

Diving Safety Manual

# University of Hawai'i System



**Written and Compiled by  
The Diving Control Board  
University of Hawai'i  
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## Acknowledgements and Forward

This manual was revised from the 1997 University of Hawaii Diving Safety Manual, to include revisions and improvements embodied in the current AAUS Guidelines for Conduct of Scientific Diving Programs and Certification of Scientific Divers, and to extend the local standard of practice as per the needs of the University of Hawaii. The manual is also available online, at: <http://www.hawaii.edu/ehso/diving> . Intermediary revisions and the most recent versions of forms found in the Appendices may be found there.

This document was authored and edited by the University of Hawaii Diving Control Board, as listed in Appendix 11.

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# CHAPTER 1. GENERAL POLICY

## 1.1 PURPOSE

### 1.1.1 The Scientific Diving Standards

The purpose of these scientific diving standards is to:

Ensure that all scientific diving under the jurisdiction of the University of Hawaii System (hereinafter referred to as the University), an Organizational Member of the American Academy of Underwater Sciences (hereinafter referred to as AAUS), is conducted in a manner that will maximize protection of scientific divers from accidental injury and/or illness, and

Set forth standards for diver training, evaluation, and authorization, which will allow a working reciprocity with other AAUS member organizations. All scientific diving conducted under the auspices of the University (Section 1.4.1) shall comply with the standards set forth in this manual. Fulfillment of these purposes shall be consistent with the furtherance of research and safety.

In 1982, the U.S. Occupational Safety and Health Administration (OSHA) exempted scientific diving from commercial diving regulations (29 CFR Part 1910, Subpart T) under certain conditions outlined below. The final guidelines for the exemption became effective in 1985 (Federal Register, Vol. 50, No. 6, p. 1046).

AAUS is recognized by OSHA as the organization setting scientific diving standards. This document incorporates the AAUS standards, and extends them based on local procedure and assent of the University of Hawaii Diving Control Board.

### 1.1.2 OSHA Scientific Diving Definition

In compliance with 29 CFR 1910.402, Scientific Diving is defined as diving performed solely as a necessary part of a scientific, research, or educational activity by University employees, students, or affiliates whose sole purpose for diving is to perform scientific research or educational tasks.

### 1.1.3 OSHA Scientific Diving Exemption

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

1. The scientific diving program shall include at least the following:
  - 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 criteria for diver training and authorization.

- b. Diving Control Board (DCB) with the majority of its members being active divers, which shall 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 for SCUBA diving.
1. The Diving is voluntary; that is, any Scientific Diver may refuse to dive at any time without concern of penalty if the diver feels the conditions or procedures are unsafe, or the diver is not fit or does not possess adequate training or experience.
2. The purpose of the project 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 troubleshooting 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.

#### 1.1.4 Liability

In adopting the policies set forth in this manual, the University assumes liability as defined in existing state law. Each person diving under University jurisdiction shall complete an Application for Scientific Diving Authorization, and endorse an Assumption of Risk, Waiver and Release Form and a Medical Consent Form (Appendix 1, Appendix 2). A diver may refuse to dive without fear of penalty at any time (see Sections 1.1.3, 2.2.7, 2.2.8, 2.2.10).

#### 1.1.5 Compliance with AAUS

1. A copy of these standards shall be approved by and filed with AAUS.
2. For each diving mode the following shall be described in writing, adhering to the standards of this manual, and be approved by the University Diving Control Board:
  - a. Criteria for diver training and authorization;
  - b. Safety procedures for the diving operation;
  - c. Responsibilities of the dive team members;
  - d. Equipment use and maintenance procedures;
  - e. Emergency procedures for each diving location, including procedures for appropriate emergency medical treatment and expeditious recompression.
3. An annual report and review of diving activities shall be prepared and submitted to the AAUS. At this time recommendations for modifications to the standards may be submitted for consideration.

## 1.2 ADMINISTRATIVE ORGANIZATION

The University President, or his/her designee, shall appoint a Diving Safety Officer (DSO), and members of a Diving Control Board (DCB) with the advice and consent of standing members of the Diving Control Board.

### 1.2.1 The Diving Safety Officer (DSO):

1. Shall serve as a voting member of the Diving Control Board.
2. Shall be appointed by the Director of the UH Environmental Health and Safety Office, with the advice and counsel of the Diving Control Board.
3. Shall be a currently active instructor, certified by a recognized dive training organization.
4. Shall be trained as a scientific diver, as defined in this manual, and should have broad technical and scientific expertise in activities related to scientific diving.
5. Shall be responsible, through the Diving Control Board, to the University President, or his/her designee, for the conduct of the scientific diving program of the University. The routine operational authority for this program, including the conduct of training and authorization, approval of dive plans, maintenance of diving records, and insuring compliance with this manual and all relevant regulations of the University--rests with the DSO.
6. May permit portions of this program to be carried out by a qualified delegate, although the DSO may not delegate responsibility for the safe conduct of the program.
7. Shall be guided in the performance of the required duties by the advice of the Diving Control Board, but operational responsibility for the conduct of the local diving program will be retained by the DSO. The DSO has the authority to waive at his/her discretion any requirements herein except the medical standards.
8. Shall suspend diving operations which he/she considers to be unsafe or unwise.
9. Shall be a member in good standing of the AAUS.

### 1.2.2 The Diving Control Board (DCB):

1. Shall include as voting members: the DSO, at least six University faculty and staff from units representative of the University's scientific diving activities, and at least one graduate student utilizing scientific diving in his/her thesis/dissertation research. A majority of these individuals must be currently active scientific divers. The University President will designate an ex-officio member to provide the DCB with advice on liability and risk management. The Chair of the Diving Medical Advisory Panel (Section 1.2.3) shall serve as a voting member.

2. Shall be responsible to the University President or his/her designee, and shall act as the official representative of the University in matters concerning the scientific diving program;
3. Shall schedule monthly meetings and meet more or less often than this, depending on the amount of business pending as determined by the DCB Chairman and DSO. A quorum shall consist of a majority of voting members. Decisions will be approved by majority vote when at least a quorum is in attendance. A chairman will be elected by the DCB each September.
4. Except the DSO, members shall each serve a term of three years, at which time they may be reappointed or recommend a successor to the DCB. The DCB will then select a replacement. Terms will be staggered to provide continuity of experience. Members unable to attend a meeting may designate a proxy.
5. Shall have autonomous and absolute authority over the scientific diving program's operations, and shall have the authority to:
  - a. Review and revise the diving safety manual, and appropriately change policy and amend the diving manual as the need arises;
  - b. Assure compliance with the manual, including adherence to the buddy system for SCUBA diving;
  - c. Approve and monitor diving projects;
  - d. Certify the depths to which a diver has been trained and shall issue, reissue, restrict and revoke diving authorizations;
  - e. Take disciplinary action for unsafe practices;
  - f. Act as a Board of Appeal to consider diver-related problems;
  - g. Establish and/or approve training programs through which applicants for authorization can satisfy the requirements of the University's diving manual;
  - h. Suspend diving programs it considers to be unsafe or unwise.
  - i. Establish criteria for equipment selection and use, as recommended by the DSO.
  - j. Approve new equipment or techniques.
  - k. Establish and/or approve facilities for the inspection and maintenance of diving and associated equipment, as recommended by the DSO.
  - l. Ensure that the University's air stations meet air quality standards (Chapter 6), as monitored by the DSO.
  - m. Periodically review the DSO's performance and program.
  - n. Shall sit as a Board of Investigation to inquire into the nature and cause of diving accidents or violations of the University diving manual.
6. The DCB shall receive each year from the DSO an annual report in order to review the previous year's diving activities and to prepare programs for the coming year. This will also be the basis of the annual report to the AAUS (Section 1.1.5).

### 1.2.3 Diving Medical Advisory Panel Chairperson (DMAP Chair)

The DCB shall appoint the Chairperson of the Diving Medical Advisory Board. The term of appointment shall be four years, renewable by the consent of the DCB.

The DMAP Chair shall:

1. Recommend to the DCB potential members of the DMAP.
2. Assist the DCB in identifying physicians in Hawaii with sufficient expertise in hyperbaric and diving medicine to conduct diving medical examinations for UH divers.
3. Act as an information resource for physicians conducting UH diving medical exams.
4. Upon request, review and comment on medical aspects of proposed dive plans.
5. Solicit consensus opinions from the DMAP on diving medical issues as needed. Report recommendations of the DMAP to the DCB. Issues may include, but are not limited to:
  - a. Contraindications to Diving;
  - b. Medical concerns of diving protocols, especially those involving advanced technology or extended operational range;
  - c. Diving emergency management considerations and feasibility of emergency treatment, especially for proposed remote, extended range, or advanced technology operations.

### 1.2.4 Diving Medical Advisory Panel (DMAP)

With advice from the DMAP Chairperson, the DCB shall select qualified physicians for inclusion on the DMAP. Term of appointment shall be for four years, renewable by approval of the DCB.

The DMAP shall meet in a manner that the members see fit, to address diving medical issues placed before the DCB, and referred to the DMAP for review.

### 1.2.5 Unit Diving Coordinator

Conditional upon approval by and consent of the DCB, units of the University system may appoint a Unit Diving Coordinator (UDC), to assume authorities and responsibilities as delegated by the DCB. This option is intended to enable large units of the University system (campus, institute, school or research unit) the ability to meet the operational and administrative needs of the unit in a timely fashion.

1. The UDC shall possess the following qualifications:
  - a. Permanent faculty or staff member in the unit;
  - b. Training as a SCUBA instructor (if the UDC is to conduct diver checkouts or training, this must be current and active);
  - c. Current active status as a UH Scientific Diver;

- d. Broad experience in Scientific Diving methods, especially with those diving techniques and activities regularly employed within the unit, and with the sites regularly dived by unit divers.
2. As delegated by the DCB on a case-by-case basis, and in coordination with the DSO, the UDC may:
    - a. Serve as unit representative to the DCB;
    - b. Maintain unit diver files on-site, and update diver qualification records in the UHDSP database, or facilitate record transfer to the DSO;
    - c. Maintain unit dive locker and equipment as per requirements of this manual;
    - d. Review and approve routine dive plans;
    - e. Conduct diver checkouts, depth authorization and proficiency dives;
    - f. Recommend to the DSO and DCB the depth to which unit divers should be authorized;
    - g. Coordinate or conduct unit scientific diver training.
  3. The UDC shall:
    - a. Communicate the results of training, supervision and diving activity to UHDSP for main records;
    - b. Ensure compliance with requirements of this manual by unit divers and diving projects;
    - c. Ensure that unit diving activity is accurately logged with UHDSP by unit divers;
    - d. Suspend any unit diving activity that the UDC feels is unwise, unsafe, or in violation of provisions of this manual or State or Federal laws or regulations.
  4. The departmental privilege of utilizing a UDC may be revoked by the DCB, if the above responsibilities are not fulfilled in a prompt and timely manner, or the DCB finds the authority or privilege is being abused or misused.

### **1.3 PROGRAM RESPONSIBILITY**

#### 1.3.1 Ultimate Authority

The Diving Control Board has the ultimate authority for the scientific diving program and its related activities.

#### 1.3.2 Policy

Policy relating to the diving program of the University shall be reported to the University President or his/her designee. The development of these policies is the responsibility of the DCB.

#### 1.3.3 Policy Administration

Administration of the University Diving Program will be the responsibility of the DCB. Daily executive control shall be delegated to the DSO.

## 1.4 OPERATIONAL CONTROL

### 1.4.1 University Auspices Defined

All diving performed by individuals necessary to and part of a scientific, research, or educational activity in conjunction with a project or study under the jurisdiction of the University shall be considered scientific diving. This shall include operations which involve:

1. University Personnel:
  - a. University employees or volunteers, where such persons are acting within their official capacity as a University affiliate, or are engaged otherwise in University scientific diving operations;
  - b. Individuals whose diving activities are in support of a research or educational project which has been approved by a University academic advisor or advisory committee, the results of which are intended to be credited towards completion of a University project, course or degree.
  - c. Individuals from auxiliary organizations who are engaged in scientific diving operations otherwise under University auspices, as defined in Section 1.4.1;
  - d. Visiting persons engaged in diving under University auspices, as defined in Section 1.4.1;
2. University-owned, purchased, rented, chartered or otherwise provided facilities, equipment, or supplies. This shall include diving equipment, vessels or motor vehicles used for diving operational support, compressors, compressed air, or other scientific supplies or equipment used to meet the diving objectives;
3. University-owned or leased locations;
4. Scientific diving activities supported in whole or part by University-administered funds.
5. All research and training proposals which include scientific diving operations must have dive modes approved by the Diving Safety Officer and/or Diving Control Board Chair prior to approval by the University Office of Research Services( ORS) and Contracts and Grants Management Office (CGMO) (Appendix 5, Appendix 6).

### 1.4.2 Diving Privileges

Certification as a UH Scientific Diver and authorization to dive under UH auspices is a privilege gained by compliance with training, qualification, and re-qualification provisions of this manual. Authorization to dive may be suspended or modified by the DSO or UDC, and restricted or revoked by the DCB, for non-compliance (Sec. 1.8).

### 1.4.3 Authorization Types

No person shall engage in scientific diving unless that person holds a recognized, valid authorization issued by the University pursuant to the provisions of this manual (Section 1.4.1, Chapter 3, Chapter 4, Chapter 7, Chapter 8). The following permit classifications will be recognized:

1. Diver-In-Training Permit. This permit signifies that a diver has completed and been certified as at least an open water diver through a nationally or internationally recognized certifying agency, scientific diving program or its equivalent (Chapter 3).
2. Active Scientific Diver Authorization. This is a permit to dive, usable only while it is current and for the purposes intended. Unless otherwise specified, it is restricted to non-bluewater open water diving not requiring decompression stops, utilizing open circuit air SCUBA, and approved dive tables to control decompression status (Chapter 4).
3. Temporary Diving Authorization. This permit constitutes a waiver of certain requirements of Chapter 4 and is issued only following a demonstration to the DSO of the required proficiency in diving. The Temporary Diving Authorization is valid only for a specified time and mode as determined by the Diving Safety Officer (Section 4.9).
4. Restricted Scientific Diver Authorization. A UH Scientific Diver whose emergency response certifications (CPR, First Aid, or Oxygen Administration) have expired, or who has conducted fewer than the minimum required number of periodic dives for Active status, but who otherwise is currently qualified as a Scientific Diver according to the requirements of Section 4.00, may be granted an authorization to dive on a Restricted Diver status. It is intended in most cases that the Restricted Status be of temporary duration while the diver obtains recertification in the expired emergency response training (Section 4.5).
  - a. A UH Diver on Restricted status is eligible to dive on projects under UH jurisdiction, provided the diver is under the supervision of a fully authorized UH Scientific Diver. Diving shall only be conducted within the Restricted Diver's depth authorization.
  - b. A UH Diver on Restricted status is ineligible to:
    - serve as a Lead Diver or Lead Buddy on a dive under UH jurisdiction;
    - be referred to other institutions under reciprocity agreements;
    - dive on projects involving joint operations with other institutions.
5. Inactive or Disqualified Diver Status. A diver placed on Inactive or Disqualified status shall not dive under UH jurisdiction until the conditions for the designation are remedied (Section 4.6).
  - a. Inactive Diver Status. A UH Diver shall be placed on Inactive Diver status if: his/her medical clearance to dive (Chapter 7) has expired, or the diver has logged no dives or otherwise not maintained current records in the past 12 months.

- b. Disqualified Status: A UH Diver or Diver candidate shall be placed on Disqualified status, if upon medical examination the diver fails to gain medical approval to dive, in accordance with Chapter 7.

#### 1.4.4 Equipment

All diving equipment used by all classifications of divers, regardless of ownership, shall conform to the standards set forth in this manual.

#### 1.4.5 Records

The Diving Safety Officer shall maintain permanent records on each diver (Chapter 3, Chapter 4, Chapter 7), including personal dive logs (Section 2.3.1), copies of all dive plans approved (Section 2.2.9), records of diving accidents (Section 2.3.2), and records of equipment modifications, tests, repairs, calibrations, and maintenance (Chapter 5).

#### 1.4.6 Sites

The regulations herein shall be observed at all locations where scientific diving is conducted. This includes all sea-going vessels owned, operated, and/or chartered by University projects. Operations involving UNOLS ships shall also comply with UNOLS regulations (Appendix 14).

#### 1.4.7 Visiting Scientific Divers and Reciprocity

1. Complete applications for visiting diver authorization shall be submitted to the DSO in conjunction with the first UH dive plan on which the visiting diver will be working, and at least 14 days prior to the start of planned diving operations.
2. UH Visiting Diver Application forms are required, including:
  - a. Diver contact information;
  - b. Waiver and release;
  - c. Medical consent;
  - d. Insurability, Employment Status and Indemnification;
  - e. Documentation of diver training, experience and proficiency;
3. The most current versions of these forms are available on the UHDSP website or by request from the DSO. Additionally, a letter describing the diving operations planned under UH jurisdiction, and identifying a host member of the UH community who is a currently authorized UH Scientific Diver shall be included.
4. If, in the opinion of the UH DSO, the environment or equipment will be significantly different than the norm for a visiting scientific diver, the diver may be asked to demonstrate his/her knowledge and skills for the planned diving, as determined by the UH DSO.

5. Reciprocity shall exist with other AAUS member organizations. A Scientific Diver currently authorized under the jurisdiction of another member organization in good standing shall also be so recognized by the University of Hawaii Diving Safety Program. Divers granted reciprocity with the University of Hawaii shall be subject to and agree to abide by all University diving regulations applicable, as outlined in this manual. The University reserves the right to require both skill and knowledge evaluations of any such divers, appropriate to the dive mode to be used, if is deemed advisable.
6. A scientific diver from another AAUS Organizational Member shall apply for permission to dive under University jurisdiction by submitting to the DSO a completed UH Visiting Diver Application (Sec.1.4.7.2) and a document containing all information exemplified in Appendix 9 (Letter of Reciprocity), which will serve as documentation of diver training, experience and proficiency (Sec.1.4.7.2e, above). The truth and accuracy of this information shall be attested to by the Chairperson of the home DCB, or the DSO of the home Organizational Member institution.
7. If a visiting diver from an AAUS Organizational Member is denied permission to dive, the UH DSO or a UH DCB designee shall promptly submit to the visiting diver and his/her home DSO an explanation of all reasons for the denial.
8. A scientific diver from an institution that is not an AAUS Organizational Member, but which has a Scientific Diving program as specified in Sections 1.1.2 and 1.1.3, may request reciprocity by submitting a completed UH Visiting Diver Application (Sec. 1.4.7.2), a copy of the home institution's Diving Safety Manual, and letters of documentation from the home DSO demonstrating compliance with qualification standards substantially similar to those of the University, including medical examinations. Such requests will be reviewed and approved or disapproved by the DSO.
9. A visiting diver not under the jurisdiction of an institutional diving safety program must apply for authorization as a Temporary Diver (Section 1.4.3, Section 4.9).
10. A UH scientific diver diving at another host institution under a UH letter of reciprocity is governed by the requirements of this manual, as well as any placed upon them by the host institution's DCB.
11. Unless otherwise arranged in advance between the UH DCB and the host institution, while visiting a host institution under reciprocity a UH scientific diver shall dive within the limits of his/her UH authorization, as specified in the letter of reciprocity.

## 1.5 DIVING PERSONNEL

### 1.5.1 Instructional Personnel

1. All personnel providing diving instruction under the jurisdiction of the University Scientific Diving Program shall be qualified trainers for the type of instruction being given, as determined by the DCB.
2. Instructional personnel will be selected by the DCB after preliminary screening of applicants by the DSO.

### 1.5.2 Lead Diver (Diving Supervisor, Person-in-charge)

For each dive, one individual shall be designated as the Lead Diver. He/she shall be at the dive location or the dive site during the diving operation. The Lead Diver shall be responsible for::

1. Coordination: Diving shall be coordinated with other known activities in the vicinity which are likely to interfere with diving operations.
2. Verification: All dive team members possess current authorization and are qualified for the diving type and mode required by the operation.
3. Briefing: The dive team members shall be briefed on:
  - a. Dive objectives;
  - b. Any unusual hazards or environmental conditions likely to affect the safety of the diving operation;
  - c. Any modifications to diving or emergency procedures necessitated by the specific diving operation;
  - d. Dive Plan items included in Section 1.5.2.5 and Section 2.2.9 .
4. Dive Planning: Planning of a diving operation shall include considerations of the safety and health aspects of the following and as outlined in Section 2.2.9:
  - a. Diving mode;
  - b. Surface and underwater conditions and hazards;
  - c. Breathing gas supply;
  - d. Thermal protection;
  - e. Diving equipment;
  - f. Dive team assignments;
  - g. Residual inert gas status of dive team members;
  - h. Decompression schedules and altitude corrections;
  - i. Emergency procedures.
5. Ensuring safety and emergency equipment is in working order and present at the dive site
6. Site evaluation. The Lead Diver shall suspend diving operations if in his/her opinion conditions are not safe.
7. Supervising completion of individual dive logs (Appendix 7, Appendix 8)

8. Reporting: Any physical problems or adverse physiological effects including symptoms of pressure related injuries must be communicated to the DSO.

### 1.5.3 Authorized Diver

Each scientific diver shall be trained, qualified, and authorized for the diving mode being used. For most scuba divers, training certified by a recognized national or international diving certification organization will be prerequisite to applying for University authorization. In most instances, certification from a commercial diving school, military diving school, or other appropriate training approved by the DCB will be required for some specialized diving modes (Chapter 8 through 18). Each dive team member shall have training and experience as outlined in Chapter 3, Chapter 4, and, as applicable, Chapter 8 through Chapter 18.

## 1.6 DEPARTMENTAL CONTROL

1. University departments and programs may own and provide to UH Scientific Divers resources in support of scientific diving operations. Such resources may include diving equipment, compressors and compressed air, other diving supplies, boats or motor vehicles.
2. Prior to release, each department or program providing resources in support of diving shall have in place measures to ensure the following:
  - a. Departmental diving resources are serviced and maintained in compliance with pertinent sections of this manual;
  - b. Use of departmental diving resources are limited to authorized personnel;
  - c. Lead Divers obtain dive plan approval from the DSO or DCB for the dives to be conducted from unit auspices;
  - d. Diving and departmental vessel operations are conducted in compliance with applicable government and University regulations.
  - e. Appropriate departmental emergency response procedures are formulated, in place, and operational while diving is conducted.
3. Departmental control measures shall be implemented to the satisfaction of the DCB. The DSO shall make a periodic review of departmental control measures. Results of the review shall be reported to the DCB and Head of the department or program with recommendations regarding whether revisions in departmental procedures are needed.

## 1.7 MEDICAL EXAMINATION

All authorized divers shall pass a medical examination (Chapter 7) and the expiration date of the examination will appear on the diver's status documentation. After any major illness or injury, or any condition requiring hospitalization for more than 24 hours, authorized divers shall submit to a medical interview or examination appropriate to the nature and extent of the

injury or illness, as determined by the examining physician, before receiving clearance to resume diving activities (Chapter 8; Appendix 3).

## **1.8 CONSEQUENCES OF VIOLATION OF REGULATIONS**

Failure to comply with the regulations of the University's diving manual may be cause for the revocation or restriction of the diver's scientific diving authorization by action of the DCB. The DCB may direct the University to invoke additional sanctions (e.g. through withholding proposals, grants, or contracts by ORS and/or CGMO) against the responsible parties if the situation requires further action.

### **1.8.1 Violation Review and Disciplinary Process.**

A diving authorization may be revoked or restricted for cause by the DCB. Violations of regulations set forth in this manual, or of regulations of governmental subdivisions not in conflict with this manual, may be considered cause. The following process and disciplinary procedures shall be followed.

1. Violation Review Process. The DSO may restrict, modify or suspend a diver's authorization for cause, pending review by the DCB.
  - a. In the case of violations resulting in a risk to personnel safety, severe equipment loss or damage, or major environmental damage, the DSO shall immediately suspend the diver's authorization, pending a review hearing by the DCB.
  - b. The DSO shall make a written notice (hard copy or email) to the diver in question. A copy of the notice shall be forwarded (or cc'd) to each DCB member.
  - c. The diver shall be given the opportunity to present his/her case in writing for reconsideration and/or reauthorization. All such written statements and requests, as identified in this section, are formal documents that shall become part of the diver's file maintained by the DSO.
  - d. The DCB Chair shall convene a review hearing at the next scheduled DCB meeting, at which the diver shall have the right to be present. If the violation requires expedited review, the DCB Chair may convene a review panel comprised of a subset of no fewer than 5 DCB members, which shall include the DSO and DMAP Chair.
  - e. The diver shall not be permitted to dive under University jurisdiction during the period of review and appeal of a suspension or revocation of authorization.
2. Disciplinary Action. Disciplinary actions available to the board shall include the following, separately or in combination:
  - a. A written reprimand placed in the diver's file;
  - b. A probationary period of length to be determined by the DCB;
  - c. Restriction or reduction of depth authorization;

- d. Restriction of dive activity;
  - e. Revocation of Lead Diver privileges;
  - f. Temporary revocation of diving authorization;
  - g. Permanent revocation of diving authorization.
3. Violations of the regulations in this manual also violating University personnel regulations, State or Federal law, or expose the University to significant legal liability shall also be reported by the DCB Chair to the appropriate authority for review.

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## **CHAPTER 2. DIVING REGULATIONS**

### **2.1 GENERAL POLICY**

No person shall engage in scientific diving operations under the auspices of the University's diving program unless he/she holds a current scientific diving authorization issued pursuant to the provisions of this manual. Procedures shall be established for emergency medical treatment of divers at a hyperbaric chamber, by in-water recompression using oxygen, or at other medical facilities as appropriate for any medical emergency.

### **2.2 DIVING PROCEDURES**

#### **2.2.1 Solo Diving Prohibition**

All diving conducted under the auspices of the University shall be planned and executed in such a manner as to insure that every diver involved in untethered diving operations maintains constant, effective communication with at least one other comparably equipped authorized scientific diver in the water. This buddy system is based upon mutual assistance, especially in the case of an emergency. Dives should be planned around the competency of the least experienced diver. If loss of effective communication occurs within a buddy team, divers shall surface and re-establish contact.

#### **2.2.2 Enclosed or Confined Spaces**

No diver shall enter confined or restricted overhead environments unless trained, and authorized by the DCB for work under such conditions. This includes any environment in which there is a physical barrier which blocks direct ascent to the surface. See Chapter 8 regarding diving in restricted overhead environments.

#### **2.2.3 Diver's Flag**

1. A diver's flag (red background with white diagonal stripe) shall be displayed prominently whenever diving is conducted under circumstances where a flag is required, or where traffic is probable, including dives conducted from shoreline access.
2. When diving from a vessel, the International Code flag Alpha (blue and white) shall be displayed when required for compliance with the current U.S. Coast Guard rules published in "Navigation Rules, International and Inland" (e.g. if the vessel is restricted in its ability to maneuver).
3. University divers shall comply with all site-specific local, state, federal, and international regulations regarding marking of diving activities.

#### **2.2.4 Flotation Devices**

1. Under normal circumstances each open circuit scuba diver shall on every dive possess the capability of establishing neutral buoyancy at the working depth, making a controlled neutrally buoyant ascent, and attaining and

maintaining positive buoyancy at the surface with an approved buoyancy control device.

#### 2.2.5 Timing Devices, Depth and Pressure Gauges, Diving Tables

1. Both members of each diving pair must have an appropriate underwater time-keeping device, an approved depth indicator and (when SCUBA is used) an approved submersible cylinder pressure gauge.
2. A set of approved diving tables shall be available at the dive location. If the US Navy tables are not used, the tables must have no-decompression limits and residual nitrogen accounting at least as conservative as the United States Navy Diving Tables. Use of alternate dive tables, dive computers, or decompression software must be approved by the Diving Control Board.

#### 2.2.6 Dive Computers

The following regulations for the use of Dive Computers (DC's) shall be followed by Scientific Divers while diving under University auspices.

1. Training Requirements:
  - a. The diver shall complete a training session on Dive Computer (DC) use, of scope deemed appropriate by the DCB. The training shall include the operational guidelines defined below and shall include a DCB-approved written examination to demonstrate knowledge mastery of DC use.
  - b. The diver shall demonstrate proficiency of DC use in a dive checkout with the DSO or his designated agent. The proficiency review shall include:
    - Proper interpretation of the DC indicator system;
    - Adherence to the DC-prescribed rates of ascent and descent;
    - Demonstration of proper DC use protocols, as outlined below.
2. Equipment Requirements:
  - a. The DCB shall reserve the right to designate makes and models of DC's which are acceptable for use during University dives.
  - b. A diver shall only use those models of DC for which the diver has demonstrated proficiency, as described above.
  - c. DC's should be tested for depth accuracy at 12 month intervals, or in accordance with manufacturer's recommendations.
3. Operational Requirements:
  - a. A diver shall not dive for 24 hours prior to activating a DC for use to control decompression status.
  - b. Each diver using a DC must have a specific and separate unit dedicated to their use for the duration of a dive series.

- c. If either member of a buddy pair does not have a DC, the dive profile shall be planned and executed using University-approved dive tables. In this situation, the diver having a DC may use it for dive time and depth recording.
- d. When both members of a buddy pair are using DC's, both divers in a buddy pair must follow whichever diver's DC which requires the most conservative profile.
- e. In the event of a DC failure at any time, diving should be terminated immediately, using appropriate ascent procedures.
- f. For DC's with manual on/off switches, the DC should not be turned off for 24 hours after the completion of diving.
- g. If a computer is switched off before it indicates that complete outgassing has occurred, the diver shall not dive for 24 hours from the end of the last dive (see Exception in point "i" below).
- h. Whenever practical, divers using DC's should make a safety decompression stop between 10 and 30 feet, for 3 to 5 minutes, especially for dives exceeding 60 feet.
- i. Only one dive should be made in any 24 hour period in which a decompression ceiling is incurred.
- j. Multi-level diving procedures should start the dive or series of dives at the maximum planned depth, followed by subsequently shallower depth exposures. "Saw-tooth" and bounce profiles should be avoided if possible.
- k. Multiple deep repetitive dives or multiple days of diving without complete outgassing should be conducted in a conservative fashion.

#### 2.2.7 Decompression Software

1. Decompression software must provide schedules more conservative than those provided by the US Navy Tables.
2. If the software allows breathing gas compositions other than air to decrease stop time, the software must produce decompression profiles more conservative than the US Navy Air Tables when software gas parameters are defined as air.
3. If the software provides schedules for helium-oxygen mixtures, the software must produce decompression profiles more conservative than the US Navy Heliox Tables.
4. The Diving Control Board shall reserve the right to designate versions of decompression software which are acceptable for use on University-affiliated dives.

### 2.2.8 Depth Limits

The University diving authorization permits the holder to dive to the depth entered on the dive card. As evidence of authorization, the card shall bear the signature of the DSO or his/her designee.

1. An authorized diver diving under University auspices shall not exceed his/her depth authorization, except by no more than one level when accompanied by a diver authorized to at least the greater depth.
2. For diving using air, the authorization depths are 40, 60, 100, 130, 150, and 190 feet (Section 4.3).
3. Depth authorizations greater than 130 feet may require specific DCB approval and special training and protocols (Chapter 10 through Chapter 13).
4. In addition to experience and knowledge verification, authorization to depths greater than 130 feet requires a demonstration of need to the satisfaction of the DCB, or DSO before authorization will be given. The necessity shall be based on scientific project objectives.
5. Depth authorizations greater than 190 feet will be granted by the DCB upon a case-by-case basis for divers authorized to use Mixed Gas (Chapter 10 through Chapter 13) or Rebreathers (Chapter 14).

### 2.2.9 Termination of Dive

1. It is the right and responsibility of a diver to terminate the dive whenever he/she feels it is unsafe to continue the dive. This decision may be made at any time, without fear of penalty. Before electing to terminate a dive, the diver must ensure that such action does not compromise the safety of another diver already in the water.
2. Under normal diving conditions, the dive shall be terminated while there is still sufficient cylinder gas pressure remaining to permit the diver to safely reach the surface, including decompression time, or to safely reach an additional breathing gas source at a decompression station.

### 2.2.10 Refusal to Dive

1. A diver may refuse to dive whenever he/she feels it is unsafe for him/her to make the dive (Section 1.1.3). This decision may be made at any time, without fear of penalty.
2. 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 judgment, conditions are unsafe or unfavorable, or if he/she would be violating the precepts of his/her training or the regulations in this manual.

### 2.2.11 Dive Plans

Before conducting any diving operations under the auspices of the University, the Lead Diver for a proposed operation shall formulate a dive plan, and submit it to the DSO for review.

The DSO shall review and approve or disapprove the dive plan in a timely fashion. For complicated operations, the DSO shall request the approval of the DCB. In such cases, review and approval should be completed within six weeks from the time of submission. Approval must be obtained prior to commencement of the diving (see Appendix 6, Application for Dive Plan Approval).

The Application for Approval shall include the following information in an application to the DSO:

1. The name, contact phone number, University affiliation, and the type and depth of diving authorization held for each participating diver.
2. Approximate total number of proposed dives, and estimated dives per day.
3. Locations of proposed dives.
4. Estimated maximum depths and bottom times anticipated.
5. Diver decompression status and repetitive dive plans, if repetitive dives are to be conducted.
6. Proposed work, equipment and boats to be employed.
7. Source of breathing gas, boats, specialized equipment.
8. Details of any hazardous conditions anticipated, and emergency procedures planned and provided for such conditions.
9. Emergency Management Plan for each listed dive site, to include the following information:
  - a. The name, address, telephone number, and relationship of a person to be contacted for each diver in the event of emergency;
  - b. Nearest operational recompression chamber, and means of contact and transport;
  - c. Nearest accessible hospital and means of contact and transport;
  - d. Available means of emergency transport and means of contact (Appendix 12).

### 2.2.12 Pre-Dive Safety Checks

1. Diver's Responsibility
  - a. Each scientific diver shall conduct a functional check of his/her diving equipment in the presence of the Diving Buddy or Tender. (See also Sections 1.1.3).
  - b. It is the diver's responsibility and duty to refuse to dive if, in his/her judgment, conditions are unfavorable, or if he/she would be violating the precepts of his/her training, or of this manual (Section 1.1.3).

- c. No dive team member shall be required to dive or be exposed to hyperbaric conditions against his/her will.
  - d. No dive team member shall be permitted to dive for the duration of any known condition likely to adversely affect the safety and health of the diver or other dive team members Chapter 7).
  - e. The diver shall terminate a dive while there are sufficient breathing gas supplies remaining to permit the diver to safely reach the surface with planned reserves, and including decompression stop requirements.
2. Equipment Requirements: Each diver shall ensure that his/her equipment is in proper working order, and that the equipment is suitable and sufficient for the type of diving operation planned. Each diver shall be equipped for the diving modes to be utilized, as defined in appropriate sections in this manual.
    - a. Each scuba diver shall have a submersible pressure gauge for monitoring scuba cylinder pressure, capable of being monitored by the diver during the dive.
    - b. Each diver shall have the capability of achieving and maintaining positive buoyancy on the surface.
    - c. Each diver shall have the capability to execute a controlled neutrally buoyant ascent, through the use of an approved buoyancy control device.
    - d. If gases other than air are used as the breathing medium, appropriate diving tables shall be used. The applicable procedures of Chapter 6 and Chapter 10-Chapter 14 regarding use of breathing mixtures other than air must be followed.
    - e. Closed and semi-closed circuit scuba (rebreathers) shall meet the requirements listed in Section 14.4.
  3. Diver Qualifications. Each diver shall be trained, qualified, and authorized for the diving mode and specialized equipment being used, the diving activity to be performed, and the depths at which the diving is to be conducted (Chapter 3, Chapter 4, Chapter 8 through Chapter 18).
  4. Site Evaluation: The environmental conditions at the site will be evaluated prior to commencement of operations. Operations will be terminated if the Lead Diver deems conditions unsafe (sec. 1.5.2).

#### 2.2.13 Post-Dive Safety Checks

1. After the completion of a dive, each diver shall report any physical problems, injury, symptoms of decompression illness, or equipment malfunctions to the Lead Diver. The Lead Diver shall file a written report of any such incident to the Diving Safety Officer as soon as practicable (Appendix 10).

2. When diving beyond 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 assist with arrangements for expeditious recompression if necessary.

#### 2.2.14 Emergency Deviation from Regulations

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 DSO by the Lead Diver explaining the circumstances and justifications for such action.

#### 2.2.15 Flying After Diving

Flying after diving can predispose a diver to decompression sickness, hence it is necessary to spend certain intervals at or near sea level before flying or otherwise ascending to higher altitudes. SYMPTOMS OF DECOMPRESSION SICKNESS CAN TAKE 24 HOURS OR MORE TO MANIFEST THEMSELVES.

Flying after diving has resulted in decompression sickness as long as three days post dive.

UH Divers shall not fly within 24 hours after a dive. Divers engaging in staged decompression diving are strongly advised to not fly for 48 hours after diving.

#### 2.2.16 Altitude Exposure During Surface Travel after Diving

UH divers shall wait an appropriate time interval before ascending to altitude after diving. Specific times shall be determined on a case-by-case basis, depending on the diving altitude exposures involved. In no case shall divers ascend to altitude in excess of 2,800 feet prior to achieving a "D" repetitive group designator on the US Navy tables, or its equivalent on other approved decompression planning materials.

### **2.3 RECORD KEEPING REQUIREMENTS**

#### 2.3.1 Personal Dive Log

Authorized scientific divers shall log every dive made under the auspices of the University and are encouraged to log all other dives. Log sheets must be submitted to the DSO on at least a monthly basis, and in no case more than 30 days after completion of a dive under University auspices. The DSO will keep the log sheets as part of each diver's permanent file. The DSO will furnish standard forms, which include the following information (Appendix 7 Personal Dive Log Reporting Sheet; Appendix 8, Personal Dive Log Reporting Sheet Guidelines):

1. Name and authorization information of Diver;
2. Date, time, and dive location;
3. Name of dive buddy;

4. Maximum depth and bottom time, and decompression profiles;
5. Name of Lead Diver, or dive plan identifier.
6. General nature of diving activities;
7. Types of diving mode, environment, platform, and life support technology used;
8. Approximate underwater and surface conditions;
9. Breathing gas composition (including decompression gases);
10. Type and method of decompression management (dive tables, dive computer, decompression software, etc...);
11. Detailed report of any accidents or potentially dangerous incidents (Section 2.3.2; Appendix 10);

If a diver conducts no dives under University auspices in a given month, he/she may notify the DSO via mail or electronic mail, instead of filing a dive log. This notification shall be included in the diver's file in lieu of the monthly dive log.

### 2.3.2 Required Incident Reporting

All diving accidents requiring recompression or resulting in death or injury requiring medical attention shall be reported to the DSO, and DCB using the form in Appendix 10. This information can be released (e.g. to AAUS, the Divers Alert Network, or the National Underwater Accident Data Center) only in blinded form or with the diver's/survivor's permission in writing. The University's regular procedures for accident reporting shall also be followed.

1. The following information shall be recorded and retained for a period of at least five years by the DSO with the record of the dive (Appendix 10, AAUS Accident or Incident Reporting Form):
  - a. Name, addresses, and phone numbers of the principal parties involved;
  - b. Summary of experience of divers involved;
  - c. Location and description of dive site and description of conditions that led to the incident;
  - d. Description of symptoms--including depth and time of onset;
  - e. Suspected causes and effects;
  - f. Diagnosis, treatment, and outcome;
  - g. Disposition of case;
  - h. Recommendations to avoid repetition of incident.
2. The DSO shall investigate and document any incident or pressure-related injury and prepare a report for the University Diving Control Board and AAUS (AAUS Incident Report Form, Appendix 10).
3. Additional information deemed necessary may be required. In addition, the University shall:
  - a. Record and report occupational injuries and illnesses in accordance with requirements of the appropriate UH Administrative Procedures;

- b. Record the occurrence of any diving related injury or illness which requires any dive team member to be hospitalized for 24 hours or more, or after an episode of unconsciousness related to diving activity, or after treatment in a recompression chamber following a diving accident; specifying the circumstances of the incident and the extent of any injuries or illnesses.

### 2.3.3 Record Maintenance

The DSO or his/her designee shall maintain permanent records for each individual scientific diver authorized. The file shall include evidence of certification level, log sheets, waiver, reports of disciplinary actions by the DCB, and other pertinent information deemed necessary. Such information shall be made available to the AAUS upon request. The DSO will maintain and file all medical reports, the results of physical examinations, and diving medical history for each diver or applicant.

1. Availability of Records: Medical records shall be available to the attending physician of a diver or former diver when released in writing by the diver or his/her survivors. "Blinded" medical data may be released at the discretion of the DSO, and DCB Chair.
2. Records and documents required by this standard shall be retained by the University for the following minimum periods:
  - a. Physician's written reports of medical examinations for UH divers: five years;
  - b. Manual for diving safety, current document and document(s) used with modifications, if any, during previous five years;
  - c. Records of dives - three years, except five years where there has been an incident of pressure-related injury;
  - d. Pressure-related injury assessment: five years;
  - e. Equipment inspection, service, and testing records: For equipment listed in Section 5.2, records shall be kept for each item from time of purchase until three years after date equipment is withdrawn from University service. Records shall include description of each test, calibration, and repair performed, the date of same, and the person or vendor which performed the test, calibration, or repair;
  - f. Records of hospitalization: five years.

## **CHAPTER 3. DIVER-IN-TRAINING PERMIT**

This section describes required training under University auspices of the non-diver applicant, previously not certified for diving, and shall be used as basis for equivalency evaluation of previously certified applicants. For requirements pertaining to divers currently possessing a valid recreational SCUBA certificate, see Section 3.3.4.

### **3.1 ELIGIBILITY**

The following individuals are eligible for the Diver in Training (DIT) permit:

1. Those individuals who as a part of the Diver Training Program have completed the requirements outlined in Sections 3.2 and 3.3, or
2. Those individuals already certified as divers who meet the following minimum requirements:
  - a. Complete an Application for UH Scientific Diver Authorization (Section 3.2.1);
  - b. Complete a medical examination as outlined in Chapter 7;
  - c. Present a recreational diving certificate from a national agency recognized by the University, as proof of at least 40 hours of diver training with a minimum of five open water training dives.
  - d. Written, pool, and open water proficiency evaluations by the DSO, as required to ensure skills equivalent to those produced by completion of Sections 3.2.and 3.3.

### **3.2 PRE-TRAINING**

#### **3.2.1 Application.**

The applicant for training shall complete the Application for UH Scientific Diver Authorization (Appendix 1), and provide supporting documentation as specified in the current version of the Application forms. The current version of the Application forms shall be available on the UH DSP website, or by request from the DSO.

#### **3.2.2 Medical Examination**

The applicant for training shall be certified by a licensed physician to be medically qualified for diving before proceeding with the training designated in Section 3.2.3 or Section 3.3 (see also Chapter 7; Appendix 3, Diving Medical Exam).

#### **3.2.3 Swimming Test**

The applicant for training shall successfully perform the following tests or their equivalent. The evaluation shall be conducted in the presence of the DSO or an examiner approved by the DSO:

1. Swim underwater without swim aids for a distance of 75 feet without surfacing.
2. Swim 400 yards in less than 12 minutes without swim aids.
3. Tread water for ten minutes, or two minutes no hands, without swim aids.
4. Without the use of swim aids, transport in the water another person of equal size a distance of 75 feet.

### **3.3 SCUBA TRAINING**

#### **3.3.1 Practical Training Evaluations**

At the completion of SCUBA training, the trainee must satisfy the DSO or the DSO's designee of the trainee's ability to perform the following in a pool or in sheltered water, as a minimum performance standard:

1. Enter water with full equipment.
2. Alternate between snorkel and SCUBA on the surface.
3. Remove, replace and clear face mask while submerged breathing from regulator.
4. Remove and replace SCUBA equipment while submerged.
5. Demonstrate understanding of underwater signs and signals.
6. Demonstrate air sharing, including both buddy breathing and the use of an alternate air source, as both donor and recipient, stationary and swimming, with and without a face mask.
7. As a diver, perform in-water rescue of a simulated passive, non-breathing victim of a diving accident, transporting the victim 50 yards in under 4 minutes.
8. Demonstrate simulated in-water mouth-to-mouth resuscitation.
9. Demonstrate water skills and ability acceptable to the DSO or evaluator.
10. Demonstrate understanding of emergency ascent techniques.
11. Demonstrate competence in controlled ascent techniques.
12. Demonstrate competence in diver-related first aid and rescue.

#### **3.3.2 Written Examination**

Before completing training, the trainee must pass a written examination for basic SCUBA diving principles and practices. A passing score on this exam is required to obtain a Diver-In-Training authorization. The exam will cover knowledge of at least the following:

1. Function, care, use and maintenance of diving equipment;
2. Physics and physiology of diving;
3. Diving regulations and precautions;
4. Nearshore currents and waves;
5. Dangerous marine animals;

6. Emergency procedures, including buoyant ascent and ascent by air sharing;
7. Currently accepted "No-Decompression," and repetitive "No-Decompression" limits, and decompression procedures;
8. Proper use of dive tables;
9. Underwater communications;
10. Aspects of fresh water and altitude diving;
11. Hazards of breath-hold dives and ascents;
12. Planning and supervision of diving operations;
13. Diving Hazards;
14. Cause, symptoms, treatment and prevention of the following:
  - a. Near Drowning;
  - b. Air Embolism and related pulmonary overpressure conditions;
  - c. Carbon Dioxide excess;
  - d. "Squeezes" associated with diving;
  - e. Oxygen Toxicity;
  - f. Nitrogen Narcosis;
  - g. Carbon Monoxide Poisoning;
  - h. Exhaustion and Panic;
  - i. Respiratory Fatigue and Motion Sickness;
  - j. Decompression Sickness;
  - k. Hypothermia - Hyperthermia;
  - l. Hypoxia and Anoxia.

### 3.3.3 Open Water Evaluation

The trainee must satisfy the DSO or an approved evaluator of his/her ability to perform at least the following in open water, as a minimum standard:

1. Surface dive to a depth of ten feet in open water without SCUBA.
2. Share a breathing air source, including both buddy breathing and use of an alternate air source as both donor and recipient. Swim effectively a prescribed distance and make a proper controlled ascent.
3. Enter and leave open water or surf, if applicable, wearing scuba gear.
4. Kick on the surface 400 yards while wearing SCUBA gear, but not breathing from the SCUBA unit.
5. Successfully complete five open water SCUBA dives for a minimum total time of four hours, of which two hours cumulative bottom time must be on SCUBA. Not more than three of these training dives shall be made in one day.
6. Demonstrate judgment adequate for safe diving.

7. Where appropriate, demonstrate the ability to maneuver in aquatic plants at and below the surface.
8. Complete a simulated emergency swimming ascent.
9. Remove, replace and clear mask and regulator while submerged.
10. Proficiently exit the water and board a diving support vessel.
11. Achieve and maintain neutral buoyancy while submerged.
12. Demonstrate techniques of self-rescue, and buddy rescue for a tired diver and unconscious non-breathing diver.
13. Navigate underwater at least a reciprocal compass course.
14. Demonstrate ability to plan and execute a dive.

#### 3.3.4 Alternative DIT Qualification of Certified Diver by Challenge Evaluation

If basic dive training is obtained outside University auspices, the applicant shall provide evidence of such training in the form of a certificate from a recognized dive training organization. The DSO or the DSO's designee shall conduct written, oral, confined water and open water evaluations as necessary, to determine that the diver's knowledge and skills are substantially equivalent to those expected of a Diver-In-Training trained according to the requirements of Sections 3.2 and 3.3. At a minimum, the candidate shall satisfactorily complete the following:

1. Application forms (section 3.2.1);
2. Diving medical examination (Section 3.2.2);
3. Inspection of personal diving equipment (Chapter 5);
4. Sheltered water skill evaluation including basic swimming skills (Section 3.2.3), and basic dive skills (Section 3.3.1), including controlled ascent, emergency air sharing, and basic diver rescue techniques;
5. Open water check-out dive to appropriate depth, including the following: basic dive planning, proper descent and ascent procedures, basic dive skills, emergency air sharing, underwater navigation, and basic diver rescue skills (Section 3.3.3).

## **CHAPTER 4. SCIENTIFIC DIVER AUTHORIZATION**

This section describes required training under University auspices for Scientific Diver authorization, and shall be used as basis for equivalency evaluation of previously certified applicants.

The Scientific Diver authorization is a permit to dive, usable only while it is current and for the purpose intended. The University requires that no person shall engage in scientific diving under University jurisdiction unless that person is authorized pursuant to provisions of this manual. The following are considered minimal standards for authorization as a University Scientific Diver.

### **4.1 PREREQUISITES**

#### 4.1.1 Eligibility

Only a person diving under the auspices of the University (Section 1.4.1) is eligible for Scientific Diver Authorization.

#### 4.1.2 Application

If not previously completed as part of DIT training, the applicant for Scientific Diver training shall complete the Application for UH Scientific Diver Authorization (Appendix 1) , and provide supporting documentation as specified in the current version of the Application forms. The current version of the Application forms shall be available on the UHDSF website, or by request from the DSO.

#### 4.1.3 Medical Examination

Each applicant for Scientific Diver Authorization shall submit a statement from a licensed physician trained in diving/undersea medicine, based on the medical examination defined in this manual (Chapter 7, Appendix 3, Diving Medical Exam), attesting to the applicant's fitness for diving.

#### 4.1.4 Qualification

Each applicant must hold a Diver-In-Training permit, or its equivalent (Chapter 3), completed within the last four months, or must demonstrate similar acceptable proficiency and knowledge to the DSO.

### **4.2 REQUIREMENTS FOR SCIENTIFIC DIVER AUTHORIZATION**

Submission of documents and participation in aptitude examinations does not automatically result in authorization. Authorization to dive under University auspices is a privilege granted by the DCB after the applicant convinces the DSO and/or members of the DCB that he/she is sufficiently skilled and proficient to be authorized, and possesses the appropriate attitudes. Authorization will be acknowledged by the signature of the DSO. Any applicant may be denied authorization who, in the evaluation of the DSO or the DCB does not possess the necessary knowledge, skills, or judgment under diving conditions for the safety of

the diver and his/her partner or team. Minimum documentation and examinations required are as follows:

#### 4.2.1 Documentation

The following completed documentation shall be submitted for review by the DSO and/or DCB:

1. Application for Scientific Diving (Appendix 1), including:
  - a. Diver contact information and university affiliation;
  - b. Diver training and experience summary;
  - c. Employment insurability verification;
  - d. Medical consent and emergency contact information;
2. Medical approval for diving (Chapter 7, Appendix 3);
3. Proof of Diver-In-Training Permit level or its equivalent (Chapter 3).

#### 4.2.2 Training

The diver must complete additional theoretical aspects and practical training for a cumulative minimum time of 100 hours beyond the Diver-In-Training Permit level. This may include dives conducted under University auspices as DIT, supervised by an authorized lead diver.

A. Required Training. The following topics are required for all scientific divers.

4. Diving Emergency Care Training. The trainee shall complete training or provide proof of current certification in the following:
  - a. Cardiopulmonary Resuscitation (CPR), to include:
    - Emergency recognition and scene safety assessment, including breathing emergencies, cardiac emergencies, stroke;
    - Initiation of Emergency Medical Services ("Chain of Survival");
    - Personal protective equipment for blood borne pathogens (Universal Precautions);
    - Primary victim assessment, including patent airway, breathing competence, and signs of circulation, including carotid artery pulse check;
    - Establishment of open airway, including methods for suspected spinal injury;
    - Rescue breathing for an adult victim;
    - Airway obstruction clearance;
    - One-Rescuer CPR for adult victims;
    - Two-Rescuer CPR for adult victims;
    - Special resuscitation considerations for electrical shock, lightning, drowning and water rescue, hypothermia, and traumatic injury;
  - b. First Aid for diving activity, to include;

- General principals of triage;
  - Secondary examination;
  - Bleeding emergencies, including bleeding control and basic bandaging techniques;
  - Wound care and disinfection;
  - Shock;
  - Burns (thermal, electrical, and chemical);
  - Smoke inhalation;
  - Musculoskeletal injury (sprains, strains, dislocations, fractures), including basic splinting and immobilization techniques;
  - Medical emergencies and sudden illness (asthma, diabetic emergency, seizures, anaphylaxis, stroke, poisoning, and food-borne illness);
  - Bites and stings, especially as pertaining to marine life commonly encountered in the regions in which diving will be performed;
- c. Emergency oxygen administration for diving accidents, including
- Causes and recognition of near-drowning, decompression sickness and cerebral arterial gas embolism;
  - Diving victim assessment, including field neurologic examination;
  - Oxygen administration by demand valve and constant-flow devices consistent with treatment of diving injury;
  - Oxygen equipment identification, deployment, care and maintenance;
  - Oxygen safety.
- d. Scuba Rescue and Diving Accident Management, including:
- Diving stress recognition and management;
  - Self-rescue techniques;
  - Passive conscious diver assist techniques;
  - Panicked-diver procedures;
  - Unconscious diver rescue (surface and submerged victim scenarios);
  - In-water rescue breathing;
  - Extraction techniques;
  - Diving accident management.
4. Practical and/or Theoretical Aspects of Diving. Practical and/or theoretical aspects of diving should include principles and activities appropriate to the diver's area of scientific study, but shall include:
- a. Administrative Issues:
- AAUS and University scientific diving regulations;
  - Coordination with other agencies;

- Governmental regulations affecting diving operations.
- b. Advanced Diver Training:
  - Diving Physics and Physiology;
  - Diving environment (applied physical and biological processes);
  - Dive site selection, location and relocation;
  - Scuba equipment design, function and field trouble shooting;
  - High-pressure gas cylinder safety (handling, maintenance, storage, and transport);
- c. Dive planning and control:
  - Procedures for planning and conducting dives not requiring - decompression stops using approved dive tables or dive computers;
  - Dive team briefing, debriefing, coordination and control;
- d. Scientific Methods in Diving:
  - Hypothesis development
  - Study site selection, location and re-location;
  - Basic observation and data collecting techniques;

## B. Additional Topics

Additional topics may include but are not limited to the following, as needed for the diver's proficiency in his/her area of science. Training should include direct practical applications of the topic to diving:

1. Specialized Diving Modes, and Equipment:
  - a. Required decompression diving;
  - b. Alternate breathing gases (nitrox, mixed gas);
  - c. Scuba cylinder filling and compressor operations;
  - d. Hookah diving;
  - e. Surface-supplied diving;
  - f. Full-face masks;
  - g. Rebreathers (Semi-closed circuit, closed-circuit);
  - h. Saturation diving;
  - i. Recompression chamber operations;
  - j. Vessel navigation, piloting, and seamanship
  - k. Specialized Diving Environments and Conditions
  - l. Blue water diving;
  - m. Confined spaces diving;
  - n. Restricted overhead environment diving;
  - o. Night diving;
  - p. Zero visibility diving;
  - q. Research vessel diving;

- r. Aquarium diving;
- s. Polluted water diving;
- t. Ice and Polar water diving;
- 2. Underwater Science Methods
  - a. Common aquatic biota (identification, ecology, behavior, handling, tagging);
  - b. Specimen collection;
  - c. Installation of scientific apparatus and instrumentation;
  - d. Use of chemicals;
  - e. Maritime history and archaeology;

#### C. Required Practical Training.

Practical training shall include at least one training dive focusing on practical diving emergency skills, including basic skills, air sharing, and self-, and diver rescue techniques. Eleven additional dives appropriate to the diver's research shall be completed to ensure a cumulative total of at least 12 logged, supervised ocean or open water dives beyond the DIT level, in a variety of dive locations and diving conditions for a cumulative bottom time of at least four hours. No more than three of these dives shall be made in one day.

#### D. Scientific Diver Written Examination.

After completion of training, the trainee must pass a written examination for SCUBA diving principles and practices. A passing score on this exam is required to obtain Scientific Diver authorization. The exam will cover knowledge of at least the following:

1. Function, care, use and maintenance of diving equipment;
2. Physics and physiology of diving;
3. Diving regulations and precautions;
4. Nearshore currents and waves;
5. Hazardous marine life;
6. Emergency procedures, including buoyant ascent and ascent by air sharing;
7. Currently accepted "No-Decompression," and repetitive "No-Decompression" limits, and decompression procedures;
8. Proper use of dive tables;
9. Underwater communications;
10. Aspects of fresh water and altitude diving;
11. Hazards of breath-hold dives and ascents;
12. Planning and supervision of diving operations;
13. Diving Hazards;
14. Cause, symptoms, treatment and prevention of the following:

- a. Near Drowning;
- b. Air Embolism and related pulmonary overpressure conditions;
- c. Carbon Dioxide excess;
- d. "Squeezes" associated with diving;
- e. Oxygen Toxicity;
- f. Nitrogen Narcosis;
- g. Carbon Monoxide Poisoning;
- h. Exhaustion and Panic;
- i. Respiratory Fatigue and Motion Sickness;
- j. Decompression Sickness;
- k. Hypothermia - Hyperthermia;
- l. Hypoxia and Anoxia.

#### 15. Scuba diver rescue and emergency management techniques

##### 4.2.3 Waiver of Requirements

If an applicant for authorization can show evidence of equivalent qualifying experience, the DSO and the DCB may grant a waiver for specific requirements of training and experience. The requirement for logging 12 dives under the supervision of an authorized Lead Diver (Section 4.2.2.C) and medical examination requirement (Chapter 7) may not be waived.

##### 4.2.4 Alternative Qualification by Challenge Evaluations

1. If equivalent dive training is obtained outside University auspices, the applicant shall provide evidence of such training in the form of documentation to the satisfaction of the DCB. The DSO shall conduct written, oral, confined water and open water evaluations as necessary, to determine that the diver's knowledge and skills are substantially equivalent to those expected of a UH Scientific Diver trained according to the requirements of Section 4.1 and 4.2.
2. Upon satisfactory completion of challenge evaluations, the diver shall be placed under Restricted Diver status (Section 1.4.3.4), with a depth authorization commensurate with the diver's skill and experience level, as determined by the DSO.
3. Upon satisfactorily completion and logging 12 supervised dives under University auspices (Section 4.2.2.C) and other outstanding items, the diver's status may be upgraded to Scientific Diver (Section 1.4.3.2).

#### **4.3 DEPTH AUTHORIZATION**

The Scientific Diver designation authorizes the diver to work as a Lead Diver or lead member of a buddy pair to the limit of the diver's depth authorization, during activities and under conditions with which the diver is experienced.

Completion of listed requirements does not automatically result in authorization to a specific level. The diver must also convince the DSO that the diver possesses the requisite knowledge, skill and attitudes to serve as Lead Diver to the indicated depth.

#### 4.3.1 Diver In Training (DIT)

This is the initial authorization level, granted upon completion of training requirements listed in Chapter 3. The DIT may dive under supervision to a maximum depth of 40 feet seawater (fsw), unless otherwise specified by the DSO.

#### 4.3.2 Authorization to 40fsw Depth

This is the initial Scientific Diver authorization level, granted upon the successful completion of requirements listed in Sections 4.1 and 4.2. If advanced diving experience, knowledge, skills and judgment are demonstrated by superior performance on evaluations, the DSO may recommend to the DCB that an entering diver be granted a deeper initial depth authorization.

#### 4.3.3 Progression to Greater Depth Levels

An authorized Scientific Diver in Active status (Section 1.4.3.2) diving under the auspices of the University may exceed his/her depth authorization only if accompanied by an approved Active-status UH Scientific Diver authorized to at least that greater depth level. Under these circumstances, the diver may exceed his/her authorized depth by one step.

#### 4.3.4 Authorization to 60fsw

An Active-status Scientific Diver holding a 40fsw authorization may be authorized to a depth of 60fsw after successfully completing under University jurisdiction 12 logged dives to depths between 30fsw and 60fsw, for a minimum total dive time of four hours. On each dive, the diver must be directly accompanied by an approved Active-status University Scientific Diver holding an authorization to at least the 60fsw level. The dives must be attested to by the signatures of an approved Lead Diver on the submitted dive log, or by written or email communication from the supervisor to the DSO. A single Lead Diver may not attest to all twelve dives. At least one dive must be done under the supervision of and attested to by a different Lead Diver.

#### 4.3.5 Authorization to 100 Feet and 130 Feet

After authorization to 60 feet, a diver may sequentially qualify for authorization to 100 feet and 130 feet through similar procedures. A minimum of 4 dives under supervisors approved by the DSO shall be made near the depth limit. Depth experience shall be validated by the Lead Diver or the diver's Scientific Diver buddy who is authorized to at least the dive depth as specified in Section 4.3.3.

For authorization deeper than 60 feet, the diver shall also demonstrate proficiency in the use of appropriate decompression tracking methods and mastery of concepts related to deeper diving.

At the discretion of the DSO, the diver may be required to conduct a dive in the deeper depth range under supervision while serving in the role of the Lead Diver, to demonstrate proficiency in coordinating and supervising deeper diving operations.

#### 4.3.6 Authorization to Depths Beyond 130 Feet

Authorizations to 150 and 190 feet may only be granted by the DCB, and shall be based at a minimum on similar provisions. For such authorizations, the DCB may require additional training and qualification in use of nitrox (Chapter 10), staged decompression diving (Chapter 11), oxygen use for decompression (Chapter 12), or mixed gas diving, (Chapter 13), as pertinent to the activity.

#### 4.3.7 Authorizations to Depths Beyond 190 fsw.

Authorization to depths over 190 feet may only be granted by the DCB, and shall be based at a minimum on similar provisions, in 50 fsw increments. Such authorizations shall require additional training and qualification in use of nitrox (Chapter 10), staged decompression (Chapter 11), oxygen use for decompression (Chapter 12), and mixed gas diving, (Chapter 13), as pertinent to the activity.

### **4.4 CONTINUATION OF AUTHORIZATION**

#### 4.4.1 Term of Authorization

Scientific Diver authorization shall expire one year from the date of issuance, or six months from the date of the last logged dive, or upon expiration of medical clearance, or first aid, CPR, or oxygen administration certification.

#### 4.4.2 Minimum Activity to Maintain Authorization

During any 12-month period, an authorized Scientific Diver must log a minimum of 12 dives. At least one dive must be logged near the maximum depth of the diver's authorization during each six-month period. Divers authorized to 150 feet or deeper may satisfy these requirements with dives to 130 feet or deeper. Failure to meet the above requirements may be cause for revocation or restriction of authorization.

#### 4.4.3 Medical Examination

Authorized Scientific Divers shall pass a periodic medical examination, as specified in Chapter 7.

After each major illness or injury as described in Section 7.1.5 and Appendix 3, an Authorized Scientific Diver shall submit to a medical interview or examination before resuming diving activities.

#### **4.5 RESTRICTED SCIENTIFIC DIVER AUTHORIZATION**

A UH Scientific Diver whose emergency response certifications (CPR, First Aid, or Oxygen Administration) have expired or who has completed less than the required minimum required periodic dives (Section 4.2.2), but who otherwise is currently qualified as a Scientific Diver according to the requirements of Chapter 4, may be granted an authorization to dive on a Restricted Diver status. It is intended in most cases that the Restricted Status be of temporary duration while the Scientific diver obtains recertification in the expired emergency response training.

1. A UH Diver on Restricted status is eligible to dive on projects under UH jurisdiction, provided the diver is under the supervision of a fully authorized UH Scientific Diver. Diving shall only be conducted within the Restricted Diver's depth authorization.
2. A UH Diver on Restricted status is ineligible:
  - a. to serve as a Lead Diver or Lead Buddy on a dive under UH jurisdiction;
  - b. for referral to other institutions under reciprocity agreements;
  - c. to work on projects involving joint operations with other institutions.

#### **4.6 INACTIVE OR DISQUALIFIED DIVER STATUS.**

A diver placed on Inactive or Disqualified status shall not dive under UH jurisdiction until the conditions for the designation are remedied.

1. Inactive Diver Status. A UH Diver shall be placed on Inactive Diver status if: his/her medical clearance to dive (Chapter 7) has expired, or the diver has logged no dives or otherwise not maintained current records in the past 12 months.
2. Disqualified Status: A UH Diver or Diver candidate shall be placed on Disqualified status, if upon medical examination the diver fails to gain medical approval to dive, in accordance with Chapter 7.

#### **4.7 REVOCATION OF AUTHORIZATION**

##### **4.7.1 Revocation for Cause**

The DSO may restrict, stop or suspend a diver's authorization for cause, pending review by the DCB (Section 1.4.2, Section 1.8). Violations of regulations set forth in this manual, or of regulations of governmental subdivisions not in conflict with this manual, may be considered cause.

##### **4.7.2 Medical Revocation**

A diving authorization may be revoked or restricted for medical reasons by the diver's examining physician, or the DCB upon recommendation of the DMAP Chair (see Chapter 7 and Appendix 3.)

## **4.8 REAUTHORIZATION**

If a diver's authorization expires or is revoked, he/she may be re-authorized after complying with such conditions as the DSO may impose. If the diver disagrees with the conditions, he/she shall be given an opportunity to present his/her case to the DCB before conditions for reauthorization are enforced. The diver shall not dive under jurisdiction of the University during the appeal period.

## **4.9 TEMPORARY DIVER AUTHORIZATION**

Requirements of Chapter 3 and Chapter 4 may be waived by the DSO if the person in question has demonstrated proficiency in diving and can contribute measurably to a planned dive. Medical examination and approval requirements may not be waived without the approval of the DMAP Chair.

### **4.9.1 Documentation of Temporary Diver**

The following shall be submitted, at a minimum, to the DSO as part of the Dive Plan Application (Section 2.2.9; Appendix 6):

1. Application for Scientific Diving Application (Appendix 1), including Assumption of Risk, Waiver, and Release Form, and Medical Consent and Emergency Contact Form;
2. Evidence of scuba certification;
3. Evidence of a medical evaluation and approval for diving consistent with the requirements of Chapter 7 (Appendix 3);
4. Emergency response training certificates (as appropriate);
5. A statement of the temporary diver's qualifications to justify waiver of requirements.
6. Documentation of practical diving skill evaluation by DSO or DSO's delegate.

### **4.9.2 Limitation of Scope**

Temporary authorization shall be restricted to the planned diving operations and shall comply with all other policies, regulations and standards of this manual, including medical requirements. A Temporary Diver may serve as Lead Diver only if specifically approved by the DSO and/or DCB.

### **4.9.3 Non-waiver of Medical Standards**

Diving medical examination and approval requirements (Chapter 7) may not be waived, except with the written approval of the DMAP Chair.

## **CHAPTER 5. DIVING EQUIPMENT**

### **5.1 GENERAL POLICY**

All equipment shall meet standards as determined by the DSO and the DCB, and as specified in this manual. Equipment that is subjected to extreme usage under adverse conditions requires more frequent testing and maintenance.

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

### **5.2 EQUIPMENT**

All inspections, tests, and maintenance specified in this manual shall be accomplished by qualified technicians or facilities approved by the DSO and the DCB.

#### **5.2.1 Regulators**

1. Approval: Only those makes and models specifically approved by the DSO and the DCB shall be used.
2. Inspection and Testing: SCUBA regulators used in the Scientific Diving Program shall be inspected and tested prior to their first use. Regulators shall be inspected and tested periodically. Normally this inspection and testing shall occur every twelve months. In no case shall a regulator be used which has not been inspected and tested within the twelve months preceding its use. The DSO may require more frequent inspection and testing for some regulators, or if heavy use indicates a need. Periodic servicing shall meet manufacturers recommendations.
3. Regulators will include a primary second stage, and an alternate breathing gas source (such as a secondary second stage or redundant gas supply).
4. If a redundant breathing gas supply is used, it shall be sufficient to return the diver to the surface at a safe, normal ascent rate, allowing for all indicated decompression stops, either precautionary or required.

#### **5.2.2 Breathing Masks and Helmets**

Breathing masks and helmets shall have the following features:

1. A non-return valve at the attachment point between helmet or mask and 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.

#### **5.2.3 SCUBA Cylinders**

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

1. SCUBA cylinders must be hydrostatically tested in accordance with federal Department of Transportation standards.
2. SCUBA cylinders must have an internal visual inspection at intervals not to exceed 12 months.
3. SCUBA cylinder valves shall be functionally tested at intervals not to exceed 12 months.
4. SCUBA cylinders and valves which are subjected to usage higher than 15 dives per month or filling by multiple users, shall be inspected at a more frequent interval.

#### 5.2.4 Buoyancy Control Devices

A buoyancy control device capable of providing neutral buoyancy at depth, a controlled ascent, and positive flotation on the surface is required.

1. Personal flotation systems, buoyancy compensators, dry suits or other variable volume buoyancy compensation devices shall be equipped with an overpressure-relief valve.
2. These devices shall be functionally inspected and tested by the DSO or his/her designee before first use. Under normal use these devices shall be inspected and tested at twelve month intervals. No such device shall be used unless it has been inspected and tested within the previous twelve months.
3. BC Inflation mechanisms shall be serviced in accordance with manufacturers' recommendations. In most cases, this is an annual requirement.
4. A separate buoyancy control device must be worn when diving in a drysuit.

#### 5.2.5 Backpacks and Weighting Systems

1. Backpacks and weighting systems without integrated buoyancy devices shall have quick release devices designed to permit jettisoning with a single motion from either hand
2. Backpacks and weighting systems shall be regularly inspected by the persons using them.

#### 5.2.6 Timing Devices, Depth Gauges and Submersible Cylinder Pressure Gauges

1. Both members of a diving pair must have an underwater timing device, an approved depth indicator, and a submersible cylinder pressure gauge.
2. The DSO and the DCB shall specify those makes and models of submersible pressure gauges and depth gauges approved for use.

3. Gauges shall be inspected and tested by the DSO or his/her designee before first use. Gauges in normal use should be inspected and tested at twelve month intervals. No gauge should be used unless it has been inspected and tested within the twelve months prior to its use.
4. Submersible pressure gauge swivels should be serviced in accordance with manufacturers' recommendations. Usually, this is an annual requirement.

#### 5.2.7 Dive Tables.

1. Only those dive tables approved by the DCB may be used.
2. A set of approved dive tables shall be available at the dive site. Dive tables shall be at least as conservative as the US Navy Tables.

#### 5.2.8 Dive Computers and Decompression Software

1. The DCB shall have the authority to authorize divers to conduct dives using dive computers or decompression software instead of dive tables.
2. The DCB shall have the authority to review and approve specific makes and models of dive computers and decompression software.
3. A set of approved dive tables shall be available at the dive site.
4. See Section 2.2.6 regarding requirements for computer-assisted diving.
5. See Section 2.2.7 regarding requirements for use of decompression software.

### **5.3 AUXILIARY EQUIPMENT**

All auxiliary equipment shall be of a type approved by the DSO and/or the DCB.

1. First Aid Supplies and Emergency Equipment
  - a. A first-aid kit adequate for the diving operation shall be available at the dive location.
  - b. When used in a hyperbaric chamber or bell, the first-aid kit shall be suitable for use under hyperbaric conditions.
  - c. An emergency oxygen supply adequate for the diving operation shall be available at the dive location. The supply shall be equipped with a multi-function regulator with demand valve and constant-flow (15 lpm, minimum) capability, The regulator shall fitted with:
    - a demand inhalator or resuscitator with oronasal mask;
    - a resuscitation mask with supplemental oxygen fitting;
    - a non-rebreather mask (high concentration).
2. Underwater Hand-held Power Tools
  - a. Electrical hand-held tools and equipment used underwater shall be specifically approved for this purpose.

- b. Electrical hand-held tools and equipment supplied with power from the surface shall be de-energized before being placed into or retrieved from the water.
  - c. Surface-powered hand-held power tools shall not be supplied with power until requested by the diver.
3. Powerhead Spears
- a. Authorization to carry powerhead spears requires DCB approval.
  - b. Powerheads shall be equipped with a safety locking device and/or only be loaded when in the water.

**5.4 RECORD KEEPING**

For University-owned equipment, records shall be kept for each item listed below from its original acquisition until three years after the date equipment is withdrawn from University service. Each equipment modification, repair, test, calibration, or maintenance service shall be logged including the date and nature of work performed, serial or identification number of item, and the name of the person performing the work. Records shall be kept for the equipment listed in Table 5.1

**Table 5.1 Diving Equipment for Which Records Shall be Kept.**

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Compressors	Submersible Pressure Gauges
Regulators	Depth Gauges
Dive Computers	Buoyancy Control Devices
SCUBA Cylinders	Cylinder Valves
Diving Helmets	Gas Control Panels
Submersible Breathing Masks	Analytical Instruments
Air Storage Cylinders	Air Filtration Systems
Rebreathers	

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All non-University equipment (e.g. personal, rental, etc.) used in conjunction with University scientific diving operations shall meet the same standards as University-owned equipment, as determined by the DSO, or his/her designee, such as a qualified Lead Diver.

## CHAPTER 6. BREATHING GAS

### 6.1 BREATHING AIR STANDARDS

#### 6.1.1 Breathing Air

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

**Table 6.1. CGA Grade E Specifications.**

<u>Component</u>	<u>Maximum Concentration</u>
Oxygen	20-22%
Carbon Monoxide	0.001% (10 ppm/v)
Carbon Dioxide	0.05% (500 ppm/v)
Condensed Hydrocarbons	5 mg/m <sup>3</sup>
Dust and Droplets of Oil and Water	Absent
Odors and Vapors	Absent

#### 6.1.2 Air to be Mixed with Greater than 40% Oxygen

In addition to the standards outlined in Section 0, the following standards shall be met for breathing air that is:

1. Placed in contact with oxygen concentrations greater than 40%, or
2. Used in Enriched Air Nitrox (EAN) filling operations by the partial pressure mixing method, with greater than 40% oxygen as the enriching agent:

**Table 6.2. Specifications for Air to be Mixed with Greater than 40% Oxygen.**

Air Purity	CGA Grade E (Section 0)
Condensed Hydrocarbons	less than or equal to 0.5 mg/m <sup>2</sup>
Hydrocarbon Contaminants	less than or equal to 0.1 mg/m <sup>3</sup>

### 6.2 OXYGEN AND MIXED GAS

#### 6.2.1 Oxygen

Oxygen used for mixing Enriched Air Nitrox (EAN) or mixed gas shall meet the purity levels for Medical (U.S.P.) Grade.

**Table 6.3. Medical (U.S.P.) Grade Oxygen Specifications.**

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Oxygen Content	Minimum 99.5%
<u>Contaminants</u>	<u>Maximum</u>
Nitrogen	0.1%
Argon	0.4%
Hydrocarbons	3 ppm
Methane	25 ppm
Carbon Dioxide	5 ppm
Carbon Monoxide	1 ppm
Moisture	25 ppm

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6.2.2 Nitrogen or Helium

Nitrogen or Helium used to produce EAN or other mixed gas breathing mixtures shall be of an acceptable grade for breathing by humans.

1. Nitrogen

**Table 6.4. Nitrogen Specifications.**

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Nitrogen Content	Minimum 99.5%
<u>Contaminants</u>	<u>Maximum</u>
Oxygen	55 ppm
Hydrocarbons	1 ppm
Carbon Dioxide	1 ppm
Carbon Monoxide	1 ppm
Moisture	25 ppm

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2. Helium

**Table 6.5 Helium Specifications.**

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Helium Content	Minimum 99.5%
<u>Contaminants</u>	<u>Maximum</u>
Oxygen	50 ppm
Hydrocarbons	1 ppm
Carbon Dioxide	1 ppm
Carbon Monoxide	1 ppm
Moisture	25 ppm

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## 6.3 COMPRESSOR SYSTEMS

### 6.3.1 Design and Location of Compressor

The following features should be considered in the design and location of compressor systems:

1. Low pressure compressors used to supply air to the diver should be equipped with a volume tank with a check valve on the inlet side, a pressure gauge, a relief valve, and a drain valve;
2. Compressed air systems over 500 psig equipped with slow-opening shut-off valves;
3. Fill station controls located in a remote position, shielded from cylinders being filled, to minimize risk of injury in the event of a cylinder failure;
4. Pressurized gas bank cylinders secured to prevent falling;
5. All high pressure lines and fittings of appropriate rated working pressures and secured every 2 feet;
6. All air compressor intakes located away from areas containing engine exhaust or other contaminants.

### 6.3.2 Compressors for Enriched Air Nitrox or Mixed Gas Systems

1. An oil-free or oil-less compressor is recommended when blending or mixing nitrox using oxygen concentrations greater than 40%, to reduce the presence of oil mist and reduce the possibility for oxygen ignition of hydrocarbons. Quality of a hyper-filtered air supply from an oil-lubricated compressor used for EAN production shall be tested quarterly and checked for oil and hydrocarbon contamination on a frequent basis.
2. The DCB and DSO shall review and approve the design of EAN filling stations under University control. Only those designs approved by the DSO and DCB shall be used in University controlled filling operations. Methods for producing EAN (membrane filtration, etc.) which do not require the addition to the SCUBA cylinder of oxygen concentrations above 40% shall be regarded as preferable to partial pressure mixing methods using high concentration oxygen.

### 6.3.3 Compressor Operation and Air Test Records

1. Gas analysis and air tests shall be performed on each University-controlled 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. Copies of the results shall be kept on file by the DSO, or the DSO's designee.
2. A log shall be maintained showing operation, repair, overhaul, filter maintenance, and temperature adjustment for each compressor.

3. Personnel filling pressure cylinders from University-owned compressors shall be periodically trained and qualified in the operation of the fill station used. Training shall be documented and kept on file by the department/program controlling fill station operations, and shall be available to the DSO or DCB upon request.

#### 6.3.4 Oxygen Systems and Systems using Greater Than 40% Oxygen (EAN)

1. Diving equipment used with oxygen or mixtures containing over 40% oxygen by volume at pressures greater than 200 psig shall be cleaned and maintained for oxygen service.
2. Components of cylinder filling stations exposed to oxygen or gas mixtures containing oxygen concentrations over 40% by volume shall be cleaned for oxygen service, and equipped with oxygen-clean fill whips, gauges, valves, and plumbing, etc. These measures are intended to maintain EAN system integrity.
3. Oxygen delivery systems and breathing gas systems using greater than 40% oxygen at pressures over 200 psig shall have slow-opening shut-off valves.
4. SCUBA cylinders and valves used in EAN production during which oxygen concentrations greater than 40% are passed into the cylinder shall be cleaned and maintained for oxygen service.

### **6.4 PRODUCTION OF SPECIAL GAS MIXTURES**

#### 6.4.1 Authorization

Production of special gas mixtures (EAN, Heliox, Trimix, etc...) shall be as authorized and approved by the DCB.

#### 6.4.2 Personnel

Personnel involved in the production of EAN and mixed gas shall be trained and qualified for the method of production used, as determined by the DCB.

## **CHAPTER 7. MEDICAL STANDARDS**

### **7.1 MEDICAL REQUIREMENTS OF DIVE TEAM**

#### **7.1.1 General**

1. The University shall determine that dive team members who are exposed to hyperbaric conditions have passed a current diving physical examination in compliance with this chapter, and have been declared by a licensed physician to be fit to engage in diving activities as may be limited or restricted in the medical evaluation report (Appendix 3).
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 (Appendix 13).
3. The diver should be free of any chronic disabling disease and be free of any condition contained in the list of conditions for which restrictions from diving is generally recommended ( Section 7.1.5, Appendix 3).

#### **7.1.2 Frequency of Medical Evaluations**

Medical evaluation shall be completed:

1. Before a diver may dive, unless an equivalent 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 University has obtained the results of that examination, and those results have been reviewed and found satisfactory by the DSO and DCB.
2. At five-year intervals from the date of initial evaluation or last equivalent evaluation up to the age of 40, every three years after the age of 40, and every two years after 60.
3. Clearance to return to diving must be obtained from a licensed physician after any major injury or illness or any condition requiring hospital care, after any episode of unconsciousness, or after any diving accident. If the injury or illness is pressure-related, then the clearance to resume diving must come from a physician trained in diving medicine.
4. More frequent medical examinations may be required for divers using certain specialized dive modes, as determined by the DCB.

#### **7.1.3 Information Provided Examining Physician**

The University shall provide a copy of the medical evaluation requirements of this standard to the examining physician as part of the diving medical examination forms (Appendix 3).

#### **7.1.4 Content of Medical Examinations**

Medical examinations conducted initially and periodically shall consist of the Following, as outlined in Appendix 3:

1. Diving Medical Exam Instructions, including list of conditions which may disqualify candidates from diving (Section 7.1.5)
2. Medical History
3. Applicant Agreement for Release of Medical Information
4. Diving Physical Examination and Required Tests (Section 7.1.6)
5. Any additional tests the physician may consider necessary;
6. Medical Evaluation of Fitness for SCUBA Diving Report (Section 7.1.7)

#### 7.1.5 Restriction of Diving

Conditions which may disqualify candidates from diving (see Bove, 1998; also listed in Appendix 3):

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.

#### 7.1.6 Laboratory Requirements for Diving Medical Examination:

The initial entry examination, first examination with a physician unfamiliar with the diver's past diving medical history, and/or the first examination over 40 shall include:

1. Examination under age 40:
  - a. Initial (Entry) Examination
    - Medical History
    - Complete Physical Exam, with emphasis on neurological and otological components
    - Chest X-ray
    - Spirometry
    - Hematocrit or Hemoglobin
    - Urinalysis
    - Any further tests deemed necessary by the physician.
  - b. Periodic re-examination (every 5 years)
    - Medical History
    - Complete Physical Exam, with emphasis on neurological and otological components
    - Hematocrit or Hemoglobin
    - Urinalysis
    - Any further tests deemed necessary by the physician
2. Examination over age 40:
  - a. Initial (Entry) Examination:
    - Medical History
    - Complete Physical Exam, with emphasis on neurological and otological components
    - Assessment of coronary artery disease risk factors including lipid profile and diabetic screening
    - Resting EKG
    - Chest X-ray
    - Spirometry
    - Urinalysis
    - Hematocrit or Hemoglobin
    - Any further tests deemed necessary by the physician. Exercise stress testing may be indicated based on risk factor analysis.

- b. Periodic re-examination (every 3 years; over age 60, every two years):
- Medical History
  - Complete Physical Exam, with emphasis on neurological and otological components
  - Assessment of coronary artery disease risk factors including lipid profile and diabetic screening
  - Resting EKG
  - Urinalysis
  - Hematocrit or Hemoglobin
  - Any further tests deemed necessary by the physician. Exercise stress testing may be indicated based on risk factor analysis.
3. For divers engaging in Specialized Diving Modes with increased physiologic concern, as identified by the DCB, the periodic examination may be required at more frequent intervals.

#### 7.1.7 Physician's Written Report

1. After any medical examination relating to the individual's fitness to dive, the University shall be provided with a written report prepared by the examining physician, which shall contain the examining physician's opinion of the individual's fitness to dive, including any recommended restrictions or limitations (Appendix 3). This shall be reviewed by the DSO and DMAP Chair.
2. Copies of the medical history, medical information release agreement, medical examination, and test results shall be returned to the DSO, and included in the diver's file.
3. The University shall make a copy of the physician's written report available to the individual.

## **VOLUME II. SPECIALIZED DIVING MODES**

### **GENERAL INTRODUCTION**

Any dive requiring staged decompression, conducted in restricted overhead environments (cavern, cave, tunnel, ice, or shipwreck penetration), conducted in bluewater (open ocean), incorporating breathing gas mixtures other than air, involving breathing gas delivery systems other than self-contained, open-circuit systems, or conducted in any other particularly hazardous environments, shall be considered Specialized Diving.

For each of these modes, the following Chapter 8 through Chapter 18 define specific considerations regarding the following issues:

1. Training prerequisite requirements, if any;
2. Training and/or experience verification requirements for University authorization;
3. Equipment requirements;
4. Operational Requirements and additional safety protocols to be used.

For dives that involve more than one specialized diving mode, all requirements for each of the relevant diving modes shall be met.

The DCB reserves the authority to review each application of specialized diving modes, and include any further requirements deemed necessary on a case-by-case basis.

## **CHAPTER 8. RESTRICTED OVERHEAD ENVIRONMENTS**

Restricted overhead environments include any diving environment in which a direct ascent to the surface is impeded by a physical barrier, including cave, cavern, ice and shipwreck penetration. It does not include underwater arches, lava tubes, opened shipwrecks or kelp forests, in which:

1. Two divers can easily swim abreast;
2. There is no significant danger of entrapment or entanglement
3. Loss of visibility due to siltation is unlikely;
4. Direct sunlight is always available for illumination.

### **8.1 TRAINING PREREQUISITES**

Active status Scientific Diver, Temporary Diver or DIT authorization, with depth authorization adequate for the planned operations is required. Restricted overhead environment training may be included as a component of scientific diver training, but only after the DIT has demonstrated general diving proficiency to the satisfaction of the DSO and/or DCB, especially buoyancy control and awareness.

### **8.2 TRAINING REQUIREMENTS**

1. Divers shall document training in restricted overhead environment diving appropriate for the conditions in which dive operations are to be conducted. Such documentation shall be to the satisfaction of the DSO and/or DCB. Training shall be conducted by agencies and instructors approved by the DSO and DCB.
2. Divers shall demonstrate to the satisfaction of the DSO or his/her designee, proficiency in planning and executing dives in a restricted overhead environment appropriate to the conditions in which diving operations are to be conducted.

### **8.3 EQUIPMENT REQUIREMENTS**

1. Divers shall employ a continuous guideline from a point outside the restricted overhead environment to their position. A minimum of three lights shall be carried by each diver. In environments in which direct sunlight is visible, each diver shall carry a minimum of two lights.
2. Redundant breathing gas delivery systems shall be designed such that no single component failure can prevent access by the diver to an appropriate breathing gas supply.
3. An alternate second stage shall be included with a hose of adequate length to facilitate emergency gas sharing while swimming in a single file formation.
4. The DCB may require redundancy in other equipment systems to ensure dive team safety, including:

- a. Submersible Cylinder Pressure Gauges;
- b. Dive Computers or Decompression Calculation Devices;
- c. Dive Timing Devices;
- d. Depth gauges;
- e. Buoyancy Control Devices;

#### **8.4 OPERATIONAL REQUIREMENTS**

1. Restricted overhead environment diving authorization will be acknowledged by the signed initials of the DSO on the UH Scientific Diver authorization card.
2. Divers shall immediately begin exiting from a restricted overhead environment when a light source or a piece of equipment fails or malfunctions.
3. Divers shall begin exiting the overhead environment as soon as any member of the dive team reaches two-thirds of his/her starting air supply.
4. Where an enclosed or confined space is not large enough for two divers, a diver shall be stationed at the underwater point of entry, an orientation line shall be used, and an emergency breathing gas supply will be available at the point of entry.
5. Emergency procedures for loss of gas supply, equipment malfunction, team separation, unexpected diving conditions and loss of visibility shall be developed. Emergency procedures shall be reviewed by the divers prior to each dive.

## **CHAPTER 9. BLUEWATER DIVING**

Bluewater diving is defined as diving conducted in any body of water in which there is no physical bottom within diving depth ranges. The following regulations are derived from the publication, Bluewater Diving Guidelines (Heine, J.N., Ed., 1986. California Sea Grant College Program Publication No. T-CSGCP-014.)

Exceptions to this standard may be made on a case-by-case basis, if a risk of entanglement with other structures exists, or there are other means of physical control. Procedures for diver control and communication must be developed to the satisfaction of the DSO and/or DCB.

### **9.1 PREREQUISITES FOR TRAINING**

Active status Scientific Diver, Temporary Diver or DIT authorization, with depth authorization adequate for the planned operations is required. Bluewater training may be included as a component of scientific diver training, but only after the DIT has demonstrated general diving proficiency to the satisfaction of the DSO and/or DCB, especially buoyancy control and awareness.

### **9.2 TRAINING REQUIREMENTS**

The diver shall complete classroom and practical training in bluewater diving techniques, and demonstrate knowledge and proficiency in bluewater diving to the satisfaction of the DSO or his/her designee.

Theoretical Training shall include:

1. Bluewater diving equipment design and deployment;
2. Support vessel configuration for bluewater diving and procedures for live-boat operations;
3. Entry procedures;
4. Buoyancy control and awareness;
5. Diver communication;
6. Dive Team control and coordination;
7. Roles and responsibilities of safety diver;
8. Scientific procedure familiarization;
9. Out-of-air procedures;
10. Dangerous marine life defensive techniques;
11. Exit procedures;
12. Emergency communication and protocols.

Practical training shall include a minimum of 4 bluewater dives under the supervision of the DSO or his/her designee.

1. The duration of each training dive should be a minimum of 20 minutes
2. The first dive should be in waters in which the bottom is within safe depths.

3. On at least one dive, the trainee should serve in the role of safety diver.

### **9.3 BLUEWATER DIVER AUTHORIZATION.**

1. Upon completion of the above training, the diver is authorized to dive during bluewater diving operations under the supervision of a qualified Lead Diver, under conditions and depths with which the diver is familiar.
2. Upon completion of 6 additional bluewater dives under the supervision of a qualified Lead Diver, the diver may be authorized to serve as Lead Diver for bluewater diving under conditions and depths with which the diver is familiar.
3. Bluewater diving authorization shall be recorded by the DSO in the diver's records, and communicated as part of any Letter of Reciprocity sent on the diver's behalf for diving operations that include Bluewater diving.

### **9.4 EQUIPMENT REQUIREMENTS**

In the absence of other mid-ocean features by which divers may orient and control their dive depth and maintain communication with each other and their support vessel, divers (except the safety diver) shall employ a down-line system with one counterweighted control line per diver in order to maintain diver contact and depth control.

1. The total weight in water of the down-line and tether array shall be no greater than that which a single diver can easily swim to the surface with his/her BCD deflated. A maximum weight of 10 lb. is suggested.
2. All diver tether attachments shall be made with connectors that can be quickly released by the diver while the line is under a tension at least equivalent to the weight of the entire array. Attachments shall be to either the diver's BCD, or to a separate harness, but not to the diver's weight belt.
3. The safety diver should be attached to the trapeze array by a short line with quick-disconnect features as above, enabling sufficient mobility to complete assigned responsibilities while ensuring contact with the array. This safety tether need not be counter-weighted.

### **9.5 OPERATIONAL REQUIREMENTS**

1. A safety diver shall be stationed at the trapeze attachment point. This diver's sole function is to monitor and control the dive team, solve entanglements, and monitor the diving environment for potential hazards. The safety diver shall be authorized to terminate diving operations for any or all members of the dive team.
2. A lookout/boat operator shall be stationed aboard any small craft from which bluewater diving is conducted as long as divers are in the water.

3. Live-boat procedures shall be developed as part of the dive plan to ensure that reliable tracking of the dive team by the support vessel is enabled and diver safety is ensured when entering or exiting the water from the boat. Especially, support vessel motors should be off or the propellers otherwise reliably disengaged during water entry and exit.

## **CHAPTER 10. NITROX FOR NON-STAGE DECOMPRESSION DIVING**

Oxygen-enriched air mixtures have become widely used for diving at intermediate depths (50-130 feet) to extend no-decompression bottom times, shorten required surface intervals, increase the physiologic safety with respect to decompression sickness, or shorten required staged decompression stops. The University sets forth the following guidelines for the use of such mixtures in non-staged decompression diving, and the guidelines in Chapter 12 for the use of such mixtures on dives requiring staged decompression.

### **10.1 PREREQUISITES**

Divers applying for authorization to use or be trained in the use of EAN mixtures for non-stage decompression diving shall hold a currently valid Diver-In-Training or Scientific Diver authorization (see Section 1.4.2 , Chapter 3 and Chapter 4). The applicant shall document completion of at least 12 logged open water SCUBA dives using compressed air.

### **10.2 TRAINING REQUIREMENTS**

Submission of documents and participation in aptitude examinations does not automatically result in authorization to use EAN under University auspices. The applicant must convince the DSO and DCB that he/she is sufficiently skilled and knowledgeable to be certified.

Authorization to use EAN may be denied to any applicant who does not demonstrate to the satisfaction of the DSO and/or DCB the appropriate judgment or proficiency to ensure the safety of the diver and dive buddy. Minimum certification and examinations required are as follows:

1. Documentation: Divers shall document training in the use of EAN for the conditions in which dive operations are to be conducted. Such documentation shall be to the satisfaction of the DSO and/or DCB. Training shall be conducted under agencies and by instructors approved by the DCB.
2. Theoretical Training. Theoretical training and proficiency shall include mastery of the following concepts, as indicated by a standardized University written examination:
  - a. Applied Gas Law Physics Physiological and Medical aspects of EAN;
  - b. CNS and Pulmonary Oxygen Toxicity;
  - c. Oxygen Dose/Time Limits;
  - d. Determination of Nitrogen status and no-stage decompression limits, using approved Nitrox tables;
  - e. Determination of Nitrogen status and no-stage decompression limits, using the Equivalent Air Depth calculations and standard air tables for any EAN mixture between 21 and 40%;

- f. Calculation of Optimal Mix and Maximum Oxygen Depth for EAN mixtures between 21 and 40%;
  - g. Causes, signs, symptoms, treatment and prevention of near drowning, arterial gas embolism, decompression and hyperbaric exposure-related illnesses, anoxia/hypoxia, and oxygen toxicity;
  - h. Emergency procedures including problem recognition, assessment, management, in-water emergency techniques, and evacuation procedures for the maladies listed above;
  - i. EAN production and analysis procedures;
  - j. University operational, logistical and emergency regulations for EAN use, dive team assignments, dive planning, and dive station components.
3. Practical Training. Divers shall demonstrate proficiency in the following, to the satisfaction of the DSO or his designee:
    - a. Breathing gas analysis;
    - b. Mixing procedures (if the diver is to be authorized to mix or blend gases to produce EAN);
    - c. Oxygen safety procedures;
    - d. Planning and execution of dives using EAN mixtures appropriate to the conditions in which diving operations are to be conducted;
  4. Water Training. A minimum of two open water EAN dives supervised by the DSO or his/her designee shall be required for authorization. Such dives will incorporate any specialized diving modes in which the diver expects to use EAN.
  5. Limits of Authorization. Authorization to use EAN is valid only within the depth range for which the diver is authorized.
  6. Waiver of Requirements. The DSO and/or DCB may grant a waiver to the above requirements of training and experience, if evidence of qualifying knowledge and experience for EAN diving can be demonstrated.
  7. Maintenance of EAN Authorization. To maintain EAN authorization, a UH Scientific Diver must:
    - a. Maintain current authorization as a Scientific Diver.
    - b. Log at least one dive every 6 months using EAN.
  5. Failure to meet the minimum activity criteria may be cause for loss or restriction of EAN authorization.
  8. Temporary EAN Authorization. With the exception of the medical examination requirements, other requirements for EAN authorization may be temporarily waived by the DSO if the diver seeking temporary authorization has demonstrated proficiency in EAN diving and can add measurably to a planned dive operation.
    - a. A statement of the temporary diver's qualifications and other supportive material (including medical approval) shall be submitted to the DSO as part of the Dive Plan Application.

- b. The diver will dive only under the supervision of a designated Lead Diver, authorized by the DSO;
- c. Temporary EAN authorization shall be restricted to the planned diving operations and shall comply with all other policies, regulations, and standards of this manual.

### **10.3 EQUIPMENT REQUIREMENTS**

All Equipment used in EAN diving shall comply with other applicable sections of this manual. Additional equipment requirements for EAN operations are as defined below.

1. For EAN mixtures containing less than 40% oxygen, normal SCUBA equipment may be used.
2. All diver worn and support equipment used or in contact with high pressure oxygen or oxygen mixtures greater than 40% oxygen by volume shall be prepared, maintained, and designated for oxygen service in compliance with ASTM Pamphlet G88-84, "Designing Systems for Oxygen Service". Oxygen cleaning of all involved equipment must take place when using high pressure oxygen concentrations greater than 40% by volume.
3. SCUBA cylinders for use with EAN shall be dedicated to that purpose. If the cylinders are to be used with gas mixtures greater than 40% oxygen or are to be filled by methods during which the valve assembly is exposed to oxygen concentrations greater than 40%, the cylinders shall be cleaned and maintained for oxygen service.
4. Any cylinders, regulators, compressors, or gas storage or handling equipment used during cylinder filling operations which may be exposed to mixtures containing greater than 40% oxygen shall be cleaned and maintained for oxygen service.
5. All EAN pressure cylinders (both SCUBA and storage) shall be color coded with a 4 inch green band around the cylinder and 1- inch yellow bands above and below the green band. The bands shall begin below the curvature of the cylinder and extend downward for a total of 6 inches.
6. An oxygen analyzer capable of determining the oxygen content in the diver's SCUBA cylinder prior to diving is required. The use of two analyzers is recommended for comparative and verification purposes.

### **10.4 OPERATIONAL REQUIREMENTS**

1. If EAN is to be used by any diver on a University dive, the diver must be authorized for EAN use appropriate with the parameters of the dive plan.
2. Oxygen partial pressures during dives shall not exceed 1.6 ATA for divers engaged in passive observation. For divers engaged in more strenuous activities, or diving in cold or arduous conditions, a more conservative oxygen partial pressure limits should be used.

3. Maximum oxygen time/dose allowances for single and daily oxygen exposures shall not exceed those defined by NOAA (Table 10.1).

**Table 10.1. NOAA Maximum Oxygen Time/Dose Limits.**

<u>PO2</u>	<u>Maximum Single Exposure Time</u>	<u>Maximum Daily Exposure Time</u>
0.6 ATA	720 min.	720 min.
0.7 ATA	570 min.	570 min.
0.8 ATA	450 min.	450 min.
0.9 ATA	360 min.	360 min.
1.0 ATA	300 min.	300 min.
1.1 ATA	240 min.	270 min.
1.2 ATA	210 min.	240 min.
1.3 ATA	180 min.	210 min.
1.4 ATA	150 min.	180 min.
1.5 ATA	120 min.	180 min.
1.6 ATA	45 min.	150 min.

6. Maximum Bottom Time shall be based on the depth of the dive and the EAN mixture being breathed. Bottom time for a single dive shall not exceed the NOAA maximum allowable “Single Exposure Limit” (Table [10.1](#)) for the maximum PO2 experienced on the dive.
7. The use of the NOAA Nitrox Decompression Tables and procedures when using NOAA Nitrox I or NOAA Nitrox II, as outlined in the NOAA Diving Manual, is acceptable as a minimal standard.
8. When utilizing the “Equivalent Air Depth” (EAD) method, dives shall be conducted using air decompression tables at least as conservative as the US Navy air tables.
9. A set of appropriate decompression tables must be available at the dive site.
10. During repetitive dives using EAN mixtures:
  - a. Repetitive dives shall be performed in compliance with procedures required by the specific tables used.
  - b. Residual Nitrogen Time shall be based on the equivalent air depth for the EAN mixture to be used on the repetitive dive, not on that of the previous dive.
  - c. Total exposure (bottom time) to a PO2 in a given 24 hour period shall not exceed the “Maximum Daily Exposure” (Table [10.1](#)).
11. EAN Mixtures between 21 and 40% oxygen yielding a maximum PO2 of no greater than 1.4 ATA at the maximum planned depth are approved for use by UH Scientific Divers authorized for EAN use.

12. If EAN is to be used during a UH project, the Lead Diver must be authorized in EAN use under conditions and applications similar to those expected during the project
13. Lead Diver responsibilities on a dive in which EAN is to be used shall include all those specified in Section 1.5.2, as well as the following:
  - d. Verification of EAN authorization of all divers using EAN on the dive;
  - e. Verification of EAN mixtures used and MOD and decompression calculations of project divers.
14. Each diver shall be ultimately responsible for confirming by direct analysis the oxygen content of his/her SCUBA cylinder, and acknowledge in writing the following dive profile information:
  - f. The target depth and appropriate EAN mixture to be used at that depth;
  - g. The maximum depth and bottom time allowed for the mixture contained in the SCUBA cylinder.
15. EAN breathing mixtures shall have a metered oxygen content of +/- 1.0% of the planned oxygen percentage. If a greater variance exists, the cylinder shall not be used for that dive or, at the Lead Diver's discretion, the dive depth may be modified to meet the limits and restrictions corresponding to the actual oxygen percentage.

## **CHAPTER 11. STAGED DECOMPRESSION DIVING**

Staged Decompression diving shall be defined as any diving during which the diver cannot perform a direct return to the surface without performing a required decompression stop to allow the release of inert gas from the diver's body.

The following procedures shall be observed when conducting dives requiring staged decompression stops or incurring a decompression ceiling.

### **11.1 TRAINING PREREQUISITES**

1. Scientific Diver qualification according to Chapter 4, with minimum depth authorization of 100 fsw
2. Minimum of 100 logged dives.
3. Demonstration of ability to safely plan and conduct dives deeper than 100 fsw.
4. Nitrox training/authorization according to Chapter 10 and Chapter 12 is recommended.

### **11.2 TRAINING REQUIREMENTS**

1. Divers shall document training in staged decompression diving appropriate for the conditions in which dive operations are to be conducted. Such documentation shall be to the satisfaction of the DSO and/or DCB. Training shall be conducted by agencies or instructors approved by the DSO and DCB.
2. Divers shall demonstrate to the satisfaction of the DSO or the DSO's designee proficiency in planning and executing staged decompression dives appropriate to the conditions in which diving operations are to be conducted.
3. Minimum training shall include the following.
  - a. A minimum of 6 hours of classroom training to ensure theoretical knowledge, to include: physics and physiology of decompression, decompression planning and procedures; gas management; equipment configurations; decompression methods, emergency procedures.
  - b. It is recommended that at least one training session be conducted in a pool of sheltered water setting, to cover equipment handling and familiarization, swimming and buoyancy control, gas consumption rate estimation, and emergency procedure practice.
  - c. At least 6 open-water training dives shall be conducted. The first two shall be in 60 - 100 fsw, simulating decompression. The following four dives shall be in 100-130 fsw depths, and may include progressively longer decompression schedules, as required for planned mission objectives. Dives shall emphasize safe decompression dive planning and execution, and the practice of emergency procedures.

- d. No training dives requiring decompression stops shall be conducted until the diver has demonstrated acceptable knowledge, skills, and attitude under simulated conditions.
  - e. The following are the minimum skills the diver must demonstrate proficiently during dives simulating and requiring decompression;
    - Buoyancy control
    - Proper ascent rate
    - Proper depth control
    - Equipment manipulation
    - Stage decompression bottle handling as pertinent to planned diving operations
    - Buddy skills
    - Gas Management
    - Time management
    - Task Loading
    - Emergency skills
  - f. Divers shall demonstrate to the satisfaction of the DSO or DSO's designee proficiency in planning and executing required decompression dives appropriate to the conditions in which diving operations are to be conducted.
  - g. Upon completion of training, the diver shall be authorized to conduct required decompression dives, pending DCB approval of project dive plan.
4. Initial depth authorization shall be 130 fsw. Progression to greater depths shall be by 4-dive increments at depth intervals as specified in Section 4.0, to a maximum depth of 190fsw. Authorization to depth levels beyond 190fsw shall require training and authorization for mixed gas diving (Chapter 13).

### **11.3 EQUIPMENT REQUIREMENTS**

- 1. Valve and regulator systems shall be configured in a redundant manner that allows continuous breathing gas delivery in the event of failure of any one component of the regulator/valve system.
- 2. One of the second stages on the primary gas supply shall be configured with a hose of adequate length to facilitate effective emergency gas sharing in the intended environment.
- 3. Cylinders with volume, configuration, and gas type(s) adequate and appropriate for planned diving operations.
- 4. Minimum dive equipment shall include;
  - a. Snorkel is optional at the DCB's discretion, as determined by the conditions and environment.

- b. Diver location devices adequate for the planned operations and environment.
- c. Compass.
- 5. Redundancy in the following components is desirable, or required at the discretion of the DSO or DCB.
  - a. Regulators on primary gas supply;
  - b. Decompression Schedules;
  - c. Dive Timing Devices;
  - d. Depth gauges;
  - e. Buoyancy Control Devices;
  - f. Cutting devices;
  - g. Lift bags and line reels;

#### **11.4 OPERATIONAL REQUIREMENTS**

1. Staged decompression authorization will be acknowledged on the UH Scientific Diver authorization document, and recording in the diver's file and database entry.
2. Approval of Dive Plan Applications to conduct staged decompression dives shall be on a case-by-case basis. Review by the DCB is required for each Dive Plan Application.
3. Staged decompression diving shall only be conducted in the presence of the DSO or the DSO's designee.
4. Diver's gas supplies shall be adequate to meet planned operational requirements and foreseeable emergency situations. Such information shall be provided as part of the Dive Plan Application.
5. At least one third of the gas supply shall be reserved for emergencies. Except in the event of an emergency, all divers shall surface with at least one-third of the gas supply remaining.
6. Decompression gas shall be available in 150% the amount estimated to be needed for a full ascent schedule as planned.
7. Breathing gases used while performing in-water decompression stops shall contain the same or greater oxygen content as that used during the dive.
8. Personnel requirements and duties shall be established for the following roles in the dive team:
  - a. Boat Captain
  - b. Diving Supervisor
  - c. Diver Tender (if needed)
  - d. Safety Diver(s)
  - e. Project Diver(s)

9. Diver/vessel contact and communications procedures shall be reviewed and approved by the DSO, and established and rehearsed to the satisfaction of the DSO or his/her designee.
10. When conducting staged decompression diving from an anchored vessel deeper than 130 feet, the dive team shall maintain contact with the vessel by one of the following means, to assist in diver location and rescue in the event of an emergency:
  - a. maintaining direct visual contact with the anchor;
  - b. following a predetermined, prominent underwater feature;
  - c. maintaining a continuous guideline between the vessel anchor and the divers;
  - d. Towing a surface marker buoy.
11. If breathing gas mixtures other than air are used for staged decompression, their use shall be in accordance with those regulations set forth in the appropriate sections of this manual ( Chapter 6).
12. Emergency procedures approved by the DCB for loss of gas supply, equipment malfunction, unexpected diving conditions, or dive team separation shall be developed. Emergency procedures shall be reviewed by the divers prior to each dive.

## **CHAPTER 12. HIGH OXYGEN CONCENTRATION NITROX FOR STAGE DECOMPRESSION**

### **12.1 TRAINING PREREQUISITES**

1. As prerequisites, candidates for training shall possess authorization or complete training in Scientific Diver (Chapter 4) and Nitrox (Chapter 10)
2. Divers shall be trained in staged decompression as outlined in Chapter 11, or shall complete such training as part of training listed below.

### **12.2 TRAINING REQUIREMENTS**

1. Divers shall document training in staged decompression diving using high oxygen concentration mixtures appropriate for the conditions in which dive operations are to be conducted. Such documentation shall be to the satisfaction of the DSO and/or DCB. Training shall be conducted by agencies or instructors approved by the DCB upon recommendation of the DSO.
2. Divers shall demonstrate proficiency in planning and executing staged decompression dives using high oxygen concentration mixtures appropriate to the conditions in which diving operations are to be conducted, to the satisfaction of the DSO or his designee.

### **12.3 EQUIPMENT REQUIREMENTS**

1. All equipment requirements for staged decompression diving shall be met, as outlined in Section 11.3.
2. All SCUBA cylinders, regulators, compressors, and gas handling and storage equipment coming in contact with oxygen concentrations greater than 40% shall be cleaned and maintained for oxygen service.

### **12.4 OPERATIONAL REQUIREMENTS**

1. All operational requirements for staged decompression diving shall be met, as outlined in Section 11.4.
2. Oxygen partial pressure in the breathing gas mixtures during staged decompression stops shall not exceed 1.6 ATA.
3. Periodic switches of breathing gas to a normoxic mixture may be made during decompression to appropriately manage risk for Acute (CNS) Oxygen Toxicity, according to schedules at least as conservative as those described by the US Navy and NOAA protocols. The NOAA Single Exposure and Daily Oxygen Dose limits (Table [10.1](#)) shall be observed.
4. An in-water safety diver shall monitor divers decompressing on high-oxygen concentration breathing gas mixtures.

## **CHAPTER 13. MIXED GAS DIVING**

Mixed gas diving is defined as dives done while breathing gas mixes containing proportions greater than 1% by volume of an inert gas other than nitrogen. The use of such mixed gas under University auspices shall be reviewed and approved by the DCB on a case-by-case basis, as the need warrants.

### **13.1 PREREQUISITES FOR TRAINING**

1. As prerequisites, candidates for training shall possess authorization or complete training in Scientific Diver (Chapter 4); Nitrox (Chapter 10); Staged Decompression (Chapter 11); High Oxygen Concentrations for Staged Decompression (Chapter 12).
2. Divers shall demonstrate to the DCB's satisfaction skills, knowledge, and attitude appropriate for training in the safe use of mixed gases.

### **13.2 TRAINING REQUIREMENTS**

A) Classroom training shall include:

1. Review of topics and issues previously outlined in nitrox and required decompression diving training as pertinent to the planned operations;
2. The use of helium or other inert gases, and the use of multiple decompression gases;
3. Equipment configurations;
4. Mixed gas decompression planning;
5. Gas management planning;
6. Thermal considerations;
7. Equivalent narcotic depth (END) determination;
8. Mission planning and logistics;
9. Emergency procedures;
10. Mixed gas production methods;
11. Methods of gas handling and cylinder filling;
12. Oxygen exposure management;
13. Gas analysis;
14. Mixed gas physics and physiology;

B) Practical Training shall include:

1. At least one confined or sheltered water session, in which divers demonstrate proficiency in required skills and techniques for proposed diving operations.
2. A minimum of 6 open water training dives.
3. At least one initial dive shall be in 130 feet or less to practice equipment handling and emergency procedures.

4. Subsequent dives will gradually increase in depth, with a majority of the training dives being conducted between 130 fsw and the planned operational depth.
5. The planned operational depth for initial training dives shall not exceed 200 fsw.

#### C) Depth of Authorization

1. Authorization to 200 fsw. Completion of the initial training outlined above shall qualify the diver to a depth of 200 fsw.
2. Authorization to 250 fsw. Diving operations beyond 200 feet requires an additional 4 training dives between 200 and 250 fsw.
3. Deeper authorizations. Authorizations to 300 and 350 fsw require an additional and progressive 4 training dives between 250 and 300fsw, and 300 fsw and 350 fsw, respectively.

### **13.3 EQUIPMENT AND GAS QUALITY REQUIREMENTS**

1. Specific equipment requirements for each project shall be developed and approved by the DCB, and met by divers, prior to engaging in mixed-gas diving. Equipment shall meet other pertinent requirements set forth elsewhere in this standard.
2. Open circuit mixed-gas equipment requirements shall comply with those specified for nitrox, staged decompression diving and use of high-oxygen percentage mixtures for decompression (Chapter 10, Chapter 11, Chapter 12)
3. The quality of inert gases used to produce breathing mixtures shall be of an acceptable grade for human consumption (Chapter 6).

### **13.4 OPERATIONAL REQUIREMENTS**

1. Approval of dive plan applications to conduct mixed gas dives shall be on a case-by-case basis.
2. All applicable operational requirements for nitrox and decompression diving shall be met.
3. The maximum pO<sub>2</sub> to be used for planning required decompression dives is 1.6. It is recommended that a pO<sub>2</sub> of less than 1.6 be used during bottom exposure.
4. Maximum planned Oxygen Toxicity Units (OTU) will be considered based on mission duration.
5. Divers decompressing on high-oxygen concentration mixtures shall closely monitor one another for signs of acute oxygen toxicity.
6. If a period of more than 6 months has elapsed since the last mixed gas dive, a series of progressive workup dives to return the diver(s) to proficiency status before the start of project diving operations are recommended.

## **CHAPTER 14. REBREATHERS**

### **14.1 GENERAL**

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 (Chapter 10, Chapter 11, Chapter 12, Chapter 13). The 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.

### **14.2 DEFINITIONS AND GENERAL INFORMATION**

1. 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 will 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.
  - a. 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.

- b. 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").
  - c. 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,.
2. 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/6m due to the risk of unsafe hyperoxic exposure.
  3. 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.
  4. 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/6m. CCR systems operate to maintain a constant oxygen partial pressure (PPO<sub>2</sub>) during the dive, regardless of depth.

### **14.3 MINIMUM PREREQUISITES, TRAINING, AND EXPERIENCE REQUIREMENTS**

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).

1. Prerequisites for Training. The following are prerequisites for entry into rebreather training:
  - a. Active-status Scientific Diver, with depth qualification (Chapter 4) sufficient for the type, make and model of rebreather, and planned application.
  - b. Completion of a minimum of 50 open-water dives on SCUBA;
  - c. 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;
  - d. 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.
2. Training. 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.
  - a. 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.
    - 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
    - Rebreather-specific information required for the safe and effective operation of the system to be used, including:

- System design and operation, including:
    - Counterlung(s);
    - CO2 scrubber;
    - CO2 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 procedures.
- b. Practical training with the particular model of rebreather to be used shall include:
- A minimum number of hours of underwater time, as indicated in Table [14.1](#).
  - The amount of required in-water time should increase proportionally to the complexity of the rebreather system used.
  - Training shall be in accordance with the manufacturer's recommendations.
- c. 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;
- d. 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.
- e. 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.
- The supervisor for these dives should be the DSO or his/her 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 Table [14.1](#) for number and cumulative water time for different rebreather types.
  - Maximum ratio of divers per designated dive supervisor is 4:1. The supervisor may dive as part of the planned operations.
3. Successful completion of the above shall qualify 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.

4. 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.
  - a. 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.
  - b. 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.
  - c. Training shall be in accordance with standards for staged-decompression (Chapter 11, Chapter 12) and mixed gas diving (Chapter 13), as applicable to rebreather systems, starting at the 130 fsw level.
5. 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 diver per month should be made to a depth near 130 fsw, practicing decompression protocols.
6. 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.

Table 14.1. Minimum Recommended Number of Dives and Cumulative Underwater Times for Various Rebreather Types (dive numbers, hours) for Entry-Level Authorization.

Type	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, 90-120min.	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 80-100 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 100-130 fsw range.

#### **14.4 EQUIPMENT REQUIREMENTS**

1. General Requirements of All Rebreathers.
  - a. Only those models of rebreathers specifically approved by DCB shall be used.
  - b. 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.
  - c. Unit performance specifications should be within acceptable levels as defined by standards of a recognized authority (CE, US Navy, Royal Navy, NOAA, etc...).
  - d. 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.
  - e. 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.

- f. A complete instruction manual is required, fully describing the operation of all rebreather components and subsystems as well as maintenance procedures.
  - g. A maintenance log is required. The unit maintenance shall be up-to-date based upon manufacturer's recommendations.
  - h. All rebreathers will be equipped with:
    - A surface/dive valve in the mouthpiece assembly, allowing sealing of the breathing loop from the external environment when not in use;
    - An automatic gas addition valve, so that manual volumetric compensation during descent is unnecessary.
    - Manual gas addition valves, so that manual volumetric compensation during descent and manual oxygen addition at all times during the dive are possible.
    - 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 (see Sec. 14.1.11)
2. Oxygen Rebreathers.
    - a. Oxygen rebreathers shall be equipped with manual and automatic gas addition valves.
  3. Semi-Closed Circuit Rebreathers.
    - a. 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.
  4. Closed Circuit Mixed-gas Rebreathers.
    - a. CCR shall incorporate a minimum of three independent oxygen sensors.
    - b. A minimum of two independent displays of oxygen sensor readings shall be available to the diver.
    - c. 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.
    - d. 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.
    - e. Redundancies in onboard electronics, power supplies, and life support systems are highly desirable.

## **14.5 OPERATIONAL REQUIREMENTS.**

General Requirements. All dives involving rebreathers must comply with applicable operational requirements for open-circuit SCUBA dives to equivalent

depths. In addition, rebreather divers must comply with the following minimum operational requirements:

1. No rebreather system should be used in situations beyond the manufacturer's stated design limits (dive depth, duration, water temperature, etc...).
2. Modifications to rebreather systems shall be in compliance with manufacturer's recommendations.
3. Rebreather maintenance is to be in compliance with manufacturer's recommendations including sanitizing, replacement of consumables (sensors, CO2 absorbent, gas, batteries, etc...) and periodic maintenance.
4. 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:
  - a. Information about the specific rebreather model to be used; including:
    - Make, model and type of rebreather system;
    - Type of CO2 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.
5. Buddy Qualifications.
  - a. 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.
  - b. 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 the open-circuit diver to return safely to the surface.
6. Oxygen Exposures
  - a. The planned oxygen partial pressure in the breathing gas shall not exceed 1.4 atmospheres at depths greater than 30 feet.
  - b. The planned oxygen partial pressure setpoint for CCR shall not exceed 1.4 atm. Setpoint at depth should be reduced to manage oxygen toxicity according to the NOAA Oxygen Exposure Limits (AAUS Manual Table citation Here...)
  - c. 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.
7. Decompression Management. The DCB shall review and approve the method of decompression management selected for a given diving application and project.

- a. 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:
  - Oxygen rebreathers: Not applicable.
  - SCR (presumed constant FO<sub>2</sub>):
  - 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<sub>2</sub>. 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<sub>2</sub> 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.
  - CCR (constant PPO<sub>2</sub>):
  - Integrated constant PPO<sub>2</sub> dive computer;
  - Non-integrated constant PPO<sub>2</sub> dive computer;
  - Constant PPO<sub>2</sub> dive tables;
  - Open-circuit (constant FO<sub>2</sub>) nitrox dive computer, set to the inspired FO<sub>2</sub> predicted using the PPO<sub>2</sub> setpoint at the maximum planned dive depth.
  - Equivalent air Depth (EAD) correction to standard open-circuit air dive tables, based on the inspired FO<sub>2</sub> predicted using the PPO<sub>2</sub> setpoint at the maximum planned dive depth.
  - Air dive computer, or air dive tables used above the maximum operating depth (MOD) of air for the PPO<sub>2</sub> setpoint selected.
8. Maintenance logs, CO<sub>2</sub> scrubber logs, battery logs, and pre-and post-dive checklists will be developed for the model of rebreather used, and will be used before and after every dive. The 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.
9. Pre-dive Checks shall include:
  - a. Gas supply cylinders full;
  - b. Composition of all supply and bail-out gases analyzed and documented;
  - c. Oxygen sensors calibrated;
  - d. Carbon dioxide canister properly packed;
  - e. Remaining duration of canister life verified;
  - f. Breathing loop assembled;
  - g. Positive and negative pressure leak checks;

- h. Automatic volume addition system working;
  - i. Automatic oxygen addition systems working;
  - j. 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);
  - k. Other procedures specific to the model of rebreather used;
  - l. Documentation of ALL components assembled;
  - m. Complete pre-dive system check performed;
  - n. Final operational verification immediately before to entering the water:
    - The 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;
10. 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.
11. 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:
- a. Open-circuit bailout cylinders or sets of cylinders, either carried or pre-positioned;
  - b. Redundant rebreather;
  - c. Pre-positioned life support equipment with topside support.
12. The carbon dioxide absorption canister shall be filled in accordance with the manufacturer's specifications.
13. The CO<sub>2</sub> absorbent material shall be used in accordance with the manufacturer's specifications for expected duration.
14. If the 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.
15. 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 the material until use.
16. Other consumables (e.g., batteries, oxygen sensors, etc.) shall be maintained, tested, and replaced in accordance with the manufacturer's specifications.

17. 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.

#### 18. Oxygen Rebreathers

- a. Oxygen rebreathers shall not be used at depths greater than 20 feet.
- b. The 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.
- c. The breathing loop shall be flushed with fresh oxygen prior to ascending to avoid hypoxia due to inert gas in the loop.

#### 19. Semi-Closed Circuit Rebreathers

- a. 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 atm, even at maximum exertion at the surface.
- b. 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>.
- c. The intermediate pressure of supply gas delivery in active-addition SCR shall be checked periodically, in compliance with manufacturer's recommendations.
- d. The maximum operating depth shall be based upon the FO<sub>2</sub> in the active supply cylinder.
- e. 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 30fsw, and at bottom depth on dives 30fsw and shallower.

#### 20. Closed-Circuit Rebreathers

- a. 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 atm but no greater than 1.4 atm.
- b. 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 atm.
- c. 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).

- d. The PPO2 set point shall not be lower than 0.4 atm or higher than 1.4 atm.

## **CHAPTER 15. SURFACE SUPPLIED DIVING—HOOKAH**

Surface-Supplied-Hookah diving systems are a form of light weight surface supplied air diving technology, usually involving a floating gas supply (low pressure compressor or compressed gas cylinder), elongated intermediate pressure hoses to the diver, and a SCUBA second stage held in the diver's mouth. This technology is usually applied in less than 30 feet, but can be extended to 60 feet. Advantages of hookah systems include less burden on the diver, increased gas supply, and a physical connection to the surface. Disadvantages include possible entanglement, risk of gas supply loss, and increased drag and hindrance from hoses in the water column.

### **15.1 PREREQUISITES**

1. Scientific Diver or DIT authorization is required.

### **15.2 TRAINING REQUIREMENTS**

1. A Scientific Diver experienced in hookah operations must serve as Lead Diver.
2. Divers must demonstrate the following skills and knowledge:
  - a. Explain hookah rig function, significant advantages and hazards of the hookah system, and contingency plans for air supply loss or entanglement;
  - b. Using proper care, perform set-up, pre- and post-dive procedures, storage, and record-keeping for the equipment;
  - c. Demonstrate ability to safely and efficiently operate the equipment with two divers (at least one checkout dive required);

### **15.3 EQUIPMENT REQUIREMENTS**

1. Only hookah units approved by the DSO shall be used under University jurisdiction.
2. Manufacturer's recommendations for maintenance and operation shall be followed.
3. Each diver will be equipped with a harness to which the hookah hose will be anchored. For open water diving, the anchor shall incorporate a mechanism that can be rapidly disconnected under load.
4. Compressor air intakes shall be located so as to avoid exhaust from compressor or boat engines.
5. Deeper than 30 feet, the diver shall be equipped with an alternate air source sufficient to return the diver to the surface in the event of an air supply failure, at a prudent ascent rate including any required decompression stops.

## **15.4 OPERATIONAL REQUIREMENTS**

1. Hookah divers shall follow buddy diving protocols.
2. An equipped safety diver capable of safely reaching the divers at the planned depth shall be on standby at the surface.
3. In water deeper than 30 feet or when a significant hazard of entanglement or current exists, each diver shall be hose-tended by a separate surface tender.
4. The dive team shall establish effective communication signals between hose tenders and divers.
5. Divers shall comply with all applicable sections of this manual regarding Scientific Diver training and authorization, equipment inspection and maintenance, air quality testing, record keeping, and operational control.
6. The hookah gas supply (based on fuel and compressor capacity or surface cylinder volume) shall be sufficient to support all divers attached for the duration of the planned dive, including decompression.
7. The compressor engine shall not be loaded with fuel until it has been shut off and cooled down for at least 15 minutes.
8. On dives below 30 feet, each diver shall be equipped with an independent diver-carried breathing gas supply, sufficient to return the diver to the surface in using safe ascent procedures, including any required decompression stops.

## **CHAPTER 16. SURFACE SUPPLIED DIVING—HELMET**

Surface-Supplied Helmet Diving refers to a life support gas delivery system involving helmets or band masks, underwater communications, tended heavy umbilicals supporting a variety of breathing gas blends, including air, delivered from shallow to great depths. Divers are seldom accompanied by an in-water buddy, and are often exposed to in-water decompression. This technology is often configured with exposure suits to protect against thermal stress and pollution.

Advantages of surface-supplied helmet diving include minimal contact with the underwater area, built-in surface communications, greater potential depth capability, and access to special gas mixtures. Disadvantages include increased complexity, weight and cost.

Surface-supplied helmet divers shall comply with all SCUBA diving procedures in this manual (except Section 0). This includes applicable regulations listed elsewhere in this chapter (Staged Decompression, EAN, Mixed Gas, etc.). Surface supplied diving shall not be conducted at depths greater than 190 feet.

### **16.1 PREREQUISITES**

1. Scientific Diver or DIT authorization is required (Chapter 3, Chapter 4).

### **16.2 TRAINING AND QUALIFICATION REQUIREMENTS**

1. Authorization as a UH Scientific Diver is required.
2. Divers shall satisfy the DCB that they possess the required training, skills, and knowledge to conduct surface-supplied operations. Divers shall meet training and experience requirements, as defined by the DCB on a case-by-case basis. Generally, this will include training and certification from a recognized training agency or school for surface-supplied diving operations.

### **16.3 EQUIPMENT REQUIREMENTS**

Specific equipment requirements shall be defined by the DCB on a case-by-case basis. Equipment maintenance, repair, and record keeping shall comply with requirements of Chapter 5 of this manual.

1. Divers shall be equipped with the following:
  - a. Strength Member;
  - b. Primary gas supply hose;
  - c. Pneumo line;
  - d. Voice communications;
  - e. Diver-carried independent reserve breathing gas supply.

2. Voice communications shall be maintained between the divers and the surface tenders. Line signals shall be established and rehearsed for the possibility of voice communication loss. Failure of voice communications shall in most cases terminate the dive.

#### **16.4 OPERATIONAL REQUIREMENTS**

1. While in the water, each diver shall be hose tended by a separate dive team member.
2. 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.
3. During operations when only one surface-supplied-helmet diver is in the water, there must be a fully equipped standby diver in attendance at the dive location.

## **CHAPTER 17. SATURATION DIVING**

Saturation divers shall comply with standards kept on file by the DSO. No saturation dive will be conducted until all members of the team have been trained in saturation diving by the DSO or by a program/facility approved by the DSO and evaluated by him/her for this type of diving. A special medical examination is required of all team members and must be conducted not more than two weeks prior to the diving.

## **CHAPTER 18. SHIPBOARD DIVING**

### **18.1 DEFINITION**

Shipboard diving operations are defined as any operations conducted from UH Research ships on which a licensed Master is in charge of vessel operations. Generally, this will pertain to the larger vessels operated by the University Marine Center, including the *R/V Kilo Moana*, *R/V Kaimikai O' Kanaloa*, and *R/V Klaus Wurteke*.

This includes operations:

1. In support of research operations;
2. In support of shipboard operations that may require shipboard or embarked divers, when commercial divers are not available, or
3. That provide diving support for emergency situations where divers are necessary to ensure the safety of the vessel, embarked personnel, or to avert major property or environmental damage.

### **18.2 AUTHORITY AND RESPONSIBILITY**

The main participants during shipboard diving operations are the Master of the Vessel, the Principal Investigator or Operations Director, and the Diving Supervisor.

1. The Master of the Vessel is responsible for the overall safety of the vessel and all personnel aboard. The Master can request diver assistance in a shipboard emergency.
2. The Principal Investigator or Operations Director may require diver assistance to support research dives.
3. The Diving Supervisor is responsible for the execution of any research diving operations or any shipboard support dives. The Diving Supervisor will determine if the divers are fit and possess adequate training and experience to respond to research or shipboard diving situations.

### **18.3 GENERAL POLICY**

Diving in response to shipboard emergencies or science support dives is voluntary. Any diver may refuse to dive at any time for any reason without concern of penalty.

Scheduled shipboard diving operations shall be outlined in an operations plan and submitted for review by the DSO and DCB.

Scheduled shipboard dives will be reviewed by all participants involved before the start of the cruise, in a meeting between the On-board Diving Supervisor, the Master, and the Chief Scientist, along with other identified key personnel involved in the diving operation.

On UNOLS vessels, these regulations shall complement and supplement the UNOLS diving regulations (Appendix 14).

**University of Hawaii Diving Safety Program**

**APPENDIX 1. APPLICATION FOR SCIENTIFIC DIVING AUTHORIZATION**

<http://www.hawaii.edu/ehso/diving/UHDiverApp.pdf>

**APPENDIX 2. INSTRUCTIONS AND FORMS FOR VISITING DIVERS**

<http://www.hawaii.edu/ehso/diving/Visit.htm>

**APPENDIX 3. DIVING MEDICAL EXAMINATION INSTRUCTIONS AND FORMS**

<http://www.hawaii.edu/ehso/diving/medicalexaminstructions.htm>

**APPENDIX 4. APPLICATION FOR SCIENTIFIC DIVING RESEARCH  
PROPOSAL APPROVAL**

<http://www.hawaii.edu/ehso/diving/grantapp.doc>

**APPENDIX 5. APPLICATION FOR APPROVAL OF STUDENT PROJECT,  
THESIS OR DISSERTATION RESEARCH**

<http://www.hawaii.edu/ehso/diving/thesisapp.doc>

**APPENDIX 6. APPLICATION FOR APPROVAL OF DIVE PLAN**

<http://www.hawaii.edu/ehso/diving/UHDivePlanAppR.pdf>

**APPENDIX 7. UNIVERSITY OF HAWAII PERSONAL DIVING LOG REPORTING  
FORMS**

<http://www.hawaii.edu/ehso/diving/UHDiveLog.pdf>

**APPENDIX 8. UNIVERSITY OF HAWAII PERSONAL DIVING LOG SHEET  
GUIDELINES AND DEFINITIONS**

<http://www.hawaii.edu/ehso/diving/uhlog-def.doc>

## **APPENDIX 9. UNIVERSITY OF HAWAII/AAUS RECIPROCITY LETTER OF REFERENCE TEMPLATE**

(Shown as a reference of required information only. To obtain a LOR, UH divers should submit to the DSO a LOR request form, available on the UHDSP web site.)

<http://www.hawaii.edu/ehso/diving/reciprocityletter.doc>

## **APPENDIX 10. AAUS ACCIDENT OR INCIDENT REPORTING FORM**

Accidents or Injuries may be reported by the DSO or DCB Chair to the following site on the Worldwide Web: <http://www.aaus.org/>

## **APPENDIX 11. UNIVERSITY OF HAWAI'I DIVING CONTROL BOARD**

### **Diving Safety Officer:**

David F. Pence, M.S.  
UH Diving Safety Program, EHSO  
2040 East West Road  
Honolulu, HI, 96822  
956-6420 work  
956-6952 fax  
[dpence@hawaii.edu](mailto:dpence@hawaii.edu)

### **Diving Medical Officer:**

Richard Smerz, M.D., Medical Director  
UH Hyperbaric Treatment Center  
Kuakini Hospital  
347 N. Kuakini St.  
Honolulu, HI 96817  
587-3425  
[rsmerz@htchawaii.c](mailto:rsmerz@htchawaii.c)

Norton T.M. Chan, Sr. Aquarist  
Waikiki Aquarium  
2777 Kalakaua Ave.  
Honolulu, HI 96818  
923-9741  
[nchan@hawaii.edu](mailto:nchan@hawaii.edu)

John Coney, Education Specialist  
Dept. of Marine Sciences, UH-Hilo  
200 W. Kawili St.  
Hilo, HI 96720  
933-3907  
[jconey@hawaii.edu](mailto:jconey@hawaii.edu)

Paul Jokiel, Ph.D.  
Hawaii Institute of Marine Biology  
UH-Manoa, MSB 213  
Honolulu, HI 96822  
236-7440  
[jokiel@hawaii.edu](mailto:jokiel@hawaii.edu)

Terry Kerby, Director Of Operations  
Hawaii Undersea Research Laboratory  
UH-Manoa, MSB 319  
Honolulu, HI 96822  
259-9991  
[tkerby@soest.hawaii.edu](mailto:tkerby@soest.hawaii.edu)

### **DCB Chair**

Timothy Tricas, Ph.D.  
Dept. of Zoology  
UH-Manoa, EDM 152  
Honolulu, HI 96822  
956-6148 or 236-7966  
[tricas@hawaii.edu](mailto:tricas@hawaii.edu)

### **Training Coordinator**

Kevin C. Flanagan  
UH Diving Safety Program, EHSO  
2040 East West Road  
Honolulu, HI, 96822  
956-6617  
[kflanaga@hawaii.edu](mailto:kflanaga@hawaii.edu)

Geno Pawlak, Ph.D.  
Ocean and Resource Engineering  
UH Manoa , HOL 404  
Honolulu, HI 96822  
956-8100  
[gpawlak@ore.hawaii.edu](mailto:gpawlak@ore.hawaii.edu)

Heather Spalding, M.S.  
Dept. of Botany  
UH-Manoa , St. John 612  
Honolulu, HI 96822  
[hspaldin@hawaii.edu](mailto:hspaldin@hawaii.edu)

Donna L. Brown, Coordinator  
Maui Community College,  
Marine Option Program  
310 Ka'ahumanua Ave.  
Kahului HI 96732  
[donnabro@hawaii.edu](mailto:donnabro@hawaii.edu)

Steve Coles, Ph. D.  
Bishop Museum,  
1525 Bernice St.  
Honolulu, HI 96817  
[scoles@bishopmuseum.org](mailto:scoles@bishopmuseum.org)

Roy Takekawa, Director (ex-officio)  
Environmental Health and Safety Office  
2040 East West Road  
Honolulu, HI 96822  
956-3200  
956-3205 fax  
[takekawa@hawaii.edu](mailto:takekawa@hawaii.edu)

## **APPENDIX 12. DIVING EMERGENCY MANAGEMENT PROCEDURES**

Introduction. A diving accident victim could be any person who has been breathing air underwater regardless of depth. It is essential that emergency procedures are pre-planned, and that medical treatment is initiated as soon as possible. It is the responsibility of the Lead Diver for each project or dive to establish effective diving emergency procedures for the local diving operations, including evacuation and medical treatment.

General Procedures. Depending on and according to the nature of the diving accident, stabilize the patient, administer 100% oxygen, contact the local Emergency Medical System (EMS) for transport to a medical facility, and contact the Diving Safety Officer, as appropriate. Explain the circumstances of the dive accident to evacuation teams, medics, and physicians. Do not assume that they understand why 100% oxygen may be required for the diving accident victim, or that recompression may be necessary.

1. Make appropriate contact with the victim, or rescue as required.
2. Establish (A)irway, (B)reathing, (C)irculation as required. Control severe bleeding and treat for Shock, as per First Aid guidelines.
3. Administer 100% oxygen, if appropriate (in cases of suspected Near Drowning, DCS, AGE, Cardiac Emergencies, or Breathing Emergencies).
4. Contact local Emergency Medical System (EMS) for transport to nearest medical treatment facility.
5. If possible, complete or assign additional personnel to complete the following actions:
  - a. Take notes of how the incident occurred, and all response measures taken, including a time table of actions;
  - b. Isolate the victim's equipment for inspection by the DSO and authorities;
  - c. Manage the accident scene for crowd control, Assign someone to keep bystanders from interfering;
  - d. Make statements regarding the incident only to University and EMS/Medical personnel. University representatives shall be responsible for providing information to the media.
6. Call the UH DSO for contact with diving physician and recompression chamber. If in Hawaii and the DSO cannot be reached, call the UH Hyperbaric Medical Center directly.
7. Notify the DSO, DCB Chair, or Director of the Environmental Health and Safety Office.
8. Complete and submit the AAUS Incident Reporting Form (Appendix 10) to the UH DSO.

## **Emergency Contact Information**

(unless specified, all area codes are 808)

### **UNIVERSITY CONTACTS**

#### **SYSTEM DIVING SAFETY OFFICER**

David Pence  
University of Hawaii-Manoa EHSO  
2040 East-West Road  
Honolulu, HI 96822  
956-6420 office  
956-6952 fax  
342-8871 cellular  
239-4418 home

#### **ENVIR. HEALTH AND SAFETY OFFICE**

Roy Takekawa, Director  
2040 East-West Road  
Honolulu, HI 96822  
956-3200 office  
956-8660 EHSO  
956-3205 fax  
846-2859 pager

#### **DIVING CONTROL BOARD CHAIR**

Dr. Timothy Tricas  
Department of Zoology  
University of Hawaii-Manoa  
Edmondson Hall  
Honolulu, HI 96720  
(808) 956-8657

#### **DIVING MEDICAL ADVISORY PANEL CHAIR**

Dr. Richard Smerz, Medical Director  
University of Hawaii Hyperbaric Treatment Center  
347 N. Kuakini St.  
Honolulu, HI 97817  
(808) 587-3425

#### **SYSTEM TRAINING COORDINATOR**

Kevin Flanagan  
University of Hawaii-Manoa EHSO  
2040 East-West Road  
Honolulu, HI 96822  
808-956-6617 (main number)

#### **SYSTEM STAFF**

Tina Tsubota, Administration and Records  
University of Hawaii-Manoa EHSO  
2040 East-West Road  
Honolulu, HI 96822  
808-956-9643 (main number)  
uhdsp@hawaii.edu (submit forms)

George (Keoki) Stender, Logistics Support Specialist  
University of Hawaii-Manoa EHSO  
2040 East-West Road  
Honolulu, HI 96822  
808-956-9643

#### **UNIT DIVING COORDINