall not be waived.
2. Divers without current CPR and/or first aid certification may receive a temporary waiver, subject to the following restrictions:
  - a. There must be 2 other persons at the dive site who do possess current certification.
  - b. The waiver will expire at the next available Institution CPR/First Responder course or, for temporary permits, at the end of the planned diving operation.

### 5.40 MAINTENANCE OF CERTIFICATION

#### 5.41 Term of Certification

Initial certification shall commence from the date of issue. Continuing certification shall commence on January 1 and expire on December 31 of each year.

#### 5.42 Minimum Diving Activity

1. All divers are required to perform and log at least 12 open water dives during their 12-month term of certification.

2. At least one dive must be logged near the maximum depth of the diver's certification during each 6 month period. Divers certified to 150 feet or deeper may satisfy these requirements with dives to 130 feet or over.
3. Dives for recertification shall comply with the requirements outlined in section 5.12, except that chamber or recreational dives may be accepted at the discretion of the DSO.

#### 5.43 Medical Examination

All certified scientific divers shall pass an initial medical examination and thereafter maintain current reexamination at the intervals specified in Section 6.12. After each major illness or injury, as described in Sec. 6.12, a certified scientific diver shall receive clearance to return to diving from a physician before resuming diving activities.

#### 5.44 Other Recertification Requirements

1. Current qualification in first aid and cardiopulmonary resuscitation shall be maintained.
  - a. After initial qualification, a CPR refresher shall be completed during the next calendar year. Thereafter CPR shall be refreshed every 2 years, alternating with Oxygen Administration.
  - b. Oxygen Administration shall be requalified every 2 years, on alternating years with CPR.
  - c. First Aid shall be requalified every 3 years.
2. Periodic demonstration of swimming proficiency, knowledge or skill of selected diving related subjects, or attendance at a training seminar may be required.

#### 5.45 Requalification of Depth Certificate

Divers who have met all the recertification requirements of this section by the expiration date of their diving certification will be requalified at their current certification level.

### **5.50 SUSPENSION, RESTRICTION, AND REVOCATION OF CERTIFICATION**

#### 5.51 Cause

1. A diving certification or permit may be revoked for cause by the DSO or the DCB. Cause may include, but not be limited to:
  - a. failure to demonstrate adequate judgment for safe diving;
  - b. violations of Institution diving regulations or negligence of diving safety procedures;
  - c. violations of federal, state, or local laws pertaining to diving or fish and game regulations while diving;
  - d. theft or gross mistreatment of Institution owned diving equipment;
  - e. failure to meet minimum medical requirements, expiration of medical exam, CPR or first aid;
  - f. failure to meet the minimum level of diving activity, fitness, or proficiency as set forth in sections 4.0 and 5.0.

5.52 Procedure for Suspension, Restriction, or Revocation

1. The DSO shall inform the diver in writing of the reason(s).
2. The diver shall be given the opportunity to appeal in writing to the DCB for reconsideration or recertification.
3. All such written statements and requests, as identified in this section, are formal documents which will become part of the diver's file.

5.53 Consequences of Suspension, Restriction, or Revocation

If a diver's certification expires or is revoked, he/she is prohibited from:

1. diving under the auspices of the Institution;
2. using Institution owned diving equipment or facilities.
3. diving under the auspices of another AAUS organizational member under reciprocity agreement.

5.54 Recertification After Expiration or Revocation

The exact procedure will vary depending upon such factors as the cause for revocation, the diver's activity level, the length of time since the last dive, etc. Recertification may be at the previous or reduced level after complying with such conditions as the DSO or DCB may impose.

## **SECTION 6.00 MEDICAL STANDARDS**

### **6.10 MEDICAL REQUIREMENTS**

#### 6.11 General

1. All certified divers, trainees and candidates who are exposed to hyperbaric conditions shall have passed a current medical examination and have been declared by the examining physician to be fit to engage in diving activities as may be limited or restricted in the medical evaluation report.
2. All medical evaluations required by this standard shall be performed by, or under the direction of, a licensed physician of the applicant-diver's choice, preferably one trained in diving/undersea medicine.
3. The diver should be free of any chronic disabling disease and be free of any conditions contained in the list of conditions for which restrictions from diving are generally recommended. (Appendix G)

#### 6.12 Frequency of Medical Evaluations

Medical evaluation shall be completed:

1. before a diver may begin diving, unless an equivalent initial medical evaluation has been given within the preceding 5 years (3 years if over the age of 40, 2 years if over the age of 60), the DSO has obtained the results of that examination, and those results have been reviewed and found satisfactory by the DSO or DCB.
2. thereafter, at five year intervals up to age 40, every three years after the age of 40, and every two years after the age of 60.
3. Clearance to return to diving must be obtained from a physician following any major injury or illness, or any condition requiring hospital care. If the injury or illness is pressure related then the clearance to return to diving must come from a physician trained in diving medicine.

#### 6.13 Information Provided Examining Physician

A copy of the medical evaluation requirements of this standard shall be provided to the examining physician. (Appendix G).

#### 6.14 Content of Medical Evaluations

Medical examinations conducted initially and at the intervals specified in section 6.12 shall consist of the following:

1. Applicant agreement for release of medical information to the Diving Safety Officer and the DCB (See Appendix G).
2. Medical history (See Appendix G)
3. Diving physical examination (Section 6.15 and Appendix G).

#### 6.15 Conditions Which May Disqualify Candidates From Diving (Adapted from Bove, 1998)

1. Abnormalities of the tympanic membrane, such as perforation, presence of a monomeric membrane, or inability to autoinflate the middle ears.
2. Vertigo including Meniere's Disease.

3. Stapedectomy or middle ear reconstructive surgery.
4. Recent ocular surgery.
5. Psychiatric disorders including claustrophobia, suicidal ideation, psychosis, anxiety states, untreated depression.
6. Substance abuse, including alcohol.
7. Episodic loss of consciousness.
8. History of seizure.
9. History of stroke or a fixed neurological deficit.
10. Recurring neurologic disorders, including transient ischemic attacks.
11. History of intracranial aneurysm, other vascular malformation or intracranial hemorrhage.
12. History of neurological decompression illness with residual deficit.
13. Head injury with sequelae.
14. Hematologic disorders including coagulopathies.
15. Evidence of coronary artery disease or high risk for coronary artery disease.
16. Atrial septal defects.
17. Significant valvular heart disease - isolated mitral valve prolapse is not disqualifying.
18. Significant cardiac rhythm or conduction abnormalities.
19. Implanted cardiac pacemakers and cardiac defibrillators (ICD).
20. Inadequate exercise tolerance.
21. Severe hypertension.
22. History of spontaneous or traumatic pneumothorax.
23. Asthma.
24. Chronic pulmonary disease, including radiographic evidence of pulmonary blebs, bullae, or cysts.
25. Diabetes mellitus.
26. Pregnancy.

#### 6.16 Laboratory Requirements for Diving Medical Examination and Intervals.

1. Initial examination under age forty:

- \*Medical History
- \*Complete Physical Exam, emphasis on neurological and otological components
- \*Chest X-ray
- \*Spirometry
- \*Hematocrit or Hemoglobin
- \*Urinalysis
- \*Any further tests deemed necessary by the physician

2. Periodic re-examination under age 40 (every 5 years)

- \*Medical History
- \*Complete Physical Exam, emphasis on neurological and otological components
- \*Hematocrit or Hemoglobin
- \*Urinalysis
- \*Any further tests deemed necessary by the physician

3. Initial exam over age 40:

- \*Medical History
- \*Complete Physical Exam, emphasis on neurological and otological components
- \*Assessment of coronary artery disease using Multiple-Risk-Factor Assessment<sup>1</sup> (age, lipid profile, blood pressure, diabetic screening, smoker)
- \*Resting EKG
- \*Chest X-ray
- \*Spirometry
- \*Hematocrit or Hemoglobin
- \*Urinalysis

- \*Any further tests deemed necessary by the physician
- \*Exercise stress testing may be indicated based on risk factor assessment.<sup>2</sup>

4. Periodic re-examination over age 40 (every 3 years); over age 60 (every two years):

- \*Medical History
- \*Complete Physical Exam, emphasis on neurological and otological components
- \*Assessment of coronary artery disease using Multiple-Risk-Factor Assessment<sup>1</sup> (age, lipid profile, blood pressure, diabetic screening, smoker)
- \*Resting EKG
- \*Hematocrit or Hemoglobin
- \*Urinalysis
- \*Any further tests deemed necessary by the physician
- \*Exercise stress testing may be indicated based on risk factor assessment.<sup>2</sup>

## 6.20 MEDICAL EXAMINATION PROCEDURES

6.21 The diver shall provide the physician with the Woods Hole Oceanographic Institution Diving Medical Questionnaire & Health History and Physician's Report of Diving Medical Examination forms (Appendix G).

6.22 The physician will complete his/her examination and submit the results and evaluation to the individual diver, who will review the form for completeness and forward the original to the DSO for his review and retention in the diver's file. This written report shall contain the examining physician's opinion of the individual's fitness to dive, including any recommended restrictions or limitations. It is strongly recommended that the diver make a copy for his/her personal files.

6.23 Completed forms must be received by the DSO in order to fulfill the medical examination requirement. Medical approval will not be accepted if the forms are incomplete or incorrect (e.g., missing or false information, missing signatures, failure to complete all of the tests required in 6.16).

6.24 The diver or the project for which the diver is working will be responsible for paying all costs associated with the medical examination.

<sup>1</sup>"Assessment of Cardiovascular Risk by Use of Multiple-Risk-Factor Equations." Grundy et al. 1999. AHA/ACC Scientific Statement. <http://www.acc.org/clinical/consensus/risk/risk1999.pdf>

<sup>2</sup> Gibbons RJ, et al. ACC/AHA Guidelines for Exercise Testing. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing). Journal of the American College of Cardiology. 30:260-311, 1997. <http://www.acc.org/clinical/guidelines/exercise.pdf>

## **SECTION 7.00 NITROX DIVING GUIDELINES**

Nitrox is defined for these guidelines as breathing mixtures composed predominately of nitrogen and oxygen, most commonly produced by the addition of oxygen or the removal of nitrogen from air.

### **7.10 PREREQUISITES**

#### 7.11 Eligibility

Only a certified Scientific Diver or Scientific Diver in Training (Sections 4.00 and 5.00) diving under the auspices of the Institution is eligible for authorization to use nitrox. After completion, review and acceptance of application materials, training and qualification as per Sec. 7.12 of these guidelines, an applicant will be authorized to use nitrox within his/her depth authorization, as specified in Section 5.2.

#### 7.12 Application and Documentation

Application and documentation for authorization to use nitrox should be made on forms specified by the Diving Control Board.

### **7.20 REQUIREMENTS FOR AUTHORIZATION TO USE NITROX**

Submission of documents and participation in aptitude examinations does not automatically result in authorization to use nitrox. The applicant must convince the DSO and members of the DCB that he/she is sufficiently skilled and proficient. The signature of the DSO on the authorization form will acknowledge authorization. After completion of training and evaluation, authorization to use nitrox may be denied to any diver to any diver who does not demonstrate to the satisfaction of the DSO or DCB the appropriate judgment or proficiency to ensure the safety of the diver and dive buddy.

Prior to authorization to use nitrox, the following minimum requirements should be met:

#### 7.21 Training

The diver must complete additional theoretical and practical training beyond the Scientific Diver In Training air certification level, to the satisfaction of the DSO and DCB (Section 5.13).

#### 7.22 Examinations

Each diver should demonstrate proficiency in skills and theory in written, oral, and practical examinations covering:

1. Written examinations covering the information presented in the classroom training session(s) (i.e., gas theory, oxygen toxicity, partial pressure determination, etc.);
2. Practical examinations covering the information presented in the practical training session(s) (i.e., gas analysis, documentation procedures, etc.);
3. Openwater checkout dives, to appropriate depths, to demonstrate the application of theoretical and practical skills learned.

#### 7.23 Minimum Activity to Maintain Authorization

The diver should log at least one (1) nitrox dive per year. Failure to meet the minimum activity level may be cause for restriction or revocation of nitrox authorization.

## 7.30 NITROX TRAINING GUIDELINES

Training in these guidelines should be in addition to training for Diver-In-Training (AAUS Standards Sec. 4.00). It may be included as part of training to satisfy the Scientific Diver training requirements (Section 5.13).

### 7.31 Classroom Instruction

1. Topics should include, but are not limited to: review of previous training; physical gas laws pertaining to nitrox; partial pressure calculations and limits; equivalent air depth (EAD) concept and calculations; oxygen physiology and oxygen toxicity; calculation of oxygen exposure and maximum safe operating depth (MOD); determination of decompression schedules (both by EAD method using approved air dive tables, and using approved nitrox dive tables); dive planning and emergency procedures; mixing procedures and calculations; gas analysis; personnel requirements; equipment marking and maintenance requirements; dive station requirements.
2. The DCB may choose to limit standard nitrox diver training to procedures applicable to diving, and subsequently reserve training such as nitrox production methods, oxygen cleaning, and dive station topics to divers requiring specialized authorization in these areas.

### 7.32 Practical Training

The practical training portion will consist of a review of skills as stated for scuba (Section 4.00, with additional training as follows:

1. Oxygen analysis of nitrox mixtures;
2. Determination of MOD, oxygen partial pressure exposure, and oxygen toxicity time limits, for various nitrox mixtures at various depths;
3. Determination of nitrogen-based dive limits status by EAD method using air dive tables, and/or using nitrox dive tables, as approved by the DCB;
4. Nitrox dive computer use may be included, as approved by the DCB.

### 7.33 Written Examination (based on classroom instruction and practical training)

Before authorization, the trainee should successfully pass a written examination demonstrating knowledge of at least the following:

1. Function, care, use, and maintenance of equipment cleaned for nitrogen use;
2. Physical and physiological considerations of nitrox diving (e.g. O<sub>2</sub> and CO<sub>2</sub> toxicity);
3. Diving regulations and procedures as related to nitrox diving, either scuba or surface-supplied (depending on intended mode);
4. Given the proper information, calculation of:
  - a. Equivalent air depth (EAD) for a given fO<sub>2</sub> and actual depth;
  - b. PO<sub>2</sub> exposure for a given fO<sub>2</sub> and depth;
  - c. Optimal nitrox mixture for a given pO<sub>2</sub> exposure limit and planned depth;
  - d. Maximum operational depth (MOD) for a given mix and pO<sub>2</sub> exposure limit;

- e. For nitrox production purposes, percentages/p.s.i. of oxygen present in a given mixture, and p.s.i. of each gas required to produce a  $fO_2$  by partial pressure mixing.
5. Decompression table and dive computer selection and usage;
6. Nitrox production methods and considerations;
7. Oxygen analysis;
8. Nitrox operational guidelines (Section 7.40), dive planning, and dive station components.

#### 7.34 Openwater Dives

A minimum of two supervised openwater dives using nitrox is required for authorization. The mode used in the dives should correspond to the intended application (i.e., scuba or surface-supplied). If the MOD for the mix being used can be exceeded at the training location, direct, in-water supervision is required.

#### 7.35 Surface-Supplied Training

All training as applied to surface-supplied diving (practical, classroom, and openwater) will follow the Institution's surface-supplied diving standards, including additions listed in Sec. 7.21 and 7.22.

### 7.40 SCIENTIFIC NITROX DIVING REGULATIONS

#### 7.41 Dive Personnel Requirements

1. Nitrox Diver In Training - A Diver In Training, who has completed the requirements of AAUS Standards Section 4.00 and the training and authorization sections of these guidelines, may be authorized by the DSO to use nitrox under the direct supervision a Scientific Diver who also holds nitrox authorization. Dive depths should be restricted to those specified in the diver's authorization.
2. Scientific Diver - A Scientific Diver who has completed the requirements of AAUS Standards Section 5.00 and the training and authorization sections of these guidelines, may be authorized by the DSO to use nitrox. Depth authorization to use nitrox should be the same as those specified in the diver's authorization, as described in AAUS Sec. 5.20.
3. Lead Diver - On any dive during which nitrox will be used by any team member, the Lead Diver should be authorized to use nitrox, and hold appropriate authorizations required for the dive, as specified in AAUS Standards. Lead Diver authorization for nitrox dives by the DSO and/or DCB should occur as part of the dive plan approval process.
4. In addition to responsibilities listed in AAUS Section 1.26, the Lead diver should:
  - a. As part of the dive planning process, verify that all divers using nitrox on a dive are properly qualified and authorized;
  - b. As part of the pre-dive procedures, confirm with each diver the nitrox mixture the diver is using, and establish dive team maximum depth and time limits, according to the shortest time limit or shallowest depth limit among the team members.
  - c. The Lead Diver should also reduce the maximum allowable  $pO_2$  exposure limit for the dive team if on-site conditions so indicate (see Sec. 7.42.1.a)

## 7.42 Dive Parameters

### 1. Oxygen Exposure Limits

- a. The inspired oxygen partial pressure experienced at depth should not exceed 1.6 ATA. All dives performed using nitrox breathing mixtures should comply with the current NOAA Diving Manual "Oxygen Partial Pressure Limits for 'Normal' Exposures"
- b. The maximum allowable exposure limit should be reduced in cases where cold or strenuous dive conditions, or extended exposure times are expected. The DCB should consider this in the review of any dive plan application which proposes to use nitrox. The Lead Diver should also review on-site conditions and reduce the allowable pO<sub>2</sub> exposure limits if conditions indicate.
- c. If using the equivalent air depth (EAD) method the maximum depth of a dive should be based on the oxygen partial pressure for the specific nitrox breathing mix to be used.

### 2. Bottom Time Limits

- a. Maximum bottom time should be based on the depth of the dive and the nitrox mixture being used.
- b. Bottom time for a single dive should not exceed the NOAA maximum allowable "Single Exposure Limit" for a given oxygen partial pressure, as listed in the current NOAA Diving Manual.

### 3. Decompression Tables and Gases

- a. A set of DCB approved nitrox decompression tables should be available at the dive site.
- b. When using the equivalent air depth (EAD) method, dives should be conducted using air decompression tables approved by the DCB.
- c. If nitrox is used to increase the safety margin of air-based dive tables, the MOD and oxygen exposure and time limits for the nitrox mixture being dived should not be exceeded.
- d. Breathing mixtures used while performing in-water decompression, or for bailout purposes, should contain the same or greater oxygen content as that being used during the dive, within the confines of depth limitations of section 7.31 and the oxygen partial pressure limits set forth in Sec. 7.32.

### 4. Nitrox Dive Computers

- a. Dive Computers may be used to compute decompression status during nitrox dives. Manufacturers' guidelines and operations instructions should be followed.
- b. Use of Nitrox dive computers should comply with dive computer guidelines included in the AAUS Standards (Appendix M).
- c. Nitrox Dive computer users should demonstrate a clear understanding of the display, operations, and manipulation of the unit being used for nitrox diving prior to using the computer, to the satisfaction of the DSO or his/her designee
- d. If nitrox is used to increase the safety margin of an air-based dive computer, the MOD and oxygen exposure and time limits for the nitrox mixture being dived should not be exceeded.

- e. Dive computers capable of pO<sub>2</sub> limit and fO<sub>2</sub> adjustment should be checked by the diver prior to the start each dive to assure compatibility with the mix being used.

## 5. Repetitive Diving

- a. Repetitive dives using nitrox mixtures should be performed in compliance with procedures required of the specific dive tables used.
- b. Residual nitrogen time should be based on the EAD for the specific nitrox mixture to be used on the repetitive dive, and not that of the previous dive.
- c. The total cumulative exposure (bottom time) to a partial pressure of oxygen in a given 24 hour period should not exceed the current NOAA Diving Manual 24-hour Oxygen Partial Pressure Limits for "Normal" Exposures.
- d. When repetitive dives expose divers to different oxygen partial pressures from dive to dive, divers should account for accumulated oxygen exposure from previous dives when determining acceptable exposures for repetitive dives. Both acute (CNS) and chronic (pulmonary) oxygen toxicity concerns should be addressed.

## 7.43 Oxygen Parameters

- 1. Authorized Mixtures - Mixtures meeting the criteria outlined in Sec. 7.42.1 may be used for nitrox diving operations, upon approval of the DCB.

### 2. Purity

- a. Oxygen used for mixing nitrox breathing gas should meet the purity levels for "Medical Grade" (U.S.P.) or "Aviator Grade" standards.
- b. In addition to the AAUS Air Purity Guidelines (AAUS Sec. 3.73), the following standard should be met for breathing air that is either

(1) placed in contact with oxygen concentrations greater than 40%, or

(2) used in nitrox production by the partial pressure mixing method with gas mixtures containing greater than 40% oxygen as the enriching agent:

Air Purity:	CGA Grade E (AAUS Sec. 3.73)
Condensed Hydrocarbons:	5 mg/m <sup>2</sup>
Hydrocarbon Contaminants:	No greater than 0.1 mg/m <sup>3</sup>

## 7.44 Gas Mixing and Analysis

### 1. Personnel Requirements

- a. Individuals responsible for producing and/or analyzing nitrox mixtures should be knowledgeable and experienced in all aspects of the technique.
- b. Only those individuals approved by the DSO and/or DCB should be responsible for mixing and/or analyzing nitrox mixtures.

### 2. Production Methods

It is the responsibility of the DCB to approve the specific nitrox production method used.

### 3 . Analysis Verification by User

- a. It is the responsibility of each diver to analyze prior to the dive the oxygen content of his/her scuba cylinder and acknowledge in writing the following information for each cylinder: fO<sub>2</sub>, MOD, cylinder pressure, date of analysis, and user's name.
- b. Individual dive log reporting forms should report fO<sub>2</sub> of nitrox used, if different than 21%.

## 7.50 NITROX DIVING EQUIPMENT

All of the designated equipment and stated requirements regarding scuba equipment required in the AAUS Standards should apply to nitrox scuba operations. Additional minimal equipment necessary for nitrox diving operations includes:

- a. Labeled SCUBA Cylinders
- b. Oxygen Analyzers

### 7.51 Oxygen Cleaning and Maintenance Requirements

#### 1. Requirement for Oxygen Service

- a. All equipment which during the dive or cylinder filling process is exposed to concentrations greater than 40% oxygen at pressures above 150 p.s.i. should be cleaned and maintained for oxygen service.
- b. Equipment used with oxygen or mixtures containing over forty percent (40%) by volume oxygen shall be designed and maintained for oxygen service.

#### 2. Oxygen systems over 125 psig shall have slow-opening shut-off valves.

This should include the following equipment: scuba cylinders, cylinder valves, scuba and other regulators, cylinder pressure gauges, hoses, diver support equipment, compressors, and fill station components and plumbing.

### 7.52 Scuba Cylinder Identification Marking

Scuba cylinders to be used with nitrox mixtures should have the following identification documentation affixed to the cylinder.

1. Cylinders should be marked "NITROX", or "EANx", or "Enriched Air"
2. Nitrox identification color-coding should include a 4-inch wide green band around the cylinder, starting immediately below the shoulder curvature. If the cylinder is not yellow in, the green band should be bordered above and below by a 1-inch yellow band.
3. The alternate marking of a yellow cylinder by painting the cylinder crown green and printing the word "NITROX" parallel to the length of the cylinder in green print is acceptable.
4. Other markings which identify the cylinder as containing gas mixes other than air may be used as the approval of the DCB.
5. A contents label should be affixed, to include the current fO<sub>2</sub>, date of analysis, and MOD.
6. The cylinder should be labeled to indicate whether the cylinder is prepared for oxygen or nitrox mixtures containing greater than 40% oxygen.

### 7.53 Regulators

Regulators to be used with nitrox mixtures containing greater than 40% oxygen should be cleaned and maintained for oxygen service, and marked in an identifying manner.

### 7.54 Other Support Equipment

1. An oxygen analyzer is required which is capable of determining the oxygen content in the scuba cylinder. Two analyzers are recommended to reduce the likelihood of errors due to a faulty analyzer. The analyzer should be capable of reading a scale of 0 to 100% oxygen, within (one) 1% accuracy.
2. All diver and support equipment should be suitable for the  $fO_2$  being used.

### 7.55 Compressor and Fill Station

1. Compressor system
  - a. The compressor/filtration system MUST produce oil-free air.
  - b. An oil-lubricated compressor placed in service for a nitrox system should be checked for oil and hydrocarbon contamination at least quarterly.
2. Fill Station Components - All components of a nitrox fill station which will contact nitrox mixtures containing greater than 40% oxygen should be cleaned and maintained for oxygen service. This includes cylinders, whips, gauges, valves, and connecting lines.

## **SECTION 8.00 OTHER DIVING TECHNOLOGY**

Certain types of diving, some of which are listed below, require equipment or procedures which require training additional to basic scientific diver certification. Divers shall comply with all scuba diving procedures in this manual unless specified.

### **8.10 STAGED DECOMPRESSION DIVING**

#### 8.11 Authorization

No diver shall plan or conduct staged decompression dives without prior approval of the Diving Control Board.

#### 8.12 Training

1. Authorization is granted only to those highly qualified individuals who have a specific need for decompression diving.
2. The candidate must demonstrate, by passing a written examination, a thorough knowledge of the specific decompression tables or dive computers, and the decompression procedures which will be used, and the recognition of and first aid for decompression sickness.
3. The candidate must be certified for the planned depth of the operation.
4. The candidate must plan and carry out, under supervision of the DSO or his designee, a minimum of 2 decompression dives (real or simulated).

#### 8.13 Procedures

1. the specific tables and procedures used must be approved in advance by the DCB.
2. A detailed dive plan, reviewed and approved by the DSO, including a written emergency evacuation plan for an injured diver shall be at the dive site.
3. Dives shall not extend into extreme exposure table range.

### **8.20 HOOKAH**

Hookah is a form of shallow water surface supplied diving where there is no voice communication with the surface.

8.21 Divers using the hookah mode shall be equipped with a diver-carried independent reserve breathing gas supply.

8.22 Each hookah diver shall be hose-tended by a separate dive team member while in the water.

8.23 The hookah breathing gas supply shall be sufficient to support all hookah divers in the water for the duration of the planned dive, including decompression.

### 8.30 SURFACE SUPPLIED DIVING

Umbilical diving utilizes a full-face mask or helmet and an umbilical bundle consisting of, as a minimum, a breathing air supply hose, pneumofathometer hose, and hard-wired communications line.

#### 8.31 Training

1. The DSO will convene, as necessary, an introductory course consisting, as a minimum, one 4-hour classroom session and three open water surface-supplied dives.
2. Classroom training will include, but not be limited to: a brief history of surface-supplied diving, introduction to the lightweight system (umbilical assembly, helmet, Dive Control System), operational procedure checklist, emergency procedures, pre and post dive inspection/maintenance procedures, and communication procedures (voice and line pull).
3. Practical training will include, but not be limited to dressing procedures, coiling/flaking hose, umbilical stretch, line pull signals, low air drill (use of bailout system), simulated work project (e.g., flange), emergency rescue of a simulated unconscious diver, exits/entries from a height (5 - 6 feet), and use of ascent line.
4. Practical training will require each candidate to participate as diver, tender/standby, and dive supervisor/dive control system operator.

#### 8.32 Procedures

1. Surface supplied divers shall comply with all scuba diving procedures in this manual (except Sections 2.31 solo diving and 3.26 buoyancy compensator).
2. Surface supplied diving shall not be conducted at depths greater than 190 fsw (58 msw).
3. Divers using the surface supplied mode shall be equipped with a diver-carried independent reserve breathing gas supply.
4. Each surface supplied diver shall be hose tended by a separate dive team member while in the water.
5. The diver's umbilical tender shall be trained as a surface-supplied diver.
6. Except in an emergency, the tender shall remain continuously at the diving station and monitor the diver's umbilical. The tender shall not be asked to perform other activities that prevent the immediate and continuous performance of this duty.
7. If diving operations are conducted in a physically confining space or under overhead obstructions, a surface-supplied diver shall be stationed at the underwater point of ingress and immediately available to assist the working diver. In this case, the dive team must include an additional qualified tender.
8. Individuals other than a qualified member of the dive team may be utilized to tend other hoses or cables, such as jetting, pneumatic tools, or electrical/lighting cables, or to perform additional tasks as may be required. These persons shall, at all times, be immediately responsive to direction from the diving supervisor.
9. Divers using the surface supplied mode shall maintain voice communication with the surface tender.
10. The surface supplied breathing gas supply shall be sufficient to support all surface supplied divers in the water for the duration of the planned dive, including decompression.
11. Diving from any pier, vessel, platform, or other structure where an air gap to the water exists requires the use of a stage, ladder, or personnel basket for entry and/or exit.

12. During surface supplied diving operations when only one diver is in the water, there must be a standby diver in attendance at the dive location.
  - a. The standby diver shall be trained in surface-supplied diving and be ready to enter the water at the diving station in order to render assistance to a stricken diver
  - b. The standby diver is to remain in the immediate vicinity of the diving control station, and be ready to enter the water when directed by the diving supervisor.
  - c. The standby diver may also tend the diver's umbilical in shallow, uncomplicated operations (see below).

#### 8.33 Minimum Personnel Requirements (surface-supplied qualified)

1. The minimum number of personnel comprising a dive team must take into account factors such as the requirements of work to be performed, overhead obstructions, the possibility of entanglements, and other factors either known or suspected which may lead to complications during the conduct of the dive.
2. The minimum umbilical diving team shall consist of three (3) divers qualified in umbilical diving, to be used only for no-decompression dives to 80 feet or less where there is reduced likelihood of diver entrapment or potential for diver incapacitation. The minimum team shall consist of:
  - a. one diving supervisor/console operator;
  - b. one tender/standby diver;
  - c. one diver.
3. For all stage decompression dives less than 130 fsw or no-decompression dives at the depth range from 80 - 130 fsw the minimum qualified team shall consist of:
  - a. One diving supervisor/console operator
  - b. One diver
  - c. One standby diver
  - d. One tender
4. For depths from 130 - 190 fsw the minimum qualified team shall consist of:
  - a. One diving supervisor/console operator (not to dive on the day of the operation)
  - b. One diver
  - c. One standby diver
  - d. Two tenders

## **8.40 BLUE WATER DIVING (Multiple Diver Tether System)**

Blue water diving is defined as diving in deep open waters (generally >200 feet deep) where the bottom or other structures cannot be used as a reference point, and where a diver could sense a loss of orientation or descend below safe diving depths.

### **8.41 Training**

1. Candidates shall possess the minimum qualifications listed in Section 2.83.4.
2. Entry level training shall consist, as a minimum, of one classroom and one open water session.
3. Classroom training shall consist of a review of the guidelines as referenced in "Blue Water Diving Guidelines" (California Sea Grant Publication No. T-CSGCP-014).
4. Practical training will include, but not be limited to, tether inspection and assembly, diving as both collector and pivot diver, and emergency procedures.

### **8.42 Procedures**

1. The multiple diver tether system shall be used in clear open water where there are no overhead obstructions or danger of entanglement.
2. Divers are tethered with lines originating from a central point such as a lightly weighted line from the support boat (usually a small inflatable launched from the mother ship).
3. A pivot (safety) diver, whose sole responsibility is monitoring the activities of the other divers, acts as a "buddy" for all other divers:
  - a. pivot diver must be in visual contact with the other divers;
  - b. pivot diver is usually located at a central pivot point;
  - c. pivot diver will be supplied with an appropriate alternate air source (e.g., "octopus" regulator).
4. The number of divers is limited to that which can effectively be monitored by the pivot diver.
5. If a pivot diver is not used, as in night or limited visibility conditions, each diver and the surface tender must have effective voice communications (e.g., full face mask with a hardwired or single sideband system).

## **8.50 ICE AND POLAR DIVING**

Divers planning to dive under ice or in polar conditions should use the following: "Guidelines for Conduct of Research Diving," National Science Foundation, Division of Polar Programs, 1990.

## **8.60 OVERHEAD ENVIRONMENTS**

8.61 Cavern, cave, ice, wreck and pipe penetration using scuba require special training, certification, and procedures not covered in this manual.

8.62 Where an enclosed or confined space is not large enough for two divers, a diver shall be stationed at the underwater point of entry and an orientation line shall be used.

8.63 Surface-supplied umbilical diving with two-way hardwired communications is the preferred mode for diving in environments without direct vertical access to the surface.

## **8.70 OTHER TECHNIQUES NOT CURRENTLY SUPPORTED AT WHOI**

### **8.71 Aquarium Diving**

The Institution does not currently support aquarium diving. If divers wish to dive at an AAUS organizational member aquarium, they must follow the aquarium diving regulations of the host organization.

### **8.72 Saturation Diving**

The Institution does not currently support saturation training or operations. If divers wish to utilize saturation diving operations at another AAUS organizational member institution, they must follow the saturation regulations of the host institution.

### **8.73 Mixed Gas Diving**

The Institution does not currently support diving with mixtures other than air or nitrox (<40% oxygen). If divers wish to utilize breathing gas mixes not covered in this manual at another AAUS organizational member institution, they must follow the mixed gas regulations of the host institution.

## Section 9.00 Rebreathers

This section defines specific considerations regarding the following issues for the use of rebreathers:

- Training and/or experience verification requirements for authorization
- Equipment requirements
- Operational requirements and additional safety protocols to be used

Application of this standard is in addition to pertinent requirements of all other sections of the AAUS Standards for Scientific Diving, Volumes 1 and 2.

For rebreather dives that also involve staged decompression and/or mixed gas diving, all requirements for each of the relevant diving modes shall be met. Diving Control Board reserves the authority to review each application of all specialized diving modes, and include any further requirements deemed necessary beyond those listed here on a case-by-case basis.

No diver shall conduct planned operations using rebreathers without prior review and approval of the DCB.

In all cases, trainers shall be qualified for the type of instruction to be provided. Training shall be conducted by agencies or instructors approved by DSO and DCB.

### 9.10 Definitions and General Information

Rebreathers are defined as any device that recycles some or all of the exhaled gas in the breathing loop and returns it to the diver. Rebreathers maintain levels of oxygen and carbon dioxide that support life by metered injection of oxygen and chemical removal of carbon dioxide. These characteristics fundamentally distinguish rebreathers from open-circuit life support systems, in that the breathing gas composition is dynamic rather than fixed.

- Advantages of rebreathers may include increased gas utilization efficiencies that are often independent of depth, extended no-decompression bottom times and greater decompression efficiency, and reduction or elimination of exhaust bubbles that may disturb aquatic life or sensitive environments.
- Disadvantages of rebreathers include high cost and, in some cases, a high degree of system complexity and reliance on instrumentation for gas composition control and monitoring, which may fail. The diver is more likely to experience hazardous levels of hypoxia, hyperoxia, or hypercapnia, due to user error or equipment malfunction, conditions which may lead to underwater blackout and drowning. Inadvertent flooding of the breathing loop and wetting of the carbon dioxide absorbent may expose the diver to ingestion of an alkaline slurry ("caustic cocktail").
- An increased level of discipline and attention to rebreather system status by the diver is required for safe operation, with a greater need for self-reliance. Rebreather system design and operation varies significantly between make and model. For these reasons when evaluating any dive plan incorporating rebreathers, risk-management emphasis should be placed on the individual qualifications of the diver on the specific rebreather make and model to be used, in addition to specific equipment requirements and associated operational protocols.

#### Oxygen Rebreathers

Oxygen rebreathers recycle breathing gas, consisting of pure oxygen, replenishing the oxygen metabolized by the diver. Oxygen rebreathers are generally the least complicated design, but are normally limited to a maximum operation depth of 20fsw due to the risk of unsafe hyperoxic exposure.

#### Semi-Closed Circuit Rebreathers

Semi-closed circuit rebreathers (SCR) recycle the majority of exhaled breathing gas, venting a portion into the water and replenishing it with a constant or variable amount of a single oxygen-enriched gas mixture. Gas addition and venting is balanced against diver metabolism to maintain safe oxygen levels by means which differ between SCR models, but the mechanism usually provides a semi-constant fraction of oxygen (FO<sub>2</sub>) in the breathing loop at all depths, similar to open-circuit SCUBA.

## Closed-Circuit Mixed Gas Rebreathers

Closed-circuit mixed gas rebreathers (CCR) recycle all of the exhaled gas and replace metabolized oxygen via an electronically controlled valve, governed by electronic oxygen sensors. Manual oxygen addition is available as a diver override, in case of electronic system failure. A separate inert gas source (diluent), usually containing primarily air, heliox, or trimix, is used to maintain oxygen levels at safe levels when diving below 20fsw. CCR systems operate to maintain a constant oxygen partial pressure (PPO<sub>2</sub>) during the dive, regardless of depth.

### 9.20 Prerequisites

Specific training requirements for use of each rebreather model shall be defined by DCB on a case-by-case basis. Training shall include factory-recommended requirements, but may exceed this to prepare for the type of mission intended (e.g., staged decompression or heliox/trimix CCR diving).

#### *Training Prerequisites*

1. Active scientific diver status, with depth qualification sufficient for the type, make, and model of rebreather, and planned application.
2. Completion of a minimum of 50 open-water dives on SCUBA.
3. For SCR or CCR, a minimum 100-fsw-depth qualification is generally recommended, to ensure the diver is sufficiently conversant with the complications of deeper diving. If the sole expected application for use of rebreathers is shallower than this, a lesser depth qualification may be allowed with the approval of the DCB.
4. Nitrox training. Training in use of nitrox mixtures containing 25% to 40% oxygen is required. Training in use of mixtures containing 40% to 100% oxygen may be required, as needed for the planned application and rebreather system. Training may be provided as part of rebreather training.

#### *Training*

Successful completion of the following training program qualifies the diver for rebreather diving using the system on which the diver was trained, in depths of 130fsw and shallower, for dives that do not require decompression stops, using nitrogen/oxygen breathing media.

Satisfactory completion of a rebreather training program authorized or recommended by the manufacturer of the rebreather to be used, or other training approved by the DCB. Successful completion of training does not in itself authorize the diver to use rebreathers. The diver must demonstrate to the DCB or its designee that the diver possesses the proper attitude, judgment, and discipline to safely conduct rebreather diving in the context of planned operations.

Classroom training shall include: A review of those topics of diving physics and physiology, decompression management, and dive planning included in prior scientific diver, nitrox, staged decompression and/or mixed gas training, as they pertain to the safe operation of the selected rebreather system and planned diving application.

1. In particular, causes, signs and symptoms, first aid, treatment and prevention of the following must be covered:
  - Hyperoxia (CNS and Pulmonary Oxygen Toxicity)
  - Middle Ear Oxygen Absorption Syndrome (oxygen ear)
  - Hyperoxia-induced myopia
  - Hypoxia
  - Hypercapnia
  - Inert gas narcosis
  - Decompression sickness
2. Rebreather-specific information required for the safe and effective operation of the system to be used, including:
  - System design and operation, including:
  - Counterlung(s)
  - CO<sub>2</sub> scrubber
  - CO<sub>2</sub> absorbent material types, activity characteristics, storage, handling and disposal

- Oxygen control system design, automatic and manual
- Diluent control system, automatic and manual (if any)
- Pre-dive set-up and testing
- Post-dive break-down and maintenance
- Oxygen exposure management
- Decompression management and applicable decompression tracking methods
- Dive operations planning
- Problem recognition and management, including system failures leading to hypoxia, hyperoxia, hypercapnia, flooded loop, and caustic cocktail
- Emergency protocols and bailout procedure

Practical Training (with model of rebreather to be used)

- A minimum number of hours of underwater time.

Type	Pool/Confined Water	O/W Training	O/W Supervised
Oxygen Rebreather	1 dive, 90 min	4 dives, 120 min.*	2 dives, 60 min
Semi-Closed Circuit	1 dive, 90-120 min	4 dives, 120 min.**	4 dives, 120 min
Closed-Circuit	1 dive, 90-120 min	8 dives, 380 min.***	4 dives, 240 min

\* Dives should not exceed 20 fsw.

\*\* First two dives should not exceed 60 fsw. Subsequent dives should be at progressively greater depths, with at least one dive in the 80 to 100 fsw range.

\*\*\* Total underwater time (pool and open water) of approximately 500 minutes. First two open water dives should not exceed 60 fsw. Subsequent dives should be at progressively greater depths, with at least 2 dives in the 100 to 130 fsw range.

- Amount of required in-water time should increase proportionally to the complexity of rebreather system used.
- Training shall be in accordance with the manufacturer's recommendations.

*Practical Evaluations*

Upon completion of practical training, the diver must demonstrate to the DCB or its designee proficiency in pre-dive, dive, and post-dive operational procedures for the particular model of rebreather to be used. Skills shall include, at a minimum:

- Oxygen control system calibration and operation checks
- Carbon dioxide absorbent canister packing
- Supply gas cylinder analysis and pressure check
- Test of one-way valves
- System assembly and breathing loop leak testing
- Pre-dive breathing to test system operation In-water leak checks
- Buoyancy control during descent, bottom operations, and ascent
- System monitoring and control during descent, bottom operations, and ascent
- Proper interpretation and operation of system instrumentation (PO2 displays, dive computers, gas supply pressure gauges, alarms, etc, as applicable)
- Unit removal and replacement on the surface.
- Bailout and emergency procedures for self and buddy, including:
  - System malfunction recognition and solution
  - Manual system control
  - Flooded breathing loop recovery (if possible)

- Absorbent canister failure
- Alternate bailout options
- Symptom recognition and emergency procedures for hyperoxia, hypoxia, and hypercapnia
- Proper system maintenance, including:
  - Full breathing loop disassembly and cleaning (mouthpiece, check-valves, hoses, counterlung, absorbent canister, etc.)
  - Oxygen sensor replacement (for SCR and CCR)
  - Other tasks required by specific rebreather models

*Written Evaluation*

A written evaluation approved by the DCB with a pre-determined passing score, covering concepts of both classroom and practical training, is required.

*Supervised Rebreather Dives*

Upon successful completion of open water training dives, the diver is authorized to conduct a series of supervised rebreather dives, during which the diver gains additional experience and proficiency.

***Supervisor for these dives should be the DSO or designee, and should be an active scientific diver experienced in diving with the make/model of rebreather being used.***

***Dives at this level may be targeted to activities associated with the planned science diving application. See the following table for number and cumulative water time for different rebreather types.***

Type	Pool/Confined Water	O/W Training	O/W Supervised
Oxygen Rebreather	1 dive, 90 min	4 dives, 120 min.*	2 dives, 60 min
Semi-Closed Circuit	1 dive, 90-120 min	4 dives, 120 min.**	4 dives, 120 min
Closed-Circuit	1 dive, 90-120 min	8 dives, 380 min.***	4 dives, 240 min

\* Dives should not exceed 20 fsw.

\*\* First two dives should not exceed 60 fsw. Subsequent dives should be at progressively greater depths, with at least one dive in the 80 to 100 fsw range.

\*\*\* Total underwater time (pool and open water) of approximately 500 minutes. First two open water dives should not exceed 60 fsw. Subsequent dives should be at progressively greater depths, with at least 2 dives in the 100 to 130 fsw range.

***Maximum ratio of divers per designated dive supervisor is 4:1. The supervisor may dive as part of the planned operations.***

*Extended Range, Required Decompression and Helium-Based Inert Gas*

Rebreather dives involving operational depths in excess of 130 fsw, requiring staged decompression, or using diluents containing inert gases other than nitrogen are subject to additional training requirements, as determined by DCB on a case-by-case basis. Prior experience with required decompression and mixed gas diving using open-circuit SCUBA is desirable, but is not sufficient for transfer to dives using rebreathers without additional training.

- As a prerequisite for training in staged decompression using rebreathers, the diver shall have logged a minimum of 25 hours of underwater time on the rebreather system to be used, with at least 10 rebreather dives in the 100 fsw to 130 fsw range.
- As a prerequisite for training for use of rebreathers with gas mixtures containing inert gas other than nitrogen, the diver shall have logged a minimum of 50 hours of underwater time on the rebreather system to be used and shall have completed training in stage decompression methods using rebreathers. The diver shall have completed at least 12 dives requiring staged decompression on the rebreather model to be used, with at least 4 dives near 130 fsw.

Training shall be in accordance with standards for required-decompression and mixed gas diving, as

applicable to rebreather systems, starting at the 130 fsw level.

#### Maintenance of Proficiency

To maintain authorization to dive with rebreathers, an authorized diver shall make at least one dive using a rebreather every 8 weeks. For divers authorized for the conduct of extended range, stage decompression or mixed-gas diving, at least one dive per month should be made to a depth near 130 fsw, practicing decompression protocols.

For a diver in arrears, the DCB shall approve a program of remedial knowledge and skill tune-up training and a course of dives required to return the diver to full authorization. The extent of this program should be directly related to the complexity of the planned rebreather diving operations.

### 9.30 Equipment Requirements

#### *General Requirements*

Only those models of rebreathers specifically approved by DCB shall be used.

Rebreathers should be manufactured according to acceptable Quality Control/Quality Assurance protocols, as evidenced by compliance with the essential elements of ISO 9004. Manufacturers should be able to provide to the DCB supporting documentation to this effect.

Unit performance specifications should be within acceptable levels as defined by standards of a recognized authority (CE, US Navy, Royal Navy, NOAA, etc.).

Prior to approval, the manufacturer should supply the DCB with supporting documentation detailing the methods of specification determination by a recognized third-party testing agency, including unmanned and manned testing. Test data should be from a recognized, independent test facility.

The following documentation for each rebreather model to be used should be available as a set of manufacturer's specifications.

These should include:

- Operational depth range
- Operational temperature range
- Breathing gas mixtures that may be used
- Maximum exercise level which can be supported as a function of breathing gas and depth
- Breathing gas supply durations as a function of exercise level and depth
- CO<sub>2</sub> absorbent durations, as a function of depth, exercise level, breathing gas, and water temperature
- Method, range and precision of inspired PPO<sub>2</sub> control, as a function of depth, exercise level, breathing gas, and temperature
- Likely failure modes and backup or redundant systems designed to protect the diver if such failures occur
- Accuracy and precision of all readouts and sensors
- Battery duration as a function of depth and temperature
- Mean time between failures of each subsystem and method of determination

A complete instruction manual is required, fully describing the operation of all rebreather components and subsystems as well as maintenance procedures.

A maintenance log is required. The unit maintenance shall be up-to-date based upon manufacturer's recommendations.

#### Minimum Equipment

1. A surface/dive valve in the mouthpiece assembly, allowing sealing of the breathing loop from the external environment when not in use.
2. An automatic gas addition valve, so that manual volumetric compensation during descent is unnecessary.

3. Manual gas addition valves, so that manual volumetric compensation during descent and manual oxygen addition at all times during the dive are possible.
4. The diver shall carry alternate life support capability (open-circuit bail-out or redundant rebreather) sufficient to allow the solution of minor problems and allow reliable access to a pre-planned alternate life support system.

#### Oxygen Rebreathers

- Oxygen rebreathers shall be equipped with manual and automatic gas addition valves.

#### Semi-Closed Circuit Rebreathers.

- SCR's shall be equipped with at least one manufacturer-approved oxygen sensor sufficient to warn the diver of impending hypoxia. Sensor redundancy is desirable, but not required.

#### Closed Circuit Mixed-gas Rebreathers.

- CCR shall incorporate a minimum of three independent oxygen sensors.
- A minimum of two independent displays of oxygen sensor readings shall be available to the diver.
- Two independent power supplies in the rebreather design are desirable. If only one is present, a secondary system to monitor oxygen levels without power from the primary battery must be incorporated.
- CCR shall be equipped with manual diluent and oxygen addition valves, to enable the diver to maintain safe oxygen levels in the event of failure of the primary power supply or automatic gas addition systems.
- Redundancies in onboard electronics, power supplies, and life support systems are highly desirable.

### 9.40 Operational Requirements

#### General Requirements

- All dives involving rebreathers must comply with applicable operational requirements for open-circuit SCUBA dives to equivalent depths.
- No rebreather system should be used in situations beyond the manufacturer's stated design limits (dive depth, duration, water temperature, etc).
- Modifications to rebreather systems shall be in compliance with manufacturer's recommendations.
- Rebreather maintenance is to be in compliance with manufacturer's recommendations including sanitizing, replacement of consumables (sensors, CO<sub>2</sub> absorbent, gas, batteries, etc) and periodic maintenance.

#### Dive Plan

In addition to standard dive plan components stipulated in AAUS Section 2.0, all dive plans that include the use of rebreathers must include, at minimum, the following details:

- Information about the specific rebreather model to be used
- Make, model, and type of rebreather system
- Type of CO<sub>2</sub> absorbent material
- Composition and volume(s) of supply gases
- Complete description of alternate bailout procedures to be employed, including manual rebreather operation and open-circuit procedures
- Other specific details as requested by DCB

#### Buddy Qualifications

A diver whose buddy is diving with a rebreather shall be trained in basic rebreather operation, hazard identification, and assist/rescue procedures for a rebreather diver.

If the buddy of a rebreather diver is using open-circuit scuba, the rebreather diver must be equipped with a means to provide the open-circuit scuba diver with a sufficient supply of open-circuit breathing gas to allow both divers to return safely to the surface.

## Oxygen Exposures

- Planned oxygen partial pressure in the breathing gas shall not exceed 1.4 atmospheres at depths greater than 30 feet.
- Planned oxygen partial pressure set point for CCR shall not exceed 1.4 ata. Set point at depth should be reduced to manage oxygen toxicity according to the NOAA Oxygen Exposure Limits.
- Oxygen exposures should not exceed the NOAA oxygen single and daily exposure limits. Both CNS and pulmonary (whole-body) oxygen exposure indices should be tracked for each diver

## Decompression Management

DCB shall review and approve the method of decompression management selected for a given diving application and project.

Decompression management can be safely achieved by a variety of methods, depending on the type and model of rebreather to be used. Following is a general list of methods for different rebreather types:

1. Oxygen rebreathers: Not applicable.
2. SCR (presumed constant  $FO_2$ ):
  - Use of any method approved for open-circuit scuba diving breathing air, above the maximum operational depth of the supply gas.
  - Use of open-circuit nitrox dive tables based upon expected inspired  $FO_2$ . In this case, contingency air dive tables may be necessary for active-addition SCR's in the event that exertion level is higher than expected.
  - Equivalent air depth correction to open-circuit air dive tables, based upon expected inspired  $FO_2$  for planned exertion level, gas supply rate, and gas composition. In this case, contingency air dive tables may be necessary for active-addition SCR's in the event that exertion level is higher than expected.
3. CCR (constant  $PPO_2$ ):
  - Integrated constant  $PPO_2$  dive computer.
  - Non-integrated constant  $PPO_2$  dive computer.
  - Constant  $PPO_2$  dive tables.
  - Open-circuit (constant  $FO_2$ ) nitrox dive computer, set to inspired  $FO_2$  predicted using  $PPO_2$  set point at the maximum planned dive depth.
  - Equivalent air depth (EAD) correction to standard open-circuit air dive tables, based on the inspired  $FO_2$  predicted using the  $PPO_2$  set point at the maximum planned dive depth.
  - Air dive computer, or air dive tables used above the maximum operating depth (MOD) of air for the

## *Maintenance Logs, CO2 Scrubber Logs, Battery Logs, and Pre-And Post-Dive Checklists*

Logs and checklists will be developed for the rebreather used, and will be used before and after every dive. Diver shall indicate by initialing that checklists have been completed before and after each dive. Such documents shall be filed and maintained as permanent project records. No rebreather shall be dived which has failed any portion of the pre-dive check, or is found to not be operating in accordance with manufacturer's specifications. Pre-dive checks shall include:

- Gas supply cylinders full
- Composition of all supply and bail-out gases analyzed and documented
- Oxygen sensors calibrated
- Carbon dioxide canister properly packed
- Remaining duration of canister life verified
- Breathing loop assembled
- Positive and negative pressure leak checks
- Automatic volume addition system working
- Automatic oxygen addition systems working

- Pre-breathe system for 3 minutes (5 minutes in cold water) to ensure proper oxygen addition and carbon dioxide removal (be alert for signs of hypoxia or hypercapnia)
- Other procedures specific to the model of rebreather used
- Documentation of ALL components assembled
- Complete pre-dive system check performed
- Final operational verification immediately before to entering the water:
  - PO<sub>2</sub> in the rebreather is not hypoxic
  - Oxygen addition system is functioning;
  - Volumetric addition is functioning
  - Bail-out life support is functioning

#### Alternate Life Support System

The diver shall have reliable access to an alternate life support system designed to safely return the diver to the surface at normal ascent rates, including any required decompression in the event of primary rebreather failure. The complexity and extent of such systems are directly related to the depth/time profiles of the mission. Examples of such systems include, but are not limited to:

- Open-circuit bailout cylinders or sets of cylinders, either carried or pre-positioned
- Redundant rebreather
- Pre-positioned life support equipment with topside support

#### CO<sub>2</sub> Absorbent Material

- CO<sub>2</sub> absorption canister shall be filled in accordance with the manufacturer's specifications.
- CO<sub>2</sub> absorbent material shall be used in accordance with the manufacturer's specifications for expected duration.
- If CO<sub>2</sub> absorbent canister is not exhausted and storage between dives is planned, the canister should be removed from the unit and stored sealed and protected from ambient air, to ensure the absorbent retains its activity for subsequent dives.
- Long-term storage of carbon dioxide absorbents shall be in a cool, dry location in a sealed container. Field storage must be adequate to maintain viability of material until use.

Consumables (e.g., batteries, oxygen sensors, etc.)

Other consumables (e.g., batteries, oxygen sensors, etc.) shall be maintained, tested, and replaced in accordance with the manufacturer's specifications.

#### Unit Disinfections

The entire breathing loop, including mouthpiece, hoses, counterlungs, and CO<sub>2</sub> canister, should be disinfected periodically according to manufacturer's specifications. The loop must be disinfected between each use of the same rebreather by different divers.

### 9.50 Oxygen Rebreathers

Oxygen rebreathers shall not be used at depths greater than 20 feet.

Breathing loop and diver's lungs must be adequately flushed with pure oxygen prior to entering the water on each dive. Once done, the diver must breathe continuously and solely from the intact loop, or re-flushing is required.

Breathing loop shall be flushed with fresh oxygen prior to ascending to avoid hypoxia due to inert gas in the loop.

### **9.60 Semi-Closed Circuit Rebreather**

The composition of the injection gas supply of a semi-closed rebreather shall be chosen such that the partial pressure of oxygen in the breathing loop will not drop below 0.2 ata, even at maximum exertion at the surface.

The gas addition rate of active addition SCR (e.g., Draeger Dolphin and similar units) shall be checked before every dive, to ensure it is balanced against expected workload and supply gas FO<sub>2</sub>.

The intermediate pressure of supply gas delivery in active-addition SCR shall be checked periodically, in compliance with manufacturer's recommendations.

Maximum operating depth shall be based upon the FO<sub>2</sub> in the active supply cylinder.

Prior to ascent to the surface the diver shall flush the breathing loop with fresh gas or switch to an open-circuit system to avoid hypoxia. The flush should be at a depth of approximately 30 fsw during ascent on dives deeper than 30 fsw, and at bottom depth on dives 30 fsw and shallower.

### **9.70 Closed-Circuit Rebreathers**

*The FO<sub>2</sub> of each diluent gas supply used shall be chosen so that, if breathed directly while in the depth range for which its use is intended, it will produce an inspired PPO<sub>2</sub> greater than 0.20 ata but no greater than 1.4 ata.*

*Maximum operating depth shall be based on the FO<sub>2</sub> of the diluent in use during each phase of the dive, so as not to exceed a PO<sub>2</sub> limit of 1.4 ata.*

*Divers shall monitor both primary and secondary oxygen display systems at regular intervals throughout the dive, to verify that readings are within limits, that redundant displays are providing similar values, and whether readings are dynamic or static (as an indicator of sensor failure).*

*The PPO<sub>2</sub> set point shall not be lower than 0.4 ata or higher than 1.4 ata.*

## **SECTION 10.0 DIVING EMERGENCY PROCEDURES**

### **10.10 GENERAL POLICY**

#### 10.11 Introduction

1. Development of exact procedures to cover all possible emergency situations cannot be accomplished in this manual because of the immense number of variables involved (e.g., differences in diving location, personnel, available medical facilities, transportation, etc.).
2. This Section is intended to serve as a planning guide for Institution divers to formulate specific procedures for their operations. Supervisory personnel, under direction of the DSO, must use judgment in selecting procedures which best suit the nature of their operation.
3. Detailed accident management and first aid techniques may be found in the NOAA Diving Manual, Red Cross Manuals, and many other approved publications.

#### 10.12 Preparedness

1. All supervisors and team members must be prepared to respond properly in the event of an accident. Prompt emergency procedures can reduce the residual effects on the victim and can possibly save a life.
2. Periodic retraining and routine practice are essential elements in emergency preparedness; emergency drills are encouraged.
3. The importance of prevention through operations planning, following safety regulations, and using common sense cannot be overemphasized.

### **10.20 ON-SITE ACCIDENT MANAGEMENT**

#### 10.21 Rescue/First Aid

1. The person nearest the victim (in scuba, usually the buddy), will initiate rescue/recovery procedures.
2. The rescuer will signal for assistance (voice, whistle, flare, etc.).
3. If the victim is not breathing, the rescuer immediately will start basic life support in the water. Resuscitation must be continued with a minimum of interruption while removing the diver from the water to the rescue platform (boat, shore, etc.), and not be discontinued until the victim resumes breathing, is pronounced dead by a physician, or is turned over to a higher authority.
4. The Lead Diver (or next senior diver in the team) will take charge of the scene and delegate tasks to other responsible individuals. Other team members, if available on site, will be dispatched by the Lead Diver to assist in the rescue efforts.
5. If an air embolism or the bends is suspected and the victim is breathing, immediately begin prescribed first aid (supine position, treat for shock, administer pure oxygen, keep under constant observation).
6. Send for aid.

## 10.22 Summoning Aid

### 1. Woods Hole Oceanographic Institution pier, immediate Woods Hole area:

- a. Dial Institution in-house phone system 2-911 to alert switchboard operator. Operator will notify Falmouth Fire Department Rescue Service and activate Institution First Aid Response Team;
- b. If off property dial 911
- c. If off property and using a cell phone call Falmouth Fire Department: 508-548-2325;
- d. A partial list of oxygen and first aid kit locations at Woods Hole Oceanographic Institution:
  - (1) Machine Shop, Iselin Building, first floor;
  - (2) Diving Locker, Iselin Building, first floor;
  - (3) Smith Lobby;
  - (4) Redfield Lobby;
  - (5) Clark Lobby.

### 2. Small Boat, Buzzards Bay or Vineyard Sound area:

- a. Radio Coast Guard, VHF Channel 16 (CB Channel 9 may be used as a last resort but is unreliable).
- b. The Port Office can monitor Channel 16, but must be notified in advance of the diving operation.
- c. If unable to contact the Coast Guard or Port Office, hail another vessel to relay the message, or proceed to the nearest inhabited dock.
- d. If in a remote area, use smoke, flares, etc., to attract attention.

### 3. At Sea

Immediately advise the vessel's Master of the situation and request what is needed for assistance (generally communication and rapid transport to shore).

### 4. Proper Radio/Telephone Protocol:

- a. Keep calm.
- b. Declare the situation an emergency (e.g., "This is an emergency. I have a diving accident victim needing treatment in a recompression chamber.").
- c. Be prepared to give detailed information regarding location (e.g., distance and direction from prominent landmarks, coordinates, etc.), name and description of vessel (never assume the pilot will recognize you), the status and number of victims (state of consciousness, etc.), pertinent environmental conditions (road/sea) or any unusual circumstances.
- d. Do not break off radio call or hang up the telephone when talking with emergency personnel. Let emergency personnel initiate termination of communication. This will ensure that they have all the information they require.

5. A checklist of persons/organizations who may need to be notified:
  - a. emergency aid/transportation (rescue squad, Coast Guard);
  - b. physician, hospital;
  - c. Divers Alert Network/recompression chamber facility;
  - d. law enforcement authorities (police);
  - e. Institution authorities (DSO, Safety Office) - MANDATORY FOR ANY DIVING ACCIDENT;
  - f. victim's family.

#### 10.23 On-Site Care of Diving Casualty

1. Follow the Accident Management Flow Chart.
2. If time and circumstances permit, administer an initial neurological.
3. If an asymptomatic emergency is managed at the scene and hospitalization or professional medical attention is not required (emergency ascent, water accident where resuscitation is not required, etc.):
  - a. provide victim with emergency identification, telephone numbers for diving physician, local medical facility, etc.);
  - b. do not let the victim drive or be alone for the next six (6) hours.
4. Any person resuscitated at the dive site must be transported to a medical facility for follow-up examination/treatment, preferably by a rescue squad with trained emergency medical personnel.

#### 10.24 Additional On-Site Procedures While Awaiting Aid/Transport

1. Recall all divers in the water; terminate all diving operations; secure equipment; be certain all dive team members are accounted for.
2. Non-involved dive team members shall stand by, await instructions, and not interfere with emergency efforts.
3. Designate dive team members to control crowds or bystanders; keep non-essential personnel away from the victim and first aid personnel; instruct dive team members not to mingle with bystanders and not to discuss the accident with anyone (this is especially necessary in a beach operation); do not allow any dive team members to leave until dismissed by the Lead Diver or DSO (in serious or fatal accidents authorization from local enforcement authorities will be required for dismissal of witnesses).

### **10.30 EMERGENCY EVACUATION GUIDELINES**

#### 10.31 General Guidelines

The following medical evacuation information should 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 procedures such as administration of oxygen to a diving casualty

must be performed. Call the Divers Alert Network (919-684-9111) for medical consultation if doubt exists that the physician/hospital possesses the competence to handle a diving casualty.

1. Maintain breathing and heart functions, ensure airway remains open ("ABC's"). If CPR is being administered, there must be an absolute minimum of interruption during transfer; any method of transfer requiring interruption of CPR should be used only as a last resort.
2. Keep patient on 100% oxygen and in a supine position during transportation.
3. Ensure paramedics/physician understand why paragraph 2 above, is necessary.
4. Ensure paramedics/physician understand why the patient must be taken to a recompression chamber instead of, or after stabilization at the hospital.
5. Do not stop giving oxygen to a diving accident patient even if patient is breathing normally unless there is a need to reopen the airway, or the patient shows signs of oxygen convulsions (100% oxygen is necessary to offload nitrogen from bubbles, to reoxygenate hypoxic tissue, and to help control cerebral edema).
6. Protect patient from adverse environmental factors, (e.g., hot sun, cold, etc.), continually monitor and record patient's condition (ABC's, level of consciousness, vital signs, etc.)
7. Do not give any pain killing drugs.
8. Instruct flight crews to fly or pressurize aircraft below 800 feet, or as low as possible.
9. Provided aircraft can handle the extra weight, the diving buddy should also be transported with the patient, because he/she also may require recompression and can provide information, comfort, and contact with the patient's relatives.
10. A complete history of all events leading up to the accident and evacuation must be forwarded with the patient.
11. Depth gauges, cylinders, regulators, and other diving equipment should be forwarded with the patient and should be properly tagged, or at least set aside without tampering, especially if the accident was fatal.
12. Be aware that a well-trained diver may be the most knowledgeable person on the scene regarding diving accidents and must, therefore, make a continuing effort to insure that proper treatment is given.

#### 10.32 Evacuation By Air

Each helicopter evacuation presents unique problems. Knowing what to expect and the procedures to follow, however, can save time, effort, and perhaps a life.

1. Request a helicopter with a medic crew and oxygen. In your request, follow the guidelines in 10.31.
2. Try to establish communications with the helicopter. If your boat does not have the necessary frequency, try to work through another boat.
3. If possible, maintain a speed of 10 to 15 knots; into wind about 20 degrees on port bow.
4. Put all antennas down, if possible, without losing communications.
5. Secure all loose objects on or around the decks because of the strong winds generated by the helicopter.

6. Make sure the patient is ready in advance of the transfer, because time is critical both to the victim and the hovering aircraft.
7. Signal the helicopter pilot when all is ready, using hand signals by day and flashlight at night.
8. DO NOT SECURE THE TRAIL LINE, BASKET, OR ANY CABLE FROM THE AIRCRAFT TO THE BOAT. ALWAYS LET THE LIFTING DEVICE (STRETCHER) TOUCH THE BOAT BEFORE HANDLING IT, TO PREVENT ELECTRIC SHOCK.
9. Place life jacket on patient.
10. Tie patient in basket, face up.
11. Attach personal information such as name, address, age, what happened, and what medication has been administered.

## **10.40 LEGAL CONSIDERATIONS**

### 10.41 Responsibility

Serious accidents and fatalities often lead to legal actions. Each diver has a responsibility as a representative of the Institution, to act in a responsible manner, both for the benefit of the Institution and him/herself.

### 10.42 Guidelines for Serious Accidents

1. Contact local law enforcement authorities if this is a fatal accident.
2. Be polite but firm regarding interviews and questions. If approached, simply indicate that information will be made available through the Institution Public Affairs Office. Remember that any statement made under stress may later cause considerable problems for members of the dive team, the Institution and the victim.
3. The Lead Diver should serve as spokesman for the dive team at the scene.
4. Give only factual information to law enforcement authorities such as name, address, Institution affiliation, persons or supervisors to contact at the Institution, the exact location of the accident, a brief description of the occurrence, whom to notify in the victim's family, etc. Avoid expressing opinions or conclusions under stress.
5. The Lead Diver will prepare a complete file on the diving operation/course including outlines, memos on procedures, and records for the Diving Control Board of all personnel, etc.
6. The Lead Diver should record the name of each team member/ student who was in attendance including name, address, their involvement (if any). Inform them that they may be asked for facts as they recall them only. Ask them not to discuss opinions with bystanders, etc.
7. Have each dive team member prepare detailed written, dated, and signed statements of facts. Do it the day of the accident, not a week later. Submit these statements to the DSO.
8. Complete the "Accident Report" (Appendix E) for the DCB.

**APPENDIX A  
EMERGENCY ASSISTANCE CHECKLIST FOR THE WOODS HOLE AREA**

**AIR TRANSPORTATION TO CHAMBER**

U.S. Coast Guard Air Station Cape Cod (508)-968-6360  
(508)-968-6361

**EMERGENCY ASSISTANCE**

From an internal WHOI phone: 2-911  
Outside phone: 911  
Cell Phone:(Falmouth Fire Department) (508) 548-2325

**DIVERS ALERT NETWORK**

Diving Emergency (24hr): (919) 684-9111  
Information: (M-F 0900-1700 EST) (919) 684-2948

**EMERGENCY RADIO FREQUENCY**

U.S. Coast Guard Radio Distress Frequency 2182 HF  
Channel 16 156.8 VHF  
Channel 9 CB

**HOSPITAL**

Falmouth Hospital (508) 548-5300  
Ter Heun Drive, Falmouth MA 02540

**POLICE**

Falmouth Police Department: (508) 548-1212  
State Police Barracks Bourne: (508) 759-4488  
State Police Barracks South Yarmouth: (508) 398-2323

**RECOMPRESSION CHAMBER FACILITIES**

Head and Neck Surgery Hyperbaric Medicine Emergency (617) 573-4411  
Massachusetts Eye and Ear Infirmary Information (617) 523-7900  
243 Charles Street, Boston, MA 02114

**SEARCH AND RESCUE**

U.S. Coast Guard Search and Rescue Station Woods Hole (508)-457-3277  
U.S. Coast Guard Base, Woods Hole (508)-457-3211

## LEAD DIVER/DIVE MASTER CHECKLIST GUIDELINES

### PLAN

- \_\_\_\_\_ 1. Analyze objectives, safety considerations, location and environment, etc.
- \_\_\_\_\_ 2. File dive plan with DSO:
  - ~ names of personnel
  - ~ date, location, vessel
  - ~ statement of objectives, procedures
  - ~ list of equipment required from dive locker
  - ~ estimated time of return
- \_\_\_\_\_ 3. Notify all appropriate individuals or offices that diving operations are planned. For dives at Woods Hole Oceanographic Institution (Iselin) Pier:
  - ~ Port Office
  - ~ Dockmaster or Mechanical Shop Supervisor
  - ~ watch officers of all vessels at pier: "do not operate propellers, high power sonar, lower equipment over the side, etc."
- \_\_\_\_\_ 4. Select and assemble and inspect operational equipment:
  - ~ radio communication (if used, notify Port Office or other person to monitor).
  - ~ dive flag or other signals
  - ~ decompression tables
  - ~ emergency assistance list
  - ~ first aid kit, spare/tools kit, oxygen resuscitator
  - ~ Woods Hole Oceanographic Institution Diving Safety Manual
- \_\_\_\_\_ 5. Prepare and equip boat:
  - ~ check engine, lights, horn, trailer, anchor and lines
  - ~ gas, oil, fresh water, and food
  - ~ life jackets, charts, navigational equipment, etc.
- \_\_\_\_\_ 6. Evaluate environmental conditions:
  - ~ weather forecast: wind, wave height, air and water temperature, precipitation
  - ~ tide tables, current
  - ~ boat traffic
  - ~ depth, bottom type

### PERSONNEL

- \_\_\_\_\_ 7. Check divers' certifications/endorsements:
  - ~ certification unexpired
  - ~ certified for planned depth
  - ~ trained and qualified for equipment, task
- \_\_\_\_\_ 8. Physically and mentally prepared:
  - ~ healthy, no colds, sinusitis, ear problems, etc.
  - ~ not intoxicated or suffering from a hangover
  - ~ not using medications or drugs which may have harmful side effects for diving
  - ~ not fatigued or suffering from unusual or severe emotional stress
  - ~ physically fit, "in shape"

### DIVING EQUIPMENT

- \_\_\_\_\_ 9. Ensure each diver possesses and thoroughly checks all necessary gear:
  - ~ mask, fins, snorkel
  - ~ wet/dry suit, booties, gloves or mitts, hood
  - ~ buoyancy compensator
  - ~ knife, tools
  - ~ weight belt and weights, quick release buckle

- ~ cylinder full
  - ~ regulator function
  - ~ submersible pressure gauge
  
  - ~ watch, depth gauge
  - ~ dive lights, whistle, other signaling devices
- \_\_\_\_ 10. Warm clothes, sun protection, etc., for post dive.
- \_\_\_\_ 11. Spare tanks, regulators, masks, etc.?

**ON-SITE PRE-DIVE CHECK**

- \_\_\_\_ 12. Divers briefed and understand task?
- \_\_\_\_ 13. Divers aware of potential safety hazards and emergency procedures, survey environmental conditions
- \_\_\_\_ 14. Buddy teams assigned?
- \_\_\_\_ 15. Flag up? radio check?
- \_\_\_\_ 16. Properly anchored (or propeller completely stopped) while divers are exiting or entering boat.
- \_\_\_\_ 17. Descending line out, buoyed safety line out?
- \_\_\_\_ 18. Ladder or platform ready?
- \_\_\_\_ 19. Divers ready?
- ~ all gear properly assembled, inspected, worn
  - ~ air on, cylinder pressure full, no free-flow or leaks
  - ~ weight belt in proper position for unobstructed release
- \_\_\_\_ 20. Tender to watch time, divers' bubbles, approaching hazards and traffic.
- \_\_\_\_ 21. Boat operator ready?

**POST DIVE**

- \_\_\_\_ 22. All divers out and OK.
- \_\_\_\_ 23. Gear restowed out of the way
- \_\_\_\_ 24. Flag down, all lines, etc. recovered.
- \_\_\_\_ 25. Rinse, dry, and store gear. Sign in Institution gear.
- \_\_\_\_ 26. Fill out Record of Dive form, personal dive log. Inform DSO of any tagged equipment, injuries, or hazards encountered.
- \_\_\_\_ 27. Inform all appropriate parties that diving operations are over and that the diving team has returned.

Refer to Appendix ~~N~~<sup>1</sup> University National Oceanographic Laboratory System Research Vessel Operating Committee Shipboard Diving Regulations for additional responsibilities during at-sea diving operations.

NAUI DIVE TABLES



WARNING: EVEN STRICT COMPLIANCE WITH THESE TABLES WILL NOT GUARANTEE AVOIDANCE OF DECOMPRESSION SICKNESS. CONSERVATIVE USAGE IS STRONGLY RECOMMENDED.

RNT RESIDUAL NITROGEN TIME  
 +ADT ACTUAL DIVE TIME  
 TNT TOTAL NITROGEN TIME

USE THIS FIGURE TO DETERMINE END-OF-DIVE LETTER GROUP

# DIVE TABLES

TABLE 1 - END-OF-DIVE LETTER GROUP

START DEPTH M	FEET	MAXIMUM DIVE TIME (MDT)		DIVE TIME REQUIRING DECOMPRESSION NO. MINUTES REQUIRED AT 15' STOP (5M)														
		00	30	00	00	15	25	30	40	50	60	70	80	90	100	110	130	150
12	40	5	15	25	30	40	50	70	80	100	110	130	150					
15	50		10	15	25	30	40	50	60	70	80							
18	60		10	15	20	25	30	40	50	55	60							
21	70		5	10	15	20	30	35	40	45	50	60	70					
24	80		5	10	15	20	25	30	35	40	45	50	60	70				
27	90		5	10	12	15	20	25	30	35	40	45	50	60	70			
30	100		5	7	10	15	20	25	30	35	40	45	50	60	70			
33	110			5	10	13	15	20	25	30	35	40	45	50	60	70		
36	120			5	10	12	15	20	25	30	35	40	45	50	60	70		
40	130			5	8	10	15	20	25	30	35	40	45	50	60	70		

M.	12	15	18	21	24	27	30	33	36	40	NEW GROUP	A	B	C	D	E	F	G	H	I	J	K	L		
FT.	40	50	60	70	80	90	100	110	120	130															
	7	6	5	4	4	3	3	3	3	3	← A	24:00 0:10	24:00 3:21	24:00 4:50	24:00 5:49	24:00 6:35	24:00 7:06	24:00 7:36	24:00 8:00	24:00 8:22	24:00 8:51	24:00 8:59	24:00 9:13		
	17	13	11	9	8	7	7	6	6	6	← B	3:20 0:10	4:49	5:48	6:34	7:05	7:35	7:59	8:21	8:50	8:58	9:12			
	113	67	44	36	27	18	15	9	8		← C		1:39	2:38	3:24	3:57	4:25	4:49	5:12	5:40	5:48	6:02			
	105	59	38	30	22	14	12	5			← D	0:10	1:10	1:58	2:29	2:59	3:21	3:44	4:03	4:20	4:36				
	93	51	31	25	17	9	8				← E		1:09	1:57	2:28	2:58	3:20	3:43	4:02	4:19	4:35				
	81	42	25	19	12	5	4				← F	0:10	0:55	1:30	2:00	2:24	2:45	3:05	3:22	3:37					
	69	33	19	14	7						← G					0:54	1:29	1:59	2:23	2:44	3:04	3:21	3:36		
	57	24	11	8							← H	0:10	0:46	1:16	1:42	2:03	2:21	2:39	2:54						
	43	14									← I					0:45	1:15	1:41	2:02	2:20	2:38	2:53			
	29	4									← J					0:10	0:41	1:07	1:30	1:48	2:04	2:20			
	14										← K					0:40	1:06	1:29	1:47	2:03	2:19				
	4										← L					0:10	0:37	1:00	1:20	1:36	1:50				
	101	76	61	50	43	38	34	31	28	25										0:33	0:54	1:11	1:25		
	87	66	52	43	38	33	30	27	25	22										0:10	0:34	0:55	1:12	1:26	
	43	14																		0:36	0:59	1:19	1:35	1:49	
	116	87	70	57	48	43	38	AVOID REPETITIVE DIVES OVER 100 FEET				← J							0:10	0:31	0:49	1:04			
	138	99	79	64	54	47					← K									0:10	0:29	0:45	1:05		
	161	111	88	72	61	53					← L									0:10	0:26	0:45	1:05		

TABLE 3 - REPETITIVE DIVE TIMETABLE

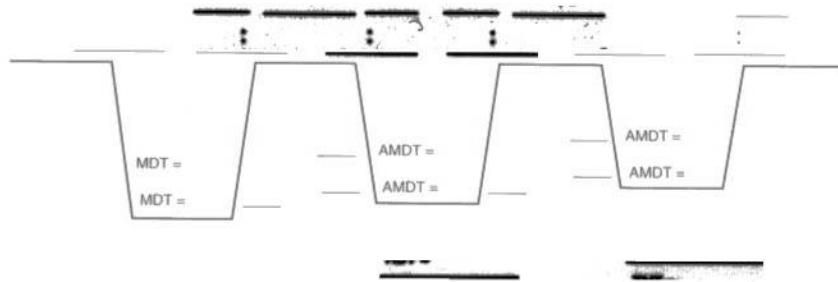
TABLE 2 - SURFACE INTERVAL TIME (SIT) TABLE

00 LIGHT FACE NUMBERS ARE RESIDUAL NITROGEN TIMES (RNT) TIME RANGES IN HOURS : MINUTES © 1989 NAUI  
 00 BOLD FACE NUMBERS ARE ADJUSTED MAXIMUM DIVE TIMES (AMDT) ACTUAL DIVE TIME SHOULD NOT EXCEED THIS NUMBER. #33501 (9/99)

APPENDIX C



DIVE PLANNING WORKSHEET



TERMS AND ABBREVIATIONS USED IN DIVE PLANNING

**Repetitive Dive** – Any dive made less than 24 hours after a previous dive.

**ADT** – Actual Dive Time – The time from the moment of descent until returning to the surface.

**Letter Group** – A letter symbol for the amount of Residual Nitrogen remaining in the body from previous dives.

**SIT** – Surface Interval Time – The time spent at the surface between dives.

**RNT** – Residual Nitrogen Time – The nitrogen remaining in the body from a dive or dives made within the past 24 hours.

**AMDT** – Adjusted Maximum Dive Time – The maximum Dive Time for the depth of a dive minus the RNT.

**TNT** – Total Nitrogen Time – The sum of RNT and ADT. This figure is used to obtain a letter group after repetitive dives.

**REMEMBER**

Consider all dives made shallower than 40'/12m as 40' dives.

On any dive, ascend no faster than one foot every two seconds (30ft/9m per minute).

For maximum dive time, make all repetitive dives shallower than your previous dive.

**APPENDIX D  
DIVING ACCIDENT FIRST AID MANUAL**

TABLE OF CONTENTS

INTRODUCTION .....D 2

I. DIVERS ALERT NETWORK AND HOW TO USE THE DAN HOT-LINE  
CORRECTLY . D 3

II. IMMEDIATE CARE OF DIVING ACCIDENT VICTIM .. D 4

Diving Accident Management Flow Chart ....D 5

Cardiopulmonary Resuscitation D 6

III. THE UNDERWATER DIVING ACCIDENT VICTIM .D 7

Mild Symptoms .....D 7

Severe Symptoms .....D 7

The Role of Oxygen .....D 8

Position .....D 8

Danger - Do Not Attempt In-Water Recompression . . D 8

IV. SIGNS AND SYMPTOMS OF PRESSURE-RELATED DIVING INJURIES D 8

Air Embolism .....D 8

Decompression Sickness .....D 9

Pneumothorax .....D10

Mediastinal Emphysema .....D10

Subcutaneous Emphysema .....D10

IV. DIAGNOSIS KEY ..... D11

V. DIVING ACCIDENT FOCUSED PATIENT SURVEY ..... D13

Primary Survey ..... D13

Secondary Survey ..... D14

VI. INITIAL NEUROLOGICAL EXAMINATION ...D 16

VII. VITAL SIGNS AND INITIAL NEUROLOGICAL EXAMINATION  
CHECKLIST ..... D19

## APPENDIX D

### EMERGENCY FIRST AID PROCEDURES FOR DIVING ACCIDENTS

#### INTRODUCTION

The information contained in this Diving Accident First Aid Manual is a simplified system of identifying and stabilizing diving accident victims and facilitating entry into the hyperbaric trauma care system. Divers have unique medical needs because of the rare and unusual nature of serious diving injuries. Because very few physicians are trained in diagnosing and treating divers, the diver him/herself must be able to recognize the signs and symptoms of injury and ensure that he/she has access to diving medical assistance, should it be needed. This manual is not intended to act as a substitute for training and practice in CPR and first aid. All divers are expected to maintain currency in emergency skills.

Although primarily intended as a treatment guide for Institution diving operations in the field, this appendix can also be used to ensure that paramedics, physicians, Coast Guard and other assisting personnel understand and perform the specialized procedures for handling diving accident cases. The reader must be cautioned, however, that the information in this manual is presented in a simplified version and is not intended to cover the complete treatment of a diving accident victim. Definitive treatment of diving accidents must be planned through consultation with medical personnel trained and engaged in diving (hyperbaric) medicine. Detailed expert medical advice on recompression therapy is continuously available through the Divers Alert Network emergency number.

Use this guide in conjunction with Section 10, Emergency Procedures for WHOI Divers.

Portions of this first aid manual have been excerpted from:

American Heart Association, Heartsaver Manual, 1987, 2001.

Corry, James, "Student Workbook for Emergency Oxygen Administration and Field Management of Scuba Diving Accidents Workshop, National Association of Underwater Instructors, Montclair, CA, 1989.

Mebane, G. Yancey, ed., "Underwater Diving Accident Manual," National Divers Alert Network, Duke University, Durham, NC, 1981.

Miller, James W., ed., NOAA Diving Manual, U.S. Government Printing Office, Washington, D.C., 1979.

Rutkowski, Dick, "Diving Accident Management," Florida Underwater Council, Miami, FL, 1982.

Somers, Lee H., "Diving Safety Bulletin," University of Michigan, 1971.

**APPENDIX D  
DIVERS ALERT NETWORK  
AND HOW TO USE THE DAN HOTLINE CORRECTLY**

The Divers Alert Network (DAN) was formed in 1981 to assist in the treatment of underwater diving accidents by providing a 24-hour telephone emergency number (919) 684-9111. The call is received at the national DAN headquarters at Duke University Medical Center in Durham, North Carolina, where it is connected with on-call physicians experienced in underwater diving accident treatment. These physicians assist with diagnosis and initial treatment of an injured diver and supervise referral to appropriate recompression chambers while working with regional coordinators throughout the U.S.

To use the emergency network, a diver or physician dials (919) 684-9111 and asks for DAN (collect calls are accepted in an actual emergency). The call is answered by an operator at the DUMC switchboard. The operators at Duke are not trained in Diving medicine. If you suspect you or another diver is suffering from decompression sickness or arterial gas embolism, tell the operator:

1. You are calling DAN;
2. You have an emergency or an urgent problem related to a dive;
3. That you must talk to the DAN physician on call.

DAN physicians carry a pager and are on call 24 hours a day. When an emergency call is taken by the operator the DAN physician is paged. If he is in the hospital the caller will be connected directly to the diving physician. If he is outside the hospital the operator will take your number to pass on to the physician or she will pass the physician's number on to you.

The physician may advise the caller directly or refer him/her to a local diving physician. If needed, the physician will work with one of 7 DAN Regional Coordinators to arrange referral and transport to an appropriate treatment facility.

DAN Regional Coordinators are qualified in diving medicine and know about treatment facilities available in their regions. In addition, each region has trained medical staff and suitable chambers available continuously.

The DAN physician or Regional Coordinator may ask you to wait at your phone number while he arranges for treatment. This can take a minimum of 5 to 15 minutes and sometimes longer. This time is necessary to contact and consult with the local treatment facility. This time frame will not place the diver in danger. If a life-threatening situation is at hand DAN should not be the first contact. Divers dealing with a gravely ill person should contact the Coast Guard first if out at sea, or the local emergency rescue service or hospital if inland. DAN should be contacted after the injured diver has been placed in the hands of professional medical personnel. Be prepared to give background information regarding the accident, name and telephone number of the physician/facility.

All calls that are not an actual diving accident or true emergency should be directed to the DAN information and office number, (919) 684-2948 which is available 9 a.m. - 5 p.m., Monday through Friday, Eastern time.

**APPENDIX D**  
**IMMEDIATE CARE OF DIVING ACCIDENT VICTIM**

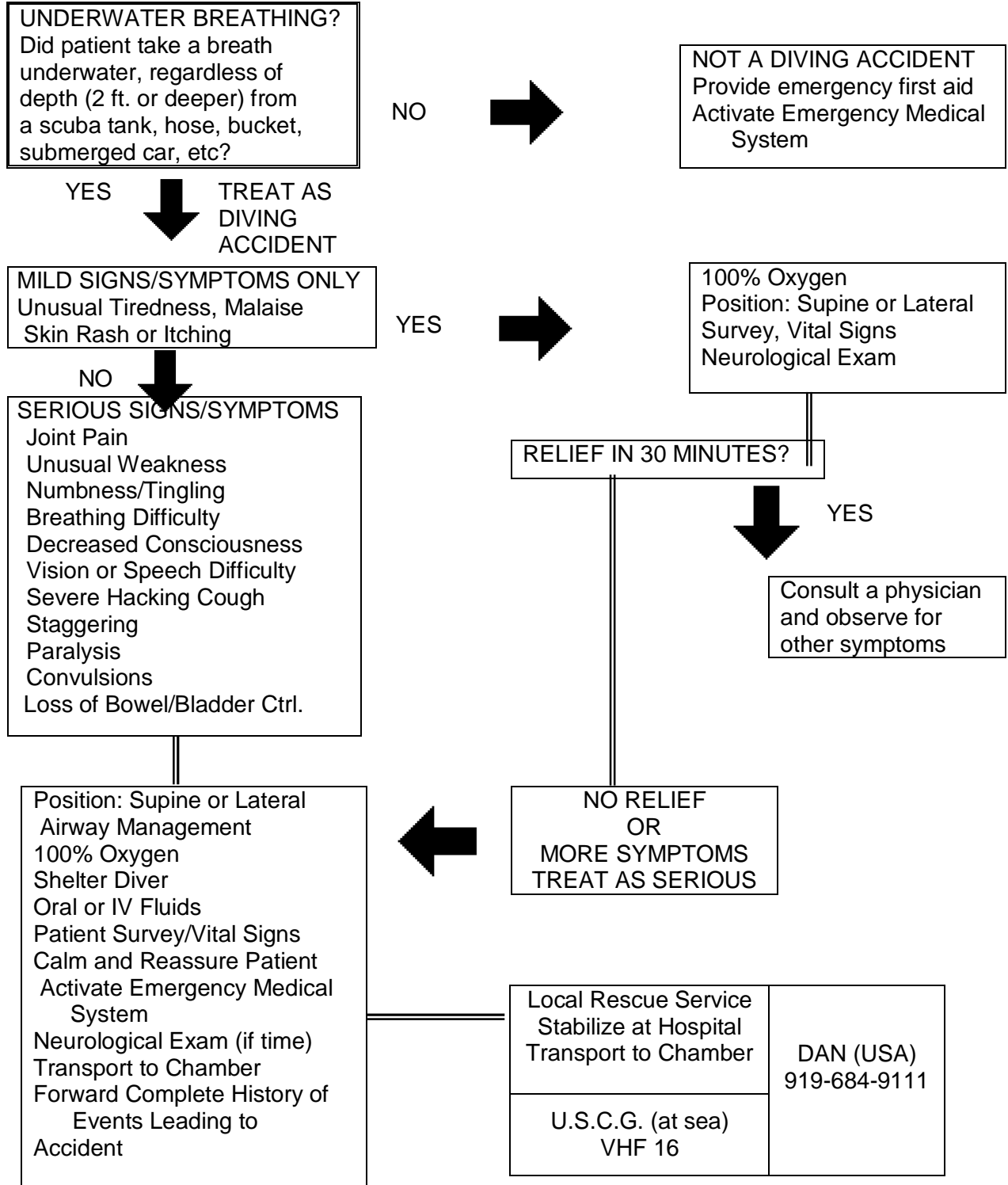
Divers Alert Network (DAN)  
(USA) 919-684-9111

1. Maintain airway, breathing, and circulation, perform CPR if required, control serious bleeding.
2. Place victim in appropriate accident management position:
  - a. Initially place all victims supine (flat on back).
  - b. Roll nauseated or unconscious patients on their side (lateral recumbent) to facilitate airway management. Paramedics use endotracheal tube in unconscious patient.
  - c. Always handle patient gently; turn the head and body as a unit.
3. Administer oxygen by demand valve or tight-fitting non-return mask at the highest possible oxygen concentration. Do not remove oxygen unless it is necessary to reopen the airway.
4. If convulsion occurs, do not forcefully restrain. Turn patient on side (supporting head and neck), maintain airway, and sweep away any vomitus. Hold patient loosely to prevent self-injury and do not force airway or tongue blade. Resume oxygen administration.
5. Protect the patient from excessive heat, cold, wetness, or noxious fumes. Comfort and reassure the patient.
6. If transport time is greater than 1 hour, give conscious, patients who are not nauseated, vomiting or have decreased level of consciousness non-alcoholic, non-caffeinated, non-carbonated oral liquids such as water, fruit juices, or diluted (i.e., half strength) balanced salt solutions e.g., Gatorade® at the rate of 4 fluid ounces every 15 minutes or as tolerated. Monitor and record urine output.
7. If qualified paramedic level medical personnel are present: intravenous fluid replacement with electrolyte solutions is preferred for unconscious or seriously injured victims. Ringer's lactate, normal saline, 5% dextrose in saline may be used, but 5% dextrose in water should not be used.
8. If at sea, contact Coast Guard; if inland, contact local emergency rescue service; contact the DAN hotline; if recompression is needed, patient should be evaluated and stabilized at the nearest hospital emergency room prior to transfer to a recompression chamber.
9. If air evacuation is used flight crews must maintain cabin pressure as close to sea level as possible (<800 feet).
10. If time and circumstances permit, perform a head to toe patient survey, take vital signs, conduct an initial neurological examination and get a full history of the incident. Send recorded findings and history with patient.

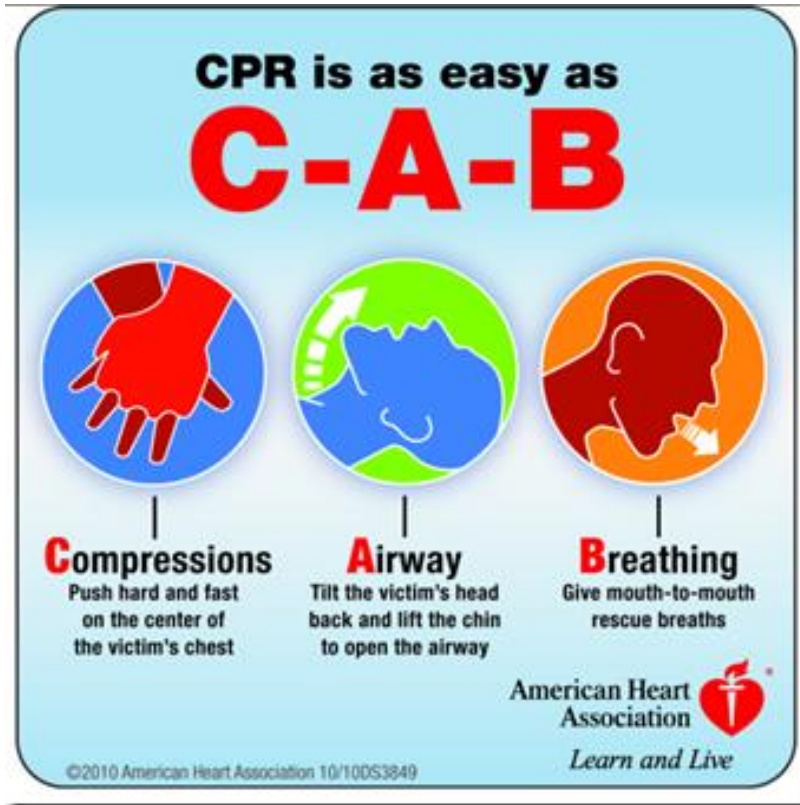
**APPENDIX D  
DIVING ACCIDENT MANAGEMENT FLOW CHART**

STAY CALM

MAINTAIN AIRWAY, BREATHING, CIRCULATION (ABC'S)  
CPR IF NECESSARY  
CONTROL SEVERE BLEEDING



APPENDIX D  
CARDIOPULMONARY RESUSCITATION (CPR)



## Chest compressions come first now

New cardiopulmonary resuscitation guidelines show the importance of starting chest compressions immediately, instead of opening the victim's airway and breathing into their mouth first.

**CPR revised guidelines: Think C-A-B**

**COMPRESSIONS**

Push at least 2 inches on adult breastbone, 100 times per minute, to move oxygenated blood to vital organs



**AIRWAY**

Open the airway and check for breathing or blockage; watch for rise of chest and listen for air movement



**BREATHING**

Tilt chin back for the unobstructed passing of air; give two breaths and resume chest compressions



**NOTE:** Those untrained in CPR can simply do chest compressions until help arrives.

SOURCE: American Heart Association

AP

## APPENDIX D THE UNDERWATER DIVING ACCIDENT VICTIM

If a diver surfaces from a dive and behaves in an unusual manner, appears confused, or has unusual fatigue, weakness or skin rash, he may have early symptoms of an underwater diving accident. In any situation suggesting an underwater diving accident, the primary question is "Did the subject breathe compressed air underwater?" If the answer is "Yes," or if the victim is unconscious then the subject must be regarded as a diving accident victim. The diving accident treatment procedure must be initiated immediately (See Flow Chart - page D5).

### **Mild Symptoms**

The injured diver may experience mild symptoms at first and ignore the warning signals until serious symptoms have developed. Fatigue or unusual tiredness and itching are considered mild symptoms and may respond to treatment with oxygen. Joint pain has sometimes been considered to be a mild symptom but requires recompression and therefore is handled as a serious symptom. No symptoms should be ignored, as the progression from mild to serious can occur rapidly.

Immediately place the diver in the supine position (flat on his back) and administer oxygen in the highest possible concentration. Oxygen treatment often relieves the symptoms or prevents them from getting worse. The victim will probably deny the possibility of having a problem and may refuse oxygen. Good judgment should prevail and the diver should receive treatment. If the symptoms appear relieved after an interval of oxygen treatment, continue administering the oxygen, as the symptoms may recur. The patient should continue to receive oxygen for at least thirty minutes for mild symptoms, and then the Flow Chart should be followed for further instructions.

### **Severe Symptoms**

Severe symptoms consisting of pain, weakness or paralysis, staggering, respiratory difficulties (chokes) or unconsciousness require immediate treatment and evacuation into the hyperbaric trauma system. Cardiopulmonary resuscitation will be required if the victim has no pulse or respiration. If a person at any time within 24 hours after a dive shows any of the severe symptoms indicated on the Flow Chart, immediately provide the victim with oxygen and place in the supine (flat on back) position. Monitor and record vital signs and follow the instructions in the Flow Chart until evacuation to a recompression chamber has been accomplished.

It is important to remember that because these signs and symptoms can develop hours after diving, the patient may show up at a hospital emergency room or other medical facility in the community. For this reason, it is important for paramedics and physicians to recognize the symptoms and to understand this problem so that the underwater diving accident procedure can be initiated. *Any person delivering an underwater diving accident patient to a medical facility should provide that facility with this manual and the complete history recorded on the forms included in this manual. The manual should stay with the patient until he reaches the Hyperbaric Trauma Center in order to provide those caring for the patient with full information concerning the accident.*

## **APPENDIX D THE ROLE OF OXYGEN**

The administration of 100% oxygen is one of the most important aspects of managing diving accidents in the field. A high concentration of oxygen will increase the oxygen partial pressure (PO<sub>2</sub>) in the blood. This establishes a steeper gradient across the bubble-tissue interface and aids in the elimination of inert gas from the offending bubbles, reducing the bubble size to some extent. Additionally, elevated oxygen PO<sub>2</sub> allows better oxygenation of tissues where the blood supply is marginal because of partial blockage by the bubbles. Further benefits of oxygen are a tendency to reverse the effects of shock and to reduce swelling (edema) of brain tissue. Oxygen should be given as soon as possible to a diving injury patient.

### **POSITION**

The modified Trendelenberg position -- a steep, 30° head down, left side down position -- has traditionally been recommended for treatment of diving casualties during first aid and transport to the chamber. The theory behind this recommendation is that the resulting increased blood pressure and dilation of cerebral arteries may tend to dislodge the offending bubbles and push them further, perhaps even into venous circulation. It is probably useful only during the first hour after the accident has occurred. Unfortunately, prolonged (>20 minutes) use of this position may cause difficulty in breathing, as the abdominal organs begin to shift downward, impinging upon the diaphragm. A serious complication of prolonged steep head low positioning in embolism patients is the inducement or aggravation of cerebral edema. The Trendelenberg position is not useful for DCS patients.

The current recommendation from DAN and the Undersea and Hyperbaric Medical Society is to use the supine position (flat on the back) for conscious patients who are not nauseous or vomiting. Moderate elevation of the legs, as in shock treatment, may prevent respiratory discomfort and still aid the cerebral circulation. If the patient's condition is made worse by lifting the legs, he should be returned to the horizontal position. Unconscious patients, or persons who are nauseated, vomiting or whose airway reflexes are not fully intact, should be placed on their side (lateral recumbent position) to help prevent aspiration of vomitus. Either the right or left side may be used. If an embolism is suspected do not allow the patient to sit or stand up.

### **DANGER - DO NOT ATTEMPT IN-WATER RECOMPRESSION**

In-water recompression should never be attempted in a diving accident. This technique usually ends with the diver forced to the surface by cold or inadequate air supply, and the only result is that the bubbles are further loaded with nitrogen, causing a worsening of symptoms. Also, it is better to treat asymptomatic divers who have omitted decompression with surface oxygen than to have them return to the water.

### **SIGNS AND SYMPTOMS OF PRESSURE-RELATED DIVING INJURIES**

#### Air Embolism

As a diver surfaces without exhaling, air trapped in the lungs expands and may rupture lung tissue releasing gas bubbles into the circulatory system where they may be distributed to the body tissues. The ascending diver is normally in a vertical position and the bubbles tend to travel upward toward the brain, eventually reaching a small artery blocking circulation. The effects of halting circulation to the brain are critical and require immediate treatment. Symptoms of embolism may be present when the victim reaches the surface or within a few

## APPENDIX D

minutes afterwards. While the presentation is often dramatic, an air embolism can also cause minimal symptoms of neurological dysfunction such as numbness or tingling of an arm or leg, weakness of a particular body region, or vision, speech or hearing loss, without loss of consciousness.

**CAUSE:**

1. Holding breath during ascent while breathing compressed gas
2. Possible result of panic or uncontrolled ascent
3. Trapping of air in lungs due to asthma, mucous, water inhalation, laryngeal spasm, cough or cold

**NOTE:** Arterial gas embolism can occur after a normal ascent. Diving with a cough or chest cold increases the risk of an embolism.

**SIGNS & SYMPTOMS**

1. Cry, gasping, grunt on surface
2. Dizziness, nausea
3. Speech or vision disturbance
4. Paralysis or weakness
5. Confusion
6. Bloody froth from mouth or nose
7. Chest pain
8. Convulsions
9. Unconsciousness
10. Cessation of breathing
11. Other neurological deficits
12. Death

**NOTE:** Symptoms and signs usually appear immediately or shortly (within 10 minutes) after surfacing. Symptoms of pulmonary barotrauma may also be present.

### Decompression Sickness

Decompression sickness (bends, Caisson disease) is the result of inadequate decompression following exposure to increased pressure. The body tissues absorb gas in proportion to the surrounding pressure and as long as the diver remains at pressure, the gas presents no problem. If the pressure is too quickly removed (as in rapid surfacing), the inert gas comes out of solution and forms bubbles in the tissues and blood stream. While immediate recompression is not usually a matter of life and death as with air embolism, the quicker recompression is initiated, the better the rate of recovery.

**CAUSE:** Inadequate decompression

**NOTE:** DCS often occurs when decompression tables have been exceeded or after a rapid ascent from a deep dive, but it can occur even on dives that are within the accepted no-decompression limits.

**SIGNS & SYMPTOMS**

1. Extreme fatigue, lethargy, malaise
2. Skin itch
3. Pain in joints of arms or legs
4. Dizziness/headache
5. Shortness of breath or uncontrollable coughing
6. Numbness or tingling sensation in extremities
7. Skin may show a blotchy rash
8. Staggering or other incoordination
9. Weakness or paralysis
10. Loss of bladder or bowel control

NOTE: Symptoms and signs usually appear anywhere between 15 minutes to 12 hours after surfacing, but may appear as much as 48 hours after a dive. If a diver surfaces with omitted decompression, have him breathe 100% oxygen rather than return to the water.

### **Pneumothorax**

Air enters chest cavity causing lungs to collapse.

CAUSE: Holding breath during ascent

- SIGNS & SYMPTOMS
1. Shortness of breath
  2. Sharp pain in chest
  3. Rapid shallow breathing
  4. Blueness of skin, lips, fingernails
  5. Lungs sound different from one side to another
  6. Resonant or "hollow+sound on percussion

- TREATMENT:
1. Monitor ABC's, administer CPR if needed, administer oxygen, immediate transport to hospital emergency room.
  2. Do NOT use recompression without chest tube.
  3. Physician will insert chest tube to withdraw air and reinflate lung.
  4. Monitor patient for signs of embolism.

### **Mediastinal Emphysema**

Air released into tissues surrounding the heart

CAUSE: Holding breath during ascent

- SIGNS & SYMPTOMS
1. Faintness
  2. Shortness of breath
  3. Pain under breastbone
  4. Change in voice

- TREATMENT
1. Monitor ABC's, administer CPR if needed, oxygen, immediate transport to hospital emergency room.
  2. Do NOT use recompression unless complicated with air embolism or decompression sickness.
  3. Observe for other problems.

### **Subcutaneous Emphysema**

Air trapped under skin (usually around neck)

CAUSE: Holding breath during ascent

- SIGNS & SYMPTOMS
1. Feeling of fullness around neck
  2. Change in voice
  3. Swelling of neck, resembling a bullfrog
  4. Difficulty swallowing
  5. Crackling sound when skin is pressed

- TREATMENT:
1. No real emergency
  2. Usually no treatment needed, but administer oxygen and transport to hospital emergency room anyway.
  3. Observe for other problems.

**APPENDIX D**

**Diver Injury Diagnosis Key**

<b>Symptom/Sign</b>	<b>Circumstances</b>	<b>Probable Injury</b>	<b>Management</b>
Bleeding/external ear	Ear pain during descent/ascent	Ruptured eardrum	Terminate diving; nothing in ear; avoid contamination; medical attention
Bleeding/external ear	Hit head	Fractured skull	Keep victim lying down and inactive; keep warm; no fluid; do not elevate feet; constant attendance; immediate medical attention.
Spitting blood	Ear pain during or following descent/ascent	(1) Ruptured eardrum ( 2) Middle ear	See Above (Ruptured Eardrum) Terminate diving; medical attention if drainage/discomfort persists
Spitting/coughing blood; bloody froth	Emergency ascent	Pulmonary injury; possible air embolism	Observe for illness and signs of neurological damage (visual disturbances, paralysis, personality changes, etc.); follow Diving Accident Management flow chart, page D-5 and Immediate Care, page D-4; also refer to chapter 9.
Bloody discharge/nose	Pain in sinuses during ascent/ descent	Sinus squeeze (or reverse sinus squeeze)	Terminate diving; medical attention if drainage/ discomfort persist.
Chest pain/ breathing	Emergency/ uncontrolled ascent; chest congestion prior to dive	Pneumothorax/ mediastinal emphysema/ subcutaneous emphysema	See Air Embolism
Neurological abnormalities including: loss of balance/ coordination visual disturbance rigidity/numbness of extremities, paralysis personality changes	Emergency/ uncontrolled ascent; or congestion prior to decompression diving; smoker; sickness symptoms dramatic & sudden; inadequate decompression	Air embolism	Go to page D-4, D-5:

**APPENDIX D**

<b>Symptom/Sign</b>	<b>Circumstances</b>	<b>Probable Injury</b>	<b>Management</b>
Cyanosis (Bluish coloration)	Emergency/ un-controlled ascent; chest congestion prior to dive; chest pain following dive	Pneumothorax/ mediastinal emphysema	See Air Embolism
Swelling in neck area	Emergency/ uncontrolled ascent; chest congestion prior to dive; chest pain following dive	Subcutaneous emphysema	See Air Embolism
Unconsciousness	Occurs while or shortly after surfacing from a dive	Air embolism or decompression sickness, heart attack	See Air Embolism
Respiratory or cardiac arrest	Occurs while or shortly after surfacing from a dive	Air embolism or decompression sickness, heart attack	See Air Embolism
Pain in joints or extremities	Occurs shortly after surfacing from a dive near or beyond no-decompression limits	Decompression sickness	See Air Embolism
Cyanosis (bluish coloration)	Loss of consciousness during dive; closed circuit or mixed gas	Carbon dioxide excess (hypercapnia) or Hypoxia	Surface; resuscitation; oxygen; medical attention; do not exclude air embolism
Reddish coloration	Loss of consciousness during or after dive	Carbon Monoxide Poisoning	See CO2 excess; oxygen until turned over to physician; monitor continuously
Respiratory distress with strong oil taste	Oil contamination of breathing air supply	Oil pneumonia	Medical attention

## APPENDIX D DIVING ACCIDENT FOCUSED PATIENT SURVEY

A common problem in the management of diving injuries is an initial misdiagnosis. Since a physician is rarely at the scene of a diving accident, it is important for divers to be able to conduct a short structured examination. The primary survey finds and corrects immediate life threatening problems and must be done immediately upon recovering the victim. The secondary survey is a structured head to toe survey using simple equipment such as a penlight, stethoscope and blood pressure cuff. One person in the team must record the time and all findings. If there is a significant wait for help to arrive, the vital signs and other indicators of the patient's condition must be repeated periodically, since the patient's condition will likely change over time. Portions of the exam may be modified to fit the situation. For example, do not have a suspected embolism patient stand or sit up. Interrupt the administration of oxygen only as required and then as briefly as possible. Record findings on the Initial Neurological Examination Checklist.

### **PRIMARY SURVEY**

Remember that a delay of only a few minutes in these actions may result in brain damage or death.

1. Assess the Accident Scene:
  - Is there an obvious mechanism of injury (fall, amputation, etc.)?
  - Is the scene safe for patient and rescuer (fire, live bare wires, etc.)?
  
2. Is the patient breathing? If not:
  - Position the victim supine (flat on back).
  - Establish an airway (head tilt-chin lift or jaw thrust).
  - Start mouth-to-mouth ventilation.
  
3. Is the heart beating? Feel for the carotid pulse at the neck. If not:
  - Locate landmark and begin compressions.
  
4. Is the patient bleeding? If yes,
  - Stop any serious bleeding with direct pressure, elevation, or pressure points (tourniquet only as a last resort).
  
5. Determine the Level of Consciousness
  - Alert: quick intelligent responses, complete awareness of surroundings, oriented to person, place, time.
  - Verbal: does he respond to a verbal stimulus?
  - Does he appear to be confused, combative, or show any personality change?
  - Does he only respond only to loud verbal stimulus?
  - Painful: does he respond only to painful stimuli (pinch or sternal rub)?
  - Unresponsive: is the patient completely unresponsive to any stimulus?
  
6. Vital Signs:
  - Take the radial pulse. Note the rate (beats per minute) and character: regular or irregular pattern; weak, normal, or very strong?
  - Note the rate (breaths per minute) and character of the respirations: regular or irregular pattern; shallow, normal, or very deep? Is there shortness of breath or other difficulty in breathing? Is it painful to breathe? Is there a cough, blood or sputum?
  - Take blood pressure

## APPENDIX D

### SECONDARY SURVEY

#### 1. Chief Complaint

- Does the patient complain of dizziness, light-headedness, or nausea?
- Is there any pain? Note site and character (sharp, diffuse, etc.)?
- Does the patient feel very cold or complain of extreme thirst?
- Does the patient's voice appear to have changed?
- Has he got diarrhea or is he vomiting? If so, note when this last occurred, frequency, and character. Is blood present?
- Is patient able to pass urine? Is it painful? Note character of urine: clear, dark, blood stained.
- Does the patient have a headache?
- If there is a major injury note site and extent.
- If bleeding has occurred, estimate blood loss.

#### 2. History: record a brief history including the dive profile, time problem started, first signs and symptoms, what was happening at the time.

Some questions to ask of the patient, dive buddy or other witnesses could include:

- Have you been diving using compressed gas recently?
- Describe your dive profiles for the past 24 hours?
- Which table or dive computer did you use, and how close to the limits did you dive?
- Were there any equipment problems or forced, rapid ascents during any dive?
- Did you or your buddy run out of air at any time or drop your weightbelt?
- Determine any allergies, current medications used, past pertinent illnesses, last oral intake, and all events leading up to this situation.
- If at sea, be prepared to relate location, radio call numbers, description of vessel, and patient data.

#### 3. Cervical Spine: inspect and gently feel the bones of the neck

- Is there any deformity? any rash or skin mottling?
- Does the patient complain of pain when certain areas are touched?
- If in doubt of injury, immobilize head and neck!

#### 4. Skull: inspect and gently feel entire skull

- Are there any cuts, swelling, depressions, areas of discoloration?
- Is there clear or bloody fluid draining from ears or nose?
- Is there any bruising behind the ears or below the eyes?
- Is the hearing equal and normal on both sides?
- Does the patient hear any abnormal sounds: buzzing, roaring, etc?

#### 5. Eyes

- Do both pupils react to light? do they react equally? are they round?
- Are the eyes bloodshot?
- Does the patient have any visual disturbances (e.g., squint, limited vision, double vision)?
- Is nystagmus present (flickering of eyes from side to side)?

#### 6. Face

- Is the skin color pale, flushed, or blue? is there any mottling, skin rash, or swelling?
- Does the skin feel warm, hot or cold to the touch?
- Is the patient sweating profusely?
- Inspect and feel for deformities, cuts, discolorations
- Inspect mouth for bleeding, broken teeth, breath odor?

## APPENDIX D

### 7. Throat

- Is the trachea (windpipe) midline, or does it appear to deviate to one side during breathing?
- Do the jugular veins appear to be abnormally distended?
- Does the skin feel crackly when pressed?

### 8. Shoulders and collarbones

- Gently feel for deformities, tenderness, look for discolorations.

### 9. Chest/rib cage

- Look: do both sides rise equally with inspiration?
- Are there any skin rashes, other discoloration? note appearance and site. Are there any other deformities, cuts?
- Feel: sternum and rib cage for deformities, point tenderness
- Listen: use stethoscope to listen for lung sounds on several locations on each side:  
Are breath sounds audible equally on each side?  
Are there any rattling or whistling sounds?
- Percuss: lightly thump several locations on each side
- Does one side appear to sound abnormally hollow or dull?

### 10. Abdomen

- Look: are there any rashes, skin mottling, cuts, etc.?
- Gently feel each quadrant  
Does the abdomen feel very rigid, or very flaccid?  
Are there any painful or tender areas? If so, note site.  
Does the patient have normal sensation
- Listen with stethoscope  
Are bowel sounds present? If so, are they louder or more frequent than normal?

### 11. Pelvic

- Gently press the pubic bone and pelvic wings for fractures.
- Palpate the femoral artery on each side of the groin.

### 12. Legs, Feet, Arms, Hands

- Look for rashes, other discolorations, swellings, deformities, etc.
- Feel for deformities (dislocations, fractures)
- Immobilize obviously broken limbs to minimize further damage.
- Feel for pulse (pedal in feet, radial in hands)
- Check capillary refill in digits
- Note skin temperature, color
- Are there any abnormal sensations: tingling, numbness, itchiness, burning, pain?

### 13. Spine

- Gently logroll patient as a unit and inspect the rear of the skull, spine, and buttocks for injuries, deformities, rashes, etc.
- If possible, logroll onto a spineboard to avoid unnecessary movement of the patient later.

**APPENDIX D**  
**INITIAL NEUROLOGICAL EXAMINATION**  
**TO BE ADMINISTERED BY NON MEDICAL PERSONNEL**

**NOTE:** This examination should be given if time, circumstances and condition of patient permit. The purpose is to check for any deficits in sensory, motor, or reflexive function. A good clue is whether the overall muscular strength is equal on both sides. When interpreting the results of this examination, attempt to determine that abnormalities are the result of the diving disorder and not a previous condition. A checklist for this examination is provided.

**MENTAL CONDITION OR STATUS**

Since less interference is required to impair functioning of the higher mental faculties, test for subtle signs of serious decompression sickness by observing:

1. Orientation

- Time (the first function to go) Example: "What day is this?"
- Place (the next to go) Example: "Where are you?"
- Person (severe impairment) Example: "What is your name?"

2. Memory

- Immediate (test with a number series)
- Recent (happenings within the past 24 hours)
- Remote (background)

3. Mental Function

- Test by using serial 7's. (Subtract 7 from 100, then 7 from the answer, and so on. If an error is repeated, like, "93, 90, 83, 80, 73, 70,+there is a condition called perseveration that usually indicates impairment)

4. Level of Consciousness

- Watch for any changes over time

5. Seizures

- These are readily apparent

**CRANIAL NERVES**

Check all cranial nerves, if possible. Test one side vs. the other side.

1. Sense of Smell (First Nerve: Olfactory)

- Test with coffee, one nostril at a time. If coffee is not available
- do not delay with the rest of this test.

2. Sight (Second Nerve: Optic)

- Hold up fingers for the patient to count; test one eye at a time.

3. Eye Movement (Third, Fourth, Sixth: Oculomotor, Trochlear, Abducens)

- Have the patient's eyes follow your finger as you move it up and down, left and right.

4. Chewing (Fifth Nerve: Trigeminal)

- Can the teeth be clenched? Feel jaw muscles on both sides simultaneously.

## APPENDIX D

5. Mouth (Seventh Nerve: Facial)
  - Can the patient smile?
  - Can both corners of the mouth be lifted simultaneously?
6. Hearing (Eighth Nerve: Acoustic)
  - Test one ear at a time by whispering or rubbing your fingers together approximately one inch away from the ear.
7. Talking (Ninth, Tenth Nerves: Glossopharyngeal, Vagus)
  - The patient will gag if the back of the throat is touched.
  - Ask the patient to say "Ah" and watch his soft palate - it will normally arch upwards.
8. Shoulder Muscles (Eleventh Nerve: Spinal Accessory)
  - Have the patient shrug the shoulders while you press down on them.
  - Note any unilateral weakness.
9. Tongue (Twelfth Nerve: Hypoglossal)
  - Can the patient stick the tongue straight out or does it deviate to one side)

### SENSORY NERVES

- Does the patient describe the presence of any abnormal sensation such as pins and needles, numbness, itchiness, or burning sensations?
- Sensation should be tested on both arms and both legs, and the front and back of the chest and abdomen.
- Can the patient detect when the fingers or a piece of soft cloth are brushed over the skin?
- Sharp vs. Dull (check one hand vs. the other) Using sharp (corner of a plastic credit card) and dull objects, see if patient can distinguish between them by testing:
  1. Back of hand
  2. Base of thumb
  3. Base of little finger

### MOTOR NERVES

1. Muscle Strength
  - Have patient grip two of your fingers with each hand. Is the strength equal in each hand?
  - With patient sitting or lying down, place your hands on the legs just above the ankle and press down lightly. Have the patient try to lift the legs. Is the strength equal in both?
2. Range of Motion
  - Check normal movement of both arms and legs.
3. Muscle Tone
  - Check if muscles are spastic (in state of contraction) or flaccid (totally relaxed).

## APPENDIX D

### COORDINATION (Cerebellar Function)

#### 1. Point of Space

- Can patient touch your finger held in front of nose?

#### 2. Finger to Nose

- Can the patient move a finger from touching your finger to tip of his nose, repeating the motion?

#### 3. Gait

- Walking gait - check for "rubber legs," staggering, and unsteadiness.
- Tandem gait - walking heel to toe.

#### 4. Balance (sharpened Romberg test)

- Have the patient stand straight, feet together, arms folded in front and eyes closed. Romberg's test is positive if he is unable to stand steadily in this position.

#### 5. Basic Reflexes (check both sides with blunt instrument)

- The knee reflex is the easiest and most helpful to test. With the patient sitting or lying he is asked to bend his knees. The examiner then strikes one leg just below the kneecap. That leg should briskly straighten. The response should be similar in both legs. If not or if there is no response in either, it suggests neurological decompression sickness.

### REFLEXES

#### 1. Babinski Reflex

- Run a blunt object up the sole of the foot. If the toes curl down toward the sole of the foot, a normal Babinski is present. If nothing happens, no conclusion can be drawn, but if the toes flex backward, upward, and spread, this is a reliable sign of probable spinal involvement.

### LANGUAGE PROBLEM

#### 1. Aphasia (speech impairment)

- Check for language errors like misplaced words and incorrect word order.

The results of this examination should be communicated to a consulting physician if a physician is not present on site, or should be given directly to an attending physician at the first opportunity.





**APPENDIX E**

**DIVE ACCIDENT REPORTING FORM**

1. DATE AND TIME OF ACCIDENT (Month/Day/Year)		2. PATIENT NAME Last First MI																						
3. JOB TITLE		4. AFFILIATION WITH WHOI  <input type="checkbox"/> A Employee <input type="checkbox"/> B Student <input type="checkbox"/> C Visiting Investigator <input type="checkbox"/> D Other _____																						
5. DEPARTMENT																								
6. WHOI ADDRESS/MS #	7. WHOI PHONE EXT.	8. HOME PHONE ( ) -																						
9. HOME ADDRESS  Street City State Zip																								
10. AGE <input type="text"/> <input type="text"/> YRS	11. SEX <input type="checkbox"/> (M or F)	12. HEIGHT <input type="text"/> <input type="text"/> FT IN	13. WEIGHT LBS. <input type="text"/> <input type="text"/> <input type="text"/>	14. YEARS DIVING YEARS MONTHS <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>																				
15. PREVIOUS MAJOR ILLNESSES/SURGERY (Provide up to 3 responses)  <input type="checkbox"/> A-Lung <input type="checkbox"/> B-Asthma <input type="checkbox"/> C-Heart <input type="checkbox"/> D-Gastrointestinal/Abdominal <input type="checkbox"/> E-Brain <input type="checkbox"/> F-Spine/Back <input type="checkbox"/> G-Limb or Joint of DCS Site <input type="checkbox"/> H-Circulation/Blood <input type="checkbox"/> I-Neurological/Nervous System <input type="checkbox"/> J-Muscle/Skeletal System <input type="checkbox"/> K-Eye <input type="checkbox"/> L-Mental/Emotional <input type="checkbox"/> M-Other _____ <input type="checkbox"/> N-None  List and describe specific Problems		16. CURRENT HEALTH PROBLEMS WITHIN PREVIOUS 2 MONTHS (Provide up to 3 responses)  <input type="checkbox"/> A-Lung <input type="checkbox"/> B-Asthma <input type="checkbox"/> C-Heart <input type="checkbox"/> D-Gastrointestinal/Abdominal <input type="checkbox"/> E-Brain <input type="checkbox"/> F-Spine/Back <input type="checkbox"/> G-Limb or Joint of DCS Site <input type="checkbox"/> H-Circulation/Blood <input type="checkbox"/> I-Neurological/Nervous System <input type="checkbox"/> J-Muscle/Skeletal System <input type="checkbox"/> K-Eye <input type="checkbox"/> L-Mental/Emotional <input type="checkbox"/> M-Other _____ <input type="checkbox"/> N-None  List and describe specific Problems																						
17. PREVIOUS DIVE ACCIDENTS <input type="checkbox"/> A-Possible DCS <input type="checkbox"/> B-DCS <input type="checkbox"/> C-Pulmonary Barotrauma <input type="checkbox"/> D-AGE <input type="checkbox"/> E-None		18. CURRENT MEDICATIONS  <input type="checkbox"/> Y-Yes or N-No <input type="checkbox"/>  Prescription Non- List: _____ Prescription		19. PREDIVE HEALTH <input type="checkbox"/> A-Nausea/Vomiting <input type="checkbox"/> B-Hangover <input type="checkbox"/> C-Diarrhea <input type="checkbox"/> D-Other <input type="checkbox"/> E-No Health Problems																				
20. ALCOHOL  Please Check (1/2) Number of Drinks, Beers, or Wine <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:15%;">None</td> <td style="width:15%;"></td> <td style="width:15%;"></td> <td style="width:15%;"></td> </tr> <tr> <td>Night Before</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Pre-dive</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Between Dives</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Post-dive</td> <td></td> <td></td> <td></td> </tr> </table>		None				Night Before				Pre-dive				Between Dives				Post-dive				21. CIGARETTE USE <input type="checkbox"/> A-Presently <input type="checkbox"/> B-In Past <input type="checkbox"/> C-Never  <input type="text"/> Packs Per Day <input type="text"/> Years Smoking		22. RECREATIONAL DRUG USE  Prior to, Between, or After Dive  <input type="checkbox"/> Y-Yes <input type="checkbox"/> N-No
None																								
Night Before																								
Pre-dive																								
Between Dives																								
Post-dive																								

Please attach separate sheet for narrative description and additional information. This information will be kept confidential and is intended for treatment and research purposes only.

**APPENDIX E**

<p><b>23. STRENUOUS EXERCISE</b> Y-Yes N-No</p> <p><input type="checkbox"/> 24 Hours Pre-dive</p> <p><input type="checkbox"/> During Dive</p> <p><input type="checkbox"/> 6 Hours Post-dive</p>	<p><b>24. AIR SUPPLY</b></p> <p><input type="checkbox"/></p> <p>A-Scuba Air B-Surface Supply Air C-Nitrox _____%O<sub>2</sub> D-Other Mixed Gas</p> <p>E-None/Breath-hold Dive</p>	<p><b>25. BUOYANCY PROBLEM</b></p> <p><input type="checkbox"/> Y-Yes N-No</p>	<p><b>27. TYPE OF SUIT</b></p> <p><input type="checkbox"/></p> <p>A-Wetsuit, Full ¼ inch B-Wetsuit, partial or + C-Drysuit D-Diveskin E-Swimsuit</p>																																																																				
<p><b>28. AIR CONSUMPTION</b></p> <p><input type="checkbox"/> A-Ran Low B-Out of Air C-Buddy Breathing (not Octopus) D-Not a Problem</p>	<p><b>29. WITHIN LIMITS</b></p> <p><input type="checkbox"/> Tables (Specify) _____</p> <p>Or</p> <p><input type="checkbox"/> Computer (Specify) _____</p>	<p><b>30. PURPOSE OF DIVE</b></p> <p><input type="checkbox"/> A-Research B-Other Work</p> <p>C-Recreation D-Training</p>	<p><b>31. ENVIRONMENT</b></p> <p><input type="checkbox"/> A-Freshwater B-Saltwater C-Pool</p>																																																																				
<p><b>32. DIVER'S PERCEPTION OF TEMPERATURE</b></p> <p><input type="checkbox"/> A-Cold B-Hot C-Comfortable</p> <p>Actual Temperature, if Known _____°F</p>	<p><b>33. CURRENT</b></p> <p><input type="checkbox"/> A-Strong B-Moderate C-Mild D-None</p>	<p><b>35. WAS THIS DIVE OR DIVE SERIES TYPICAL OF YOUR NORMAL TYPE OF DIVING?</b></p> <p><input type="checkbox"/> Y-Yes N-No</p> <p>If NO, explain: _____</p>																																																																					
<p><b>34. ALTITUDE</b></p> <p><input type="checkbox"/> A-Sea Level B-&gt;Sea Level but m1000 Feet C-&gt;1000 Feet</p>	<p><b>36. EQUIPMENT USED ON DIVE</b> (Please check all that apply)</p> <p><input type="checkbox"/> Depth Gauge</p> <p><input type="checkbox"/> Timing Device/watch</p> <p><input type="checkbox"/> Buoyancy Compensator (BC)</p> <p><input type="checkbox"/> BC Inflator Hose Used</p> <p><input type="checkbox"/> Dive Computer</p>	<p><b>37. EQUIPMENT MALFUNCTION</b></p> <p><input type="checkbox"/> A-None B-Regulator C-BC</p> <p><input type="checkbox"/> D-Weight Belt E-Dry Suit F-Dive Computer G-Inflator Hose</p> <p><input type="checkbox"/> H-Contaminated Air Supply I-Using Unfamiliar Equipment J-Other: _____</p>	<p><b>38. TYPE OF DIVE</b></p> <p>Y-Yes N-No</p> <p><input type="checkbox"/> Single</p> <p><input type="checkbox"/> Repetitive</p>																																																																				
<p><b>39. DIVE SERIES</b> Please fill in all that apply up to and including your last dive. If you skipped a day please leave that day blank.</p> <table style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="width:35%;"></th> <th style="width:10%;">DAY 1</th> <th style="width:10%;">DAY 2</th> <th style="width:10%;">DAY 3</th> <th style="width:10%;">DAY 4</th> <th style="width:10%;">DAY 5</th> <th style="width:10%;">DAY 6</th> <th style="width:10%;">DAY 7</th> </tr> </thead> <tbody> <tr> <td>Total # of Dives</td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> </tr> <tr> <td>Any Night Dive? (How Many?)</td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> </tr> <tr> <td>Any Symptoms? (Y or N)</td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> </tr> <tr> <td>A-All No-stop dive(s)?</td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> </tr> <tr> <td>B-Safety Stops Used?</td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> </tr> <tr> <td>C-Any Dive With Decompression Stops?</td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> </tr> <tr> <td>Deepest Dive (feet)</td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/></td> </tr> </tbody> </table>									DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	Total # of Dives	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	Any Night Dive? (How Many?)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	Any Symptoms? (Y or N)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	A-All No-stop dive(s)?	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	B-Safety Stops Used?	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	C-Any Dive With Decompression Stops?	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	Deepest Dive (feet)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7																																																																
Total # of Dives	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>																																																																
Any Night Dive? (How Many?)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>																																																																
Any Symptoms? (Y or N)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>																																																																
A-All No-stop dive(s)?	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>																																																																
B-Safety Stops Used?	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>																																																																
C-Any Dive With Decompression Stops?	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>																																																																
Deepest Dive (feet)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>																																																																
<p><b>40. TYPE OF DIVE</b></p> <p><input type="checkbox"/> A-Single      <input type="checkbox"/> A-Multilevel B-Repetitive    B-Square</p>				<p><b>41. WOMEN ONLY: When the accident occurred, were you (up to 2 responses):</b></p> <p><input type="checkbox"/> A-Menstruating B-On Birth Control Medication C-Pregnant D-None of the Above</p>																																																																			
<p><b>42. LOCATION OF DIVE SITE</b> (As Appropriate: dive site name, body of water, city, country, island, coordinates, vessel)</p>																																																																							

**APPENDIX E**

<p><b>43. SIGNS AND SYMPTOMS</b></p> <table style="width:100%; border: none;"> <tr> <td style="width: 15%;">1<sup>st</sup> Symptom</td> <td style="width: 5%;"><input type="checkbox"/></td> <td style="width: 30%;">A-Pain B-Rash C-Itching</td> <td style="width: 50%;">Q-Hemoptysis/Coughing R-Muscle Twitching S-Convulsions</td> </tr> <tr> <td>2<sup>nd</sup> Symptom</td> <td><input type="checkbox"/></td> <td>D-Weakness E-Numbness/Tingling F-Dizziness/vertigo</td> <td>T-Hearing Loss U-Ringing Ears V-Decreased Skin Sensation</td> </tr> <tr> <td>3<sup>rd</sup> Symptom</td> <td><input type="checkbox"/></td> <td>G-Semi-consciousness H-Unconsciousness I- Restlessness</td> <td>W-Bladder Problem X-Bowel Problem Y-Personality Change</td> </tr> <tr> <td>4<sup>th</sup> Symptom</td> <td><input type="checkbox"/></td> <td>J-Extreme Fatigue K-Visual Disturbance L-Speech Disturbance</td> <td>Z-Difficulty Walking/Standing 1-Reflex Change 2-Other_____</td> </tr> <tr> <td>5<sup>th</sup> Symptom</td> <td><input type="checkbox"/></td> <td>M-Headache N- Paralysis O-Difficulty Breathing</td> <td></td> </tr> <tr> <td>6<sup>th</sup> Symptom</td> <td><input type="checkbox"/></td> <td>P-Nausea/Vomiting</td> <td></td> </tr> </table>	1 <sup>st</sup> Symptom	<input type="checkbox"/>	A-Pain B-Rash C-Itching	Q-Hemoptysis/Coughing R-Muscle Twitching S-Convulsions	2 <sup>nd</sup> Symptom	<input type="checkbox"/>	D-Weakness E-Numbness/Tingling F-Dizziness/vertigo	T-Hearing Loss U-Ringing Ears V-Decreased Skin Sensation	3 <sup>rd</sup> Symptom	<input type="checkbox"/>	G-Semi-consciousness H-Unconsciousness I- Restlessness	W-Bladder Problem X-Bowel Problem Y-Personality Change	4 <sup>th</sup> Symptom	<input type="checkbox"/>	J-Extreme Fatigue K-Visual Disturbance L-Speech Disturbance	Z-Difficulty Walking/Standing 1-Reflex Change 2-Other_____	5 <sup>th</sup> Symptom	<input type="checkbox"/>	M-Headache N- Paralysis O-Difficulty Breathing		6 <sup>th</sup> Symptom	<input type="checkbox"/>	P-Nausea/Vomiting		<p><b>44. FIRST AID ADMINISTERED BEFORE HOSPITAL OR CHAMBER HELP WAS RECEIVED?</b> Y-Yes N-No</p> <p><input type="checkbox"/> Oxygen</p> <p><input type="checkbox"/> Oral Fluids</p> <p><input type="checkbox"/> Aspirin</p> <p><input type="checkbox"/> CPR</p>																							
1 <sup>st</sup> Symptom	<input type="checkbox"/>	A-Pain B-Rash C-Itching	Q-Hemoptysis/Coughing R-Muscle Twitching S-Convulsions																																													
2 <sup>nd</sup> Symptom	<input type="checkbox"/>	D-Weakness E-Numbness/Tingling F-Dizziness/vertigo	T-Hearing Loss U-Ringing Ears V-Decreased Skin Sensation																																													
3 <sup>rd</sup> Symptom	<input type="checkbox"/>	G-Semi-consciousness H-Unconsciousness I- Restlessness	W-Bladder Problem X-Bowel Problem Y-Personality Change																																													
4 <sup>th</sup> Symptom	<input type="checkbox"/>	J-Extreme Fatigue K-Visual Disturbance L-Speech Disturbance	Z-Difficulty Walking/Standing 1-Reflex Change 2-Other_____																																													
5 <sup>th</sup> Symptom	<input type="checkbox"/>	M-Headache N- Paralysis O-Difficulty Breathing																																														
6 <sup>th</sup> Symptom	<input type="checkbox"/>	P-Nausea/Vomiting																																														
<p><b>45. LOCATION</b> Block A = location of symptom. Then Please check (½) L = left, R = Right, B = bilateral/both sides</p> <table style="width:100%; border: none;"> <tr> <td></td> <td style="text-align: center;">A</td> <td style="text-align: center;">L</td> <td style="text-align: center;">R</td> <td style="text-align: center;">B</td> <td></td> </tr> <tr> <td>1<sup>st</sup> Symptom</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>A-Head B-Face C-Sinus</td> </tr> <tr> <td>2<sup>nd</sup> Symptom</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>D-Eyes E-Ears F-Neck</td> </tr> <tr> <td>3<sup>rd</sup> Symptom</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>G-Shoulder H-Entire Arm I- Upper Arm</td> </tr> <tr> <td>4<sup>th</sup> Symptom</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>J-Elbow K-Forearm L-Wrist</td> </tr> <tr> <td>5<sup>th</sup> Symptom</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>M-Hand N- Fingers O-Chest</td> </tr> <tr> <td>6<sup>th</sup> Symptom</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>P-Back Q-Upper Back R-Lower Back S-Abdomen T-Buttock U-Groin V-Hip W-Entire Leg X-Thigh Y-Knee Z-Calf 1-Shin 2-Ankle 3-Foot 4-Toes 5-Trunk 6-Generalized 7-Other_____</td> </tr> </table>		A	L	R	B		1 <sup>st</sup> Symptom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	A-Head B-Face C-Sinus	2 <sup>nd</sup> Symptom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D-Eyes E-Ears F-Neck	3 <sup>rd</sup> Symptom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	G-Shoulder H-Entire Arm I- Upper Arm	4 <sup>th</sup> Symptom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	J-Elbow K-Forearm L-Wrist	5 <sup>th</sup> Symptom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	M-Hand N- Fingers O-Chest	6 <sup>th</sup> Symptom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	P-Back Q-Upper Back R-Lower Back S-Abdomen T-Buttock U-Groin V-Hip W-Entire Leg X-Thigh Y-Knee Z-Calf 1-Shin 2-Ankle 3-Foot 4-Toes 5-Trunk 6-Generalized 7-Other_____	<p><b>46. INITIAL CONTACT WAS:</b></p> <p><input type="checkbox"/></p> <p>A-DAN Emergency B-DAN Non-emergency C-Hospital Emergency Room D-Emergency Medical Service (EMS) E-US Coast Guard F-Physician G-Dive Instructor H-Other_____</p> <hr/> <p><b>47. TOTAL DELAY FROM SYMPTOM ONSET TO CONTACTING DAN OR OTHER MEDICAL HELP:</b></p> <p>Hours <input type="text"/> or Days <input type="text"/></p>					
	A	L	R	B																																												
1 <sup>st</sup> Symptom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	A-Head B-Face C-Sinus																																											
2 <sup>nd</sup> Symptom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D-Eyes E-Ears F-Neck																																											
3 <sup>rd</sup> Symptom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	G-Shoulder H-Entire Arm I- Upper Arm																																											
4 <sup>th</sup> Symptom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	J-Elbow K-Forearm L-Wrist																																											
5 <sup>th</sup> Symptom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	M-Hand N- Fingers O-Chest																																											
6 <sup>th</sup> Symptom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	P-Back Q-Upper Back R-Lower Back S-Abdomen T-Buttock U-Groin V-Hip W-Entire Leg X-Thigh Y-Knee Z-Calf 1-Shin 2-Ankle 3-Foot 4-Toes 5-Trunk 6-Generalized 7-Other_____																																											
<p><b>48. SYMPTOM ONSET</b></p> <table style="width:100%; border: none;"> <tr> <td></td> <td style="text-align: center;">Hours</td> <td style="text-align: center;">Minutes</td> <td style="text-align: center;">or</td> <td style="text-align: center;">Before Surfacing from Dive</td> </tr> <tr> <td>1<sup>st</sup> Symptom</td> <td><input type="text"/></td> <td><input type="text"/></td> <td></td> <td><input type="checkbox"/></td> </tr> <tr> <td>2<sup>nd</sup> Symptom</td> <td><input type="text"/></td> <td><input type="text"/></td> <td></td> <td><input type="checkbox"/></td> </tr> <tr> <td>3<sup>rd</sup> Symptom</td> <td><input type="text"/></td> <td><input type="text"/></td> <td></td> <td><input type="checkbox"/></td> </tr> <tr> <td>4<sup>th</sup> Symptom</td> <td><input type="text"/></td> <td><input type="text"/></td> <td></td> <td><input type="checkbox"/></td> </tr> <tr> <td>5<sup>th</sup> Symptom</td> <td><input type="text"/></td> <td><input type="text"/></td> <td></td> <td><input type="checkbox"/></td> </tr> <tr> <td>6<sup>th</sup> Symptom</td> <td><input type="text"/></td> <td><input type="text"/></td> <td></td> <td><input type="checkbox"/></td> </tr> </table>		Hours	Minutes	or	Before Surfacing from Dive	1 <sup>st</sup> Symptom	<input type="text"/>	<input type="text"/>		<input type="checkbox"/>	2 <sup>nd</sup> Symptom	<input type="text"/>	<input type="text"/>		<input type="checkbox"/>	3 <sup>rd</sup> Symptom	<input type="text"/>	<input type="text"/>		<input type="checkbox"/>	4 <sup>th</sup> Symptom	<input type="text"/>	<input type="text"/>		<input type="checkbox"/>	5 <sup>th</sup> Symptom	<input type="text"/>	<input type="text"/>		<input type="checkbox"/>	6 <sup>th</sup> Symptom	<input type="text"/>	<input type="text"/>		<input type="checkbox"/>	<p><b>49 ANY OF THE SYMPTOMS FROM #43 PRIOR TO THE LAST DIVE?</b> Y-Yes N-No <input type="checkbox"/></p> <p>If Yes, which symptom(s)?</p> <table style="width:100%; border: none;"> <tr> <td>1<sup>st</sup> Symptom</td> <td><input type="checkbox"/></td> </tr> <tr> <td>2<sup>nd</sup> Symptom</td> <td><input type="checkbox"/></td> </tr> <tr> <td>3<sup>rd</sup> Symptom</td> <td><input type="checkbox"/></td> </tr> <tr> <td>4<sup>th</sup> Symptom</td> <td><input type="checkbox"/></td> </tr> <tr> <td>5<sup>th</sup> Symptom</td> <td><input type="checkbox"/></td> </tr> <tr> <td>6<sup>th</sup> Symptom</td> <td><input type="checkbox"/></td> </tr> </table>	1 <sup>st</sup> Symptom	<input type="checkbox"/>	2 <sup>nd</sup> Symptom	<input type="checkbox"/>	3 <sup>rd</sup> Symptom	<input type="checkbox"/>	4 <sup>th</sup> Symptom	<input type="checkbox"/>	5 <sup>th</sup> Symptom	<input type="checkbox"/>	6 <sup>th</sup> Symptom	<input type="checkbox"/>
	Hours	Minutes	or	Before Surfacing from Dive																																												
1 <sup>st</sup> Symptom	<input type="text"/>	<input type="text"/>		<input type="checkbox"/>																																												
2 <sup>nd</sup> Symptom	<input type="text"/>	<input type="text"/>		<input type="checkbox"/>																																												
3 <sup>rd</sup> Symptom	<input type="text"/>	<input type="text"/>		<input type="checkbox"/>																																												
4 <sup>th</sup> Symptom	<input type="text"/>	<input type="text"/>		<input type="checkbox"/>																																												
5 <sup>th</sup> Symptom	<input type="text"/>	<input type="text"/>		<input type="checkbox"/>																																												
6 <sup>th</sup> Symptom	<input type="text"/>	<input type="text"/>		<input type="checkbox"/>																																												
1 <sup>st</sup> Symptom	<input type="checkbox"/>																																															
2 <sup>nd</sup> Symptom	<input type="checkbox"/>																																															
3 <sup>rd</sup> Symptom	<input type="checkbox"/>																																															
4 <sup>th</sup> Symptom	<input type="checkbox"/>																																															
5 <sup>th</sup> Symptom	<input type="checkbox"/>																																															
6 <sup>th</sup> Symptom	<input type="checkbox"/>																																															
<p><b>50. FLYING OR INCREASED ELEVATION AFTER DIVING AND PRIOR TO TREATMENT?</b></p> <p><input type="checkbox"/> A-Commercial airline <input type="checkbox"/> B-Nonpressurized Aircraft <input type="checkbox"/> C-Med-evac Flight <input type="checkbox"/> D-Mountain Elevation <input type="checkbox"/> E-Does not Apply</p> <p>Hours Postdive (flew or went into elevation)</p> <p><input type="text"/></p> <p>Elevation in Feet</p> <p><input type="text"/></p>																																																

**APPENDIX F**

**DIVE PLAN**

INSTRUCTIONS: Fill in all applicable information, sign and date, and submit to the Diving Safety Officer well in advance of the proposed diving activity.

Principle Investigator:		Department:
Location of Diving Operation:		
Project Title:		
Date(s) of Cruise/Operation:	Estimated Time (local ops only) Departure _____ Return _____	
Platform (shore, small craft, ship, pool, etc.):		
Vessel Name:	Cruise Number:	

**ENVIRONMENT: CHECK ALL THAT APPLY**

Type of Diving		Diving Mode	
Bottom oriented(near shore)	Repetitive diving	Open circuit SCUBA	
Bottom oriented (off shore)	Multi-day diving	Surface Supplied	
Blue water (tethered)	Cold Water (m50° F)	Full facemask	
Blue water (untethered)	Strong current	Hookah	
Night diving	Surge, swell or surf	Rebreather	
Decompression diving	Under ice	Dry Suit	
Cave or cavern	Wreck		
Other		Maximum Depth: _____ Ft.	

**BREATHING GAS**

Air	EAN _____ % O <sub>2</sub>	Mixed Gas (list mix composition in attachment)
-----	----------------------------	--

**DIVING TABLES/COMPUTERS**

USN No-D	NAUI	Other (list)
Dive Computers (list)		

**PROCEDURES**

Briefly describe the proposed operation, including specific scientific diving procedures to be used and typical daily diving schedule (time and duration of dives (continue on attachment, if necessary))


**SPECIFIC SITE HAZARDS (continue on attachment if necessary)**




## Appendix G

### DIVING MEDICAL EXAM OVERVIEW FOR THE EXAMINING PHYSICIAN

#### TO THE EXAMINING PHYSICIAN:

This person, \_\_\_\_\_, requires a medical examination to assess their fitness for certification as a Scientific Diver for the Woods Hole Oceanographic Institution. Their answers on the Diving Medical History Form (attached) may indicate potential health or safety risks as noted. Your evaluation is requested on the attached scuba Diving Fitness Medical Evaluation Report. If you have questions about diving medicine, you may wish to consult one of the references on the attached list or contact one of the physicians with expertise in diving medicine whose names and phone numbers appear on an attached list, the Undersea Hyperbaric and Medical Society, or the Divers Alert Network. Please contact the undersigned Diving Safety Officer if you have any questions or concerns about diving medicine or the Woods Hole Oceanographic Institution standards. Thank you for your assistance.

\_\_\_\_\_  
Diving Safety Officer

\_\_\_\_\_  
Date

\_\_\_\_\_  
Printed Name

\_\_\_\_\_  
Phone Number

Scuba and other modes of compressed-gas diving can be strenuous and hazardous. A special risk is present if the middle ear, sinuses, or lung segments do not readily equalize air pressure changes. The most common cause of distress is eustachian insufficiency. Recent deaths in the scientific diving community have been attributed to cardiovascular disease. Please consult the following list of conditions that usually restrict candidates from diving.

(Adapted from Bove, 1998: bracketed numbers are pages in Bove)

#### CONDITIONS WHICH MAY DISQUALIFY CANDIDATES FROM DIVING

1. Abnormalities of the tympanic membrane, such as perforation, presence of a monomeric membrane, or inability to autoinflate the middle ears. [5, 7, 8, 9]
2. Vertigo, including Meniere's Disease. [13]
3. Stapedectomy or middle ear reconstructive surgery. [11]
4. Recent ocular surgery. [15, 18, 19]
5. Psychiatric disorders including claustrophobia, suicidal ideation, psychosis, anxiety states, untreated depression. [20 - 23]
6. Substance abuse, including alcohol. [24 - 25]
7. Episodic loss of consciousness. [1, 26, 27]
8. History of seizure. [27, 28]
9. History of stroke or a fixed neurological deficit. [29, 30]
10. Recurring neurologic disorders, including transient ischemic attacks. [29, 30]
11. History of intracranial aneurysm, other vascular malformation or intracranial hemorrhage. [31]
12. History of neurological decompression illness with residual deficit. [29, 30]
13. Head injury with sequelae. [26, 27]
14. Hematologic disorders including coagulopathies. [41, 42]
15. Evidence of coronary artery disease or high risk for coronary artery disease. [33 - 35]
16. Atrial septal defects. [39]
17. Significant valvular heart disease - isolated mitral valve prolapse is not disqualifying. [38]
18. Significant cardiac rhythm or conduction abnormalities. [36 - 37]
19. Implanted cardiac pacemakers and cardiac defibrillators (ICD). [39, 40]
20. Inadequate exercise tolerance. [34]
21. Severe hypertension. [35]
22. History of spontaneous or traumatic pneumothorax. [45]
23. Asthma. [42 - 44]
24. Chronic pulmonary disease, including radiographic evidence of pulmonary blebs, bullae, or cysts. [45, 46]
25. Diabetes mellitus. [46 - 47]
26. Pregnancy. [56]

## Appendix G

### SELECTED REFERENCES IN DIVING MEDICINE

Available from Best Publishing Company, P.O. Box 30100, Flagstaff, AZ 86003-0100, the Divers Alert Network (DAN) or the Undersea and Hyperbaric Medical Society (UHMS), Durham, NC

- Elliott, D.H. ed. 1996. *Are Asthmatics Fit to Dive?* Kensington, MD: Undersea and Hyperbaric Medical Society.
- Bove, A.A. 2011. The cardiovascular system and diving risk. *Undersea and Hyperbaric Medicine* 38(4): 261-269.
- Thompson, P.D. 2011. The cardiovascular risks of diving. *Undersea and Hyperbaric Medicine* 38(4): 271-277.
- Douglas, P.S. 2011. Cardiovascular screening in asymptomatic adults: Lessons for the diving world. *Undersea and Hyperbaric Medicine* 38(4): 279-287.
- Mitchell, S.J., and A.A. Bove. 2011. Medical screening of recreational divers for cardiovascular disease: Consensus discussion at the Divers Alert Network Fatality Workshop. *Undersea and Hyperbaric Medicine* 38(4): 289-296.
- Grundy, S.M., Pasternak, R., Greenland, P., Smith, S., and Fuster, V. 1999. Assessment of Cardiovascular Risk by Use of Multiple-Risk-Factor Assessment Equations. AHA/ACC Scientific Statement. *Journal of the American College of Cardiology*, 34: 1348-1359. <http://content.onlinejacc.org/cgi/content/short/34/4/1348>
- Bove, A.A. and Davis, J. 2003. *DIVING MEDICINE*, Fourth Edition. Philadelphia: W.B. Saunders Company.
- Edmonds, C., Lowry, C., Pennefather, J. and Walker, R. 2002. *DIVING AND SUBAQUATIC MEDICINE*, Fourth Edition. London: Hodder Arnold Publishers.
- Bove, A.A. ed. 1998. *MEDICAL EXAMINATION OF SPORT SCUBA DIVERS*, San Antonio, TX: Medical Seminars, Inc.
- NOAA DIVING MANUAL, NOAA. Superintendent of Documents. Washington, DC: U.S. Government Printing Office.
- U.S. NAVY DIVING MANUAL. Superintendent of Documents, Washington, DC: U.S. Government Printing Office, Washington, D.C.

**APPENDIX G**

**AAUS MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING REPORT**

Name of Applicant (Print ) \_\_\_\_\_ Date of Medical Evaluation \_\_\_\_\_

**To The Examining Physician:** Scientific divers require periodic scuba diving medical examinations to assess their fitness to engage in diving with self-contained underwater breathing apparatus (scuba). Their answers on the Diving Medical History Form may indicate potential health or safety risks as noted. Scuba diving is an activity that puts unusual stress on the individual in several ways. Your evaluation is requested on this Medical Evaluation form. Your opinion on the applicant's medical fitness is requested. Scuba diving requires heavy exertion. The diver must be free of cardiovascular and respiratory disease (see references, following page). An absolute requirement is the ability of the lungs, middle ears and sinuses to equalize pressure. Any condition that risks the loss of consciousness should disqualify the applicant. Please proceed in accordance with the AAUS Medical Standards (Sec. 6.00). If you have questions about diving medicine, please consult with the Undersea Hyperbaric Medical Society or Divers Alert Network.

**TESTS: THE FOLLOWING TESTS ARE REQUIRED:**

**DURING ALL INITIAL AND PERIODIC RE-EXAMS (UNDER AGE 40):**

- Medical history
- Complete physical exam, with emphasis on neurological and otological components
- Urinalysis
- Any further tests deemed necessary by the physician

**ADDITIONAL TESTS DURING FIRST EXAM OVER AGE 40 AND PERIODIC RE-EXAMS (OVER AGE 40):**

- Chest x-ray (Required only during first exam over age 40)
- Resting EKG
- Assessment of coronary artery disease using Multiple-Risk-Factor Assessment<sup>1</sup> (age, lipid profile, blood pressure, diabetic screening, smoking)

Note: Exercise stress testing may be indicated based on Multiple-Risk-Factor Assessment<sup>2</sup>

**PHYSICIAN'S STATEMENT:**

\_\_\_\_\_ 01 Diver **IS** medically qualified to dive for: \_\_\_\_\_ 2 years (over age 60)  
\_\_\_\_\_ 3 years (age 40-59)  
\_\_\_\_\_ 5 years (under age 40)

\_\_\_\_\_ 02 Diver **IS NOT** medically qualified to dive:: \_\_\_\_\_ Permanently \_\_\_\_\_ Temporarily.

I have evaluated the above mentioned individual according to the American Academy of Underwater Sciences medical standards and required tests for scientific diving (Sec. 6.00 and Appendix 1) and, in my opinion, find no medical conditions that may be disqualifying for participation in scuba diving. I have discussed with the patient any medical condition(s) that would not disqualify him/her from diving but which may seriously compromise subsequent health. The patient understands the nature of the hazards and the risks involved in diving with these conditions.

\_\_\_\_\_ MD or DO Signature \_\_\_\_\_ Date

\_\_\_\_\_  
Name (Print or Type)

\_\_\_\_\_  
Address

\_\_\_\_\_  
Telephone Number

\_\_\_\_\_  
E-Mail Address

My familiarity with applicant is: \_\_\_\_\_ This exam only \_\_\_\_\_ Regular physician for \_\_\_\_\_ years

My familiarity with diving medicine is:  
\_\_\_\_\_

# AAUS MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING REPORT

## APPLICANT'S RELEASE OF MEDICAL INFORMATION FORM

---

Name of Applicant (Print or Type) \_\_\_\_\_

I authorize the release of this information and all medical information subsequently acquired in association with my diving to the \_\_\_\_\_ Diving Safety Officer and Diving Control Board or their designee at (place) \_\_\_\_\_ on (date) \_\_\_\_\_

Signature of Applicant \_\_\_\_\_

Date \_\_\_\_\_

---

### REFERENCES

<sup>1</sup> Grundy, S.M., Pasternak, R., Greenland, P., Smith, S., and Fuster, V. 1999. Assessment of Cardiovascular Risk by Use of Multiple-Risk-Factor Assessment Equations. AHA/ACC Scientific Statement. *Journal of the American College of Cardiology*, 34: 1348-1359. <http://content.onlinejacc.org/cgi/content/short/34/4/1348>

## DIVING MEDICAL HISTORY FORM

(To Be Completed By Applicant-Diver)

Name \_\_\_\_\_ Sex \_\_\_\_ Age \_\_\_\_ Wt. \_\_\_\_ Ht. \_\_\_\_

Sponsor \_\_\_\_\_ Date \_\_\_\_/\_\_\_\_/\_\_\_\_  
 (Dept./Project/Program/School, etc.) (Mo/Day/Yr)

**TO THE APPLICANT:**

Scuba diving places considerable physical and mental demands on the diver. Certain medical and physical requirements must be met before beginning a diving or training program. Your accurate answers to the questions are more important, in many instances, in determining your fitness to dive than what the physician may see, hear or feel as part of the diving medical certification procedure.

This form shall be kept confidential by the examining physician. If you believe any question amounts to invasion of your privacy, you may elect to omit an answer, provided that you shall subsequently discuss that matter with your own physician who must then indicate, in writing, that you have done so and that no health hazard exists.

Should your answers indicate a condition, which might make diving hazardous, you will be asked to review the matter with your physician. In such instances, their written authorization will be required in order for further consideration to be given to your application. If your physician concludes that diving would involve undue risk for you, remember that they are concerned only with your well-being and safety.

	Yes	No	Please indicate whether or not the following apply to you	Comments
1			Convulsions, seizures, or epilepsy	
2			Fainting spells or dizziness	
3			Been addicted to drugs	
4			Diabetes	
5			Motion sickness or sea/air sickness	
6			Claustrophobia	
7			Mental disorder or nervous breakdown	
8			Are you pregnant?	
9			Do you suffer from menstrual problems?	
10			Anxiety spells or hyperventilation	
11			Frequent sour stomachs, nervous stomachs or vomiting spells	
12			Had a major operation	
13			Presently being treated by a physician	
14			Taking any medication regularly (even non-prescription)	
15			Been rejected or restricted from sports	
16			Headaches (frequent and severe)	
17			Wear dental plates	
18			Wear glasses or contact lenses	
19			Bleeding disorders	
20			Alcoholism	
21			Any problems related to diving	
22			Nervous tension or emotional problems	

	Yes	No	Please indicate whether or not the following apply to you	Comments
23			Take tranquilizers	
24			Perforated ear drums	
25			Hay fever	
26			Frequent sinus trouble, frequent drainage from the nose, post-nasal drip, or stuffy nose	
27			Frequent earaches	
28			Drainage from the ears	
29			Difficulty with your ears in airplanes or on mountains	
30			Ear surgery	
31			Ringing in your ears	
32			Frequent dizzy spells	
33			Hearing problems	
34			Trouble equalizing pressure in your ears	
35			Asthma	
36			Wheezing attacks	
37			Cough (chronic or recurrent)	
38			Frequently raise sputum	
39			Pleurisy	
40			Collapsed lung (pneumothorax)	
41			Lung cysts	
42			Pneumonia	
43			Tuberculosis	
44			Shortness of breath	
45			Lung problem or abnormality	
46			Spit blood	
47			Breathing difficulty after eating particular foods, after exposure to particular pollens or animals	
48			Are you subject to bronchitis	
49			Subcutaneous emphysema (air under the skin)	
50			Air embolism after diving	
51			Decompression sickness	
52			Rheumatic fever	
53			Scarlet fever	
54			Heart murmur	
55			Large heart	
56			High blood pressure	
57			Angina (heart pains or pressure in the chest)	
58			Heart attack	

	Yes	No	Please indicate whether or not the following apply to you	Comments
59			Low blood pressure	
60			Recurrent or persistent swelling of the legs	
61			Pounding, rapid heartbeat or palpitations	
62			Easily fatigued or short of breath	
63			Abnormal EKG	
64			Joint problems, dislocations or arthritis	
65			Back trouble or back injuries	
66			Ruptured or slipped disk	
67			Limiting physical handicaps	
68			Muscle cramps	
69			Varicose veins	
70			Amputations	
71			Head injury causing unconsciousness	
72			Paralysis	
73			Have you ever had an adverse reaction to medication?	
74			Do you smoke?	
75			Have you ever had any other medical problems not listed? If so, please list or describe below;	
76			Is there a family history of high cholesterol?	
77			Is there a family history of heart disease or stroke?	
78			Is there a family history of diabetes?	
79			Is there a family history of asthma?	
80			Date of last tetanus shot? Vaccination dates?	

Please explain any "yes" answers to the above questions.

---



---



---



---



---



---



---

I certify that the above answers and information represent an accurate and complete description of my medical history.

---

Signature

Date

**RECOMMENDED PHYSICIANS WITH EXPERTISE IN DIVING MEDICINE**

List of local Medical Doctors that have training and expertise in diving or undersea medicine:

1. \_\_\_\_\_  
Name  
\_\_\_\_\_  
Address  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
Telephone

2. \_\_\_\_\_  
Name  
\_\_\_\_\_  
Address  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
Telephone

3. \_\_\_\_\_  
Name  
\_\_\_\_\_  
Address  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
Telephone

4. \_\_\_\_\_  
Name  
\_\_\_\_\_  
Address  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
Telephone

**WOODS HOLE OCEANOGRAPHIC INSTITUTION  
DIVING STATEMENT OF UNDERSTANDING, ASSUMPTION OF RISK AND RELEASE**

I, (Print name) \_\_\_\_\_ am aware that underwater diving instruction and diving are potentially hazardous activities, and I am voluntarily participating in these activities with knowledge of the dangers involved. **I HEREBY AGREE TO ACCEPT ANY AND ALL RISKS OF INJURY OR DEATH.**

- I understand that skin, SCUBA, Closed Circuit Rebreather and Exosuit diving are physical activities involving heavy exertion and total immersion in water, that I must be in good general health, free from cardiovascular and respiratory disease, have good exercise tolerance, and that even momentary impairment of consciousness underwater may be fatal. I further understand that there is a risk of drowning while engaged in aquatic activities.
- I understand that divers are subject to a variety of pressure-related injuries and influences that may have serious consequences, and that all of my body air spaces must equalize pressure readily. I understand that some of these injuries and influences may include, but are not limited to ruptured eardrums, dysbaric osteonecrosis, pneumothorax, arterial gas embolism, and decompression sickness, which may result in permanent loss of hearing, paralysis, paresthesia, bowel and/or bladder incontinence, other long-term effects, as yet poorly defined, or even death.
- I understand that, while most aquatic organisms are harmless to human beings, some do have the capability to bite, sting, scratch, claw, or inject harmful substances into my body, and that open wounds underwater may result in injury infection, allergic reactions and even death.
- I understand that the aquatic environment may present other influences which could result in injury or illness which include, but are not limited to reduced or zero visibility, strong winds, rough water, strong currents, surge, swells, surf, pollution, entanglements from line, nets, or aquatic vegetation, and exposure to temperature extremes.
- I understand that diving from boats, ships, piers, and other man-made or natural structures, that other vessel traffic nearby, that equipment handling by others, or myself, and that just being aboard a boat may be hazardous.
- I understand that diving with compressed air involves certain risks, and injuries can occur which require treatment in a hyperbaric chamber. I further understand that the diving operations which are necessary for training, certification, recertification, and research may be conducted at a site that is remote, either by time or distance or both, from such a hyperbaric chamber, and nonetheless agree to proceed with such dives. I still wish to proceed with the course and other diving activities in spite of the possible absence of a hyperbaric chamber in proximity to the dive site.

**IT IS MY INTENT, BY SIGNING THIS DOCUMENT, FOR MYSELF, MY HEIRS, EXECUTORS, ADMINISTRATORS OR ASSIGNS, TO EXCEPT, RELEASE, WAIVE AND RELIEVE WOODS HOLE OCEANOGRAPHIC INSTITUTION, IT'S TRUSTEES, OFFICERS, AND EMPLOYEES FROM ANY LIABILITY FOR PERSONAL INJURY, PROPERTY DAMAGE OR WRONGFUL DEATH ARISING FROM MY PARTICIPATION IN DIVING INSTRUCTION, DIVING ACTIVITIES, OR ANY ACTIVITIES INCIDENTAL TO DIVING OPERATIONS. I HERBY PERSONALLY ASSUME ALL RISK IN CONNECTION WITH SAID COURSE OR ANY OTHER DIVING WHILE UNDER THE AUSPICES OF WOODS HOLE OCEANOGRAPHIC INSTITUTION FOR ANY HARM INJURY, LOSS, OR DAMAGE WHICH MAY BEFALL ME AS A RESULT OF MY PARTICIPATION IN THE COURSE OR OTHER DIVING ACTIVITIES, WHETHER FORESEEN OR UNFORESEEN**

**I CERTIFY THAT I HAVE READ THIS FORM. I FULLY UNDERSTAND AND ACKNOWLEDGE THAT DIVING IS A POTENTIALLY DANGEROUS ACTIVITY, AND I UNDERSTAND THE LEGAL RIGHTS I AM GIVING UP BY SIGNING THIS DOCUMENT.**

\_\_\_\_\_  
DIVIER SIGNATURE

\_\_\_\_\_  
DATE

\_\_\_\_\_  
WITNESS SIGNATURE

\_\_\_\_\_  
DATE

**Diving Statement of Understanding Assumption or Risk and Release** Page 2

Please copy the following statement below:

I know SCUBA ,Closed Circuit Rebreather and Exosuit diving and associated activities subject me to the risk of death and serious injury. I hereby, exempt, release, waive, and relieve WHOI and any of its employees or affiliates from any liability arising from or relating to participating in said diving activities.

\_\_\_\_\_  
Diving Candidate

\_\_\_\_\_  
Date

\_\_\_\_\_  
Witness

\_\_\_\_\_  
Date

**APPLICATION FOR SCUBA DIVING TRAINING/CERTIFICATION AND DIVING RESUME  
WOODS HOLE OCEANOGRAPHIC INSTITUTION SCIENTIFIC DIVING PROGRAM**

INSTRUCTIONS: Please fill in the requested information as completely as possible. Print legibly in ink or type. Attach the requested enclosures and return to the Diving Locker (MS #28).

**PERSONAL**

Name:		Birthdate (MoDaYr)		Age:	
Job Title:		Department		Email:	
Office Location:			MS#	SSN	
Home Address:			City	State	Zip
Home Phone:		Home Institution: WHOI <input type="checkbox"/> Other: <input type="checkbox"/>			
Work Phone:		Fax:			
WHOI Affiliation (Employee, student, casual, visiting investigator, guest):					

**EMERGENCY CONTACT** (Person to notify in case of emergency)

Name		Relationship:			
Home Address					
Home Phone		Work Phone			

**DESCRIPTION OF NEED FOR DIVE TRAINING/CERTIFICATION**

Briefly describe project for which you will use diving at WHOI. Temporary Permit applicants include location and dates of cruise/operation


**DIVING TRAINING CERTIFICATIONS**

Certification Level	Agency e.g., NAUI, PADI	Date of Completion	Training Location	Instructor Name & Number
CPR				
First Aid				
Oxygen Admin.				
Other (lifesaving, WSI, EMT, DMT, Paramedic, Chamber Operator, Boating Safety, Dive Rescue, etc.)				

**SWIMMING ABILITY (√)**

Non or Weak Swimmer	Average to strong: 400 Yards m12 min	Lifesaving Certification	Water Safety Instructor
---------------------	---	-----------------------------	----------------------------

**SKINDIVING EXPERIENCE (Swimming with fins, mask and snorkel) (√)**

No Experience	Novice (1-5 times)	Moderate (6-50)	Expert (>50)
---------------	--------------------	-----------------	--------------

**SCIENTIFIC DIVING CERTIFICATION**

Organization	Expiration Date	Depth Rating	Name of Diving Officer

**DIVING EXPERIENCE:**  Estimated  Calculated from Logbook

Number of Years:		Total Hours Underwater:		Maximum Depth (career):		Ft.	
Total # Dives (career):							
0-40 feet	41-70 feet	71-100 feet	101-130 feet	>130 feet	Total		
Total # Dives							
Within last 24 months		Within last 12 months			Within last 6 months		
Maximum Depth Last 12 Months			Ft.	Date Last Openwater Dive			____ / ____ / ____

**ENVIRONMENT/TECHNOLOGY EXPERIENCE**

Please mark the appropriate letter indicating your degree of diving experience with the following:

<b>O</b> Inexperienced <b>L</b> Novice (1-10 times) <b>M</b> Moderate (11-50) <b>E</b> Extensive (>50)				
Small Boats (m20q)	Closed or Semi-closed Circuit Rebreather	Fresh Water Lake, Pond, Quarry	Surface-Supplied (Bandmask, Helmet)	
Vessels 21q, 100q	Decompression Diving	Fresh Water River	Hookah	
Ships > 100q	Dive Computers	Mud/Silty Bottom	Commercial Diving	
Beach Entry	Saturation	Kelp Forest Diving	Military Diving	
Rock Shore Entry	Nitrox	Coral Reef	Search and Recovery	
Entry through Surf (>3q)	Other Mixed Gas	Wall Diving	Underwater Photography	
Physical Overhead	Tropical Water (>75° F)	Open Sea (Blue Waterq)	Night Diving	
Under Ice Diving	Temperate Water 40-75°	Drift Diving	Compass Navigation	
Cave Penetration	Frigid Water (<40° F)	Strong Currents (~ 1 knot)	Turbid (<5qvisibility)	
Wreck Penetration	Ocean/Salt Water	Altitude Diving (>1000q)	Clear (>50qvisibility)	

**GEOGRAPHICAL LOCATION EXPERIENCE** (New England, California, Caribbean, etc.)


**ENCLOSURES:** Enclose the following supporting documents with this application:

1. Photocopies of all pertinent certification cards (both front and reverse)
2. A dive log must be presented for inspection if you are a certified diver
3. Reciprocity forms from your home institution DSO if you are a current Scientific Diver

**STATEMENT:** I certify that the above information is correct and that I am in good health. I agree to follow the safety regulations of the W.H.O.I. Diving Safety Manual and to abide by whatever limitation or restriction may be imposed by the Diving Safety Officer and/or Diving Control Board.

\_\_\_\_\_  
SIGNATURE OF CANDIDATE

\_\_\_\_\_  
DATE (MONTH/DAY/YEAR)

**APPROVAL:** The requirements for W.H.O.I. diving certification are listed in the Diving Safety Manual. Obtaining and maintaining a diving certification involves a considerable investment of time and some expenses. Department/supervisor approval indicates that the applicant's use of diving is required by the project and that the project will support the candidate's time and related costs.

Project Supervisor: \_\_\_\_\_  
NAME (PRINTED OR TYPED)

\_\_\_\_\_  
SIGNATURE

\_\_\_\_\_  
DATE

Department Chairman \_\_\_\_\_

**DIVING SAFETY OFFICER APPROVAL**

**DIVING CONTROL BOARD APPROVAL**

\_\_\_\_\_  
EDWARD F. O'BRIEN

\_\_\_\_\_  
LAURENCE P. MADIN

APPENDIX K

WHOI/AAUS RECIPROCITY LETTER OF REFERENCE

This letter is to confirm the standing of \_\_\_\_\_ as a Scientific Diver in the Woods Hole Oceanographic Institution Diving Program. WHOI is an organizational member of the American Academy of Underwater Sciences and adheres to the standards set forth in the AAUS Standards for Scientific Diving.

This diver's standing in the WHOI Diving Program is as follows:

(Date) \_\_\_\_\_ Active in WHOI Program since (written examination and skill evaluation dives)
\_\_\_\_\_ Last diving medical examination
\_\_\_\_\_ Scuba regulator/equipment service/test
\_\_\_\_\_ CPR training (Agency: American Heart Association)
\_\_\_\_\_ Oxygen administration: (Agency) Divers Alert Network
\_\_\_\_\_ Standard First Aid (Agency: National Safety Council)
\_\_\_\_\_ Date of last dive
Number of dives completed within previous 12 months? \_\_\_\_\_
Maximum depth recorded in past 12 months \_\_\_\_\_
Depth certification \_\_\_\_\_ Ft.
Any restrictions? (Y/N) \_\_\_\_\_ if yes, explain:
\_\_\_\_\_

Additional Pertinent Certifications, Authorizations or Training: \_\_\_\_\_
\_\_\_\_\_

Name of diver: \_\_\_\_\_
Emergency Information: (To notify in an emergency)
Name: \_\_\_\_\_
Relationship: \_\_\_\_\_
Telephone: (work) \_\_\_\_\_
(home) \_\_\_\_\_
Address: \_\_\_\_\_

This is to verify that the above individual is currently a certified scientific diver at WHOI.

Edward F O'Brien \_\_\_\_\_ Date \_\_\_\_\_
Diving Safety Officer Phone: (508) 289-2239
MS #28, WHOI Fax: (508) 457-2195
Woods Hole, MA 02543 email: <mailto:eobrien@whoi.edu>

**APPENDIX K**

**AAUS CHECKOUT DIVE AND TRAINING EVALUATION**

Certified scientific divers and Divers-In-Training from AAUS organizational members should be able to demonstrate proficiency in the following skills during checkout dives or training evaluation dives with the Dive Safety Officer or designee:

- Knowledge of AAUS diving standards and regulations
- Pre-dive planning, briefing, site orientation, and buddy check
- Use of dive tables and/or dive computer
- Equipment familiarity
- Underwater signs and signals
- Proper buddy contact
- Monitor cylinder pressure, depth, bottom time
- Swim skills:
  - Surface dive to 10 ft. without scuba gear
  - Demonstrate watermanship and snorkel skills
  - Surface swim without swim aids (400 yd. <12min)
  - Underwater swim without swim aids (25 yd. without surfacing)
  - Tread water without swim aids (10 min.), or without use of hands (2 min.)
  - Transport another swimmer without swim aids (25yd)
- Entry and exit (pool, boat, shore)
- Mask removal and clearing
- Regulator removal and clearing
- Surface swim with scuba; alternate between snorkel and regulator (400 yd.)
- Neutral buoyancy (hover motionless in midwater)
- Proper descent and ascent with B.C.
- Remove and replace weight belt while submerged
- Remove and replace scuba cylinder while submerged
- Alternate air source breathing with and without mask (donor/receiver)
- Buddy breathing with and without mask (donor/receiver)
- Simulated emergency swimming ascent
- Compass and underwater navigation
- Simulated decompression and safety stop
- Rescue:
  - Self-rescue techniques
  - Tows of conscious and unconscious victim
  - Simulated in-water rescue breathing
  - Rescue of submerged non-breathing diver (including equipment removal, simulated rescue breathing, towing, and recovery to boat or shore)
    - Use of emergency oxygen on breathing and non-breathing victim
    - Accident management and evacuation procedures

Additional Training (optional)

---

---

---

---

---

## SAFE ASCENT RECOMMENDATIONS

From: AAUS BIOMECHANICS OF SAFE ASCENTS WORKSHOP.1990, Lang and Egstrom (Eds.)

It has long been the position of the American Academy of Underwater Sciences that the ultimate responsibility for safety rests with the individual diver.

The time has come to encourage divers to slow their ascents.

1. Buoyancy compensation is a significant problem in the control of ascents.
2. Training in, and understanding of, proper ascent techniques is fundamental to safe diving practice.
3. Before certification, the diver is to demonstrate proper buoyancy, weighting and a controlled ascent, including a "hovering" stop.
4. Diver shall periodically review proper ascent techniques to maintain proficiency.
5. Ascent rates shall not exceed 60 fsw per minute.
6. A stop in the 10-30 fsw zone for 3-5 min is recommended on every dive.
7. When using a dive computer or tables, non-emergency ascents are to be at the rate specified for the system being used.
8. Each diver shall have instrumentation to monitor ascent rates.
9. Divers using dry suits shall have training in their use.
10. Dry suits shall have a hands-free exhaust valve.
11. Buoyancy compensators (BCs) shall have a reliable rapid exhaust valve which can be operated in a horizontal swimming position.
12. A buoyancy compensator is required with dry suit use for ascent control and emergency flotation.
13. Breathing 100% oxygen above water is preferred to in-water air procedures for omitted decompression.

## GUIDELINES FOR USE OF DIVE COMPUTERS

From AAUS Dive Computer Workshop. Lang and Hamilton (Eds.). U.S.C. Sea Grant Program, Los Angeles, CA, 1989

1. Only those makes and models of dive computers specifically approved by the Diving Control Board may be used.
2. Any diver desiring the approval to use a dive computer as a means of determining decompression status must apply to the Diving Control Board, complete an appropriate practical training session and pass a written examination.
3. Each diver relying on a dive computer to plan dives and indicate or determine decompression status must have his own unit.
4. On any given dive, both divers in the buddy pair must follow the most conservative dive computer.
5. If the dive computer fails at any time during the dive, the dive must be terminated and appropriate surfacing procedures should be initiated immediately.
6. A diver should not dive for 18 hours before activating a dive computer to use it to control his diving.
7. Once the dive computer is in use, it must not be switched off until it indicates complete outgassing has occurred or 18 hours have elapsed, whichever comes first.
8. When using a dive computer, non-emergency ascents are to be at a rate specified for the make and model of dive computer being used.
9. Ascent rates shall not exceed 40 fsw/min in the last 60 fsw.
10. Whenever practical, divers using a dive computer should make a stop between 10 and 30 feet for 5 minutes, especially for dives below 60 fsw.
11. Only 1 dive on the dive computer in which the NDL of the tables or dive computer has been exceeded may be made in any 18-hour period.
12. Repetitive and multi-level diving procedures should start the dive, or series of dives, at the maximum planned depth, followed by subsequent dives of shallower exposures.
13. Multiple deep dives require special consideration.

## University National Oceanographic Laboratory System Research Vessel Operating Committee Shipboard Diving Regulations

(Reprinted from the UNOLS Shipboard Safety Standards, RVOC Safety Training Manual.)  
[http://www.gso.uri.edu/unols/saf\\_stand/99/chapter16.pdf](http://www.gso.uri.edu/unols/saf_stand/99/chapter16.pdf)

### 16.0 POLICY

Scientific diving is a normal part of oceanographic research vessel operations. Such diving conducted from a University-National Oceanographic Laboratory System (UNOLS) vessel must be under the auspices of a diving program that meets the minimum American Academy of Underwater Sciences (AAUS) Standards for Scientific Diving Certification and Operation of Scientific Diving Programs. Operators without a program may accommodate scientific diving cruises which are under the auspices of an institution with such a program.

### 16.1 DIVING PROCEDURES, RULES AND REGULATIONS

For all cruises a single lead institution's campus diving administration will be designated. This is usually accomplished by agreement of all campus diving administrations involved. Items which refer to the campus diving administration may, in fact, be the concern of the Diving Safety Officer according to the practices of the institutions involved. The procedures, rules and regulations that govern the diving operation are those of the designated lead institution, subject to the approval of the operator's Marine Office.

### 16.2 CRUISE PLANNING

In a timely fashion prior to the cruise:

1. The Principal Investigator will insure that a cruise plan is supplied to his or her campus diving administration, who will forward the cruise plan, once approved, to the lead institution's campus diving administration and the Chief Scientist. The dive plan, prepared in a standard format, includes: diving credentials for all diving members of the scientific party, detailed operational plans, emergency plans including accident management and emergency evacuation protocols, a list of needed medical supplies, a specified quantity of medical grade oxygen with a positive pressure demand delivery system and required diving support equipment (e.g., small boats).
2. The lead institution's diving administration will, after approving this plan, forward it to the operator's Marine Office.

### 16.3 CRUISE PERSONNEL

1. The Master has responsibility for the safety of all activities aboard including diving (Section 14.4).
2. The Chief Scientist is responsible for the coordination and execution of the entire scientific mission (Section 14.5).
3. The Principal Investigator of the diving project (who may or may not be the Chief Scientist) is responsible for the planning and coordination of the research diving operations.
4. The On-Board Diving Supervisor will be proposed by the Principal Investigator and approved by the lead institution's diving administration. The On-Board Diving Supervisor is responsible for the execution of the research diving operations in accordance with the cruise dive plan. He or she has the authority to restrict or suspend diving operations and alter the cruise dive plan in consultation with the Master and Principal Investigator/Chief Scientist. The On-Board Diving Supervisor's responsibilities include:
  - a. Meeting with the Master and Chief Scientist to review the cruise dive plan and emergency procedures prior to diving.
  - b. Remaining in regular communication with the Master on the progress of the research diving operation.
  - c. Assuring that both the lead and operating institution's diving manuals are available to the scientists and crew aboard the vessel.
  - d. Inspecting high pressure cylinders and breathing air compressors to assure that they meet the lead institution's standards.
5. Research Divers must recognize their individual responsibility for their safety.

## DEFINITION OF TERMS

**Air sharing** - The sharing of an air supply between divers.

**Altitude Diving** - Diving conducted in excess of 1,000 feet above sea level.

**Bottom Time/Dive Time** - The total time underwater.

**Breath-hold Diving** - A diving mode in which the diver uses no self-contained or surface-supplied air or oxygen supply.

**Buddy Breathing** - The sharing of a single air source between divers.

**Buddy Diver** - Second member of the dive team.

**Buddy system** - Two comparably equipped scuba divers in the water in constant communication.

**Buoyant Ascent** - An ascent made using some form of positive buoyancy.

**Burst Pressure** - The pressure at which a pressure containment device would fail structurally.

**Certified Diver** - A diver who holds a recognized valid certification from the Institution Scientific Diving Program, an AAUS organizational member, or recognized certifying agency.

**Controlled Ascent** - Any one of several kinds of ascents including normal, swimming, and air sharing ascents where the diver(s) maintain control so a pause or stop can be made during the ascent.

**Cylinder** - A pressure vessel for the storage of gases.

**Decompression Chamber** - A pressure vessel for human occupancy. Also called a hyperbaric chamber or recompression chamber.

**Decompression Sickness** - A condition with a variety of symptoms which may result from gas and bubbles in the tissues of divers after pressure reduction.

**Decompression Table** - A profile or set of profiles of depth-time relationships for ascent rates and breathing mixtures to be followed after a specific depth-time exposure or exposures. (Also called dive tables.)

**Dive** - A descent into the water, an underwater diving activity utilizing compressed gas, an ascent, and return to the surface.

**Dive Computer**- A microprocessor based device which computes a diver's theoretical decompression status, in real time, by using pressure (depth) and time as input to a decompression model, or set of decompression tables, programmed into the device.

**Dive Location** - A surface or vessel from which a diving operation is conducted.

**Dive Site** - The physical location of a diver during a dive.

**Diver** - An individual in the water who uses apparatus, including snorkel, which supplies breathing gas at ambient pressure.

**Diver-In-Training** - An individual gaining experience and training in additional diving activities under the supervision of a dive team member experienced in those activities.

**Diver-Carried Reserve Breathing Gas** - A diver-carried independent supply of air or mixed gas (as appropriate) sufficient under standard operating conditions to allow the diver to reach the surface, or another source of breathing gas, or to be reached by another diver.

**Diving Mode** - A type of diving required specific equipment, procedures, and techniques, for example, snorkel, scuba, surface-supplied air, or mixed gas.

**Diving Control Board (DCB)** - The group of individuals who act as the official representative of the campus in matters concerning the scientific diving program (see Section 1.24).

**Diving Safety Officer (DSO)** - The individual responsible for the safe conduct of the scientific diving program of the campus (see Section 1.23).

**Eanx (Enriched Air Nitrox)** . See Nitrox

**Emergency Ascent** - An ascent made under emergency conditions where the diver exceeds the normal ascent rate.

**FSW** - Feet of seawater, or equivalent static head.

**Hookah Diving** - A type of shallow water surface-supplied diving where there is no voice communication with the surface.

**Hyperbaric Chamber** - See decompression chamber.

**Hyperbaric Conditions** - Pressure conditions in excess of normal atmospheric pressure at the dive location.

**Lead Diver** - The certified diver with experience and training to conduct the diving operation.

**Mixed-Gas Diving** - A diving mode in which the diver is supplied in the water with a breathing gas other than air.

**Nitrox** . A nitrogen/oxygen breathing gas mixture of greater than 21% oxygen

**No-Decompression Limits** - The depth-time limits of the "no-decompression limits and repetitive dive group designations table for no-decompression air dives" at a rate specified by the tables or computers used.

**Normal Ascent** - An ascent made with an adequate air supply at a rate specified by the table or computer being used by the diver.

**Organizational Member** - An organization which is a current member of the AAUS, and which has a program that adheres to the standards of the AAUS as set forth in the AAUS Standards for Scientific Diving Certification and Operation of Scientific Diving Programs.

**Pressure-Related Injury** - An injury resulting from pressure disequilibrium within the body as the result of hyperbaric exposure. Examples include: decompression sickness, pneumothorax, mediastinal emphysema, air embolism, subcutaneous emphysema, or ruptured eardrum.

**Pressure Vessel** - See cylinder.

**Psig** - pounds per square inch gauge.

**Recompression Chamber** - see decompression chamber.

**Scientific Diving** - Scientific diving is defined (29 CFR 1910.402) as diving performed solely as a necessary part of a scientific, research, or educational activity by employees whose sole purpose for diving is to perform scientific research tasks.

**Scuba Diving** - A diving mode independent of surface supply in which the diver uses open circuit self-contained underwater breathing apparatus.

**Standby Diver** - A diver at the dive location capable of rendering assistance to a diver in the water.

**Surface Supplied Diving** - A diving mode in which the diver in the water is supplied from the dive location with compressed gas for breathing.

**Umbilical** - The composite hose bundle between a dive location and a diver or bell, or between a diver and a bell, which supplies a diver or bell with breathing gas, communications, power, or heat, as appropriate to the diving mode or conditions, and includes a safety line between the diver and the dive location.

## APPENDIX P

**Volume Tank** . A pressure vessel connected to the outlet of a compressor and used as an air reservoir.

**Working, or Service Pressure** - The normal pressure at which a system is designed to operate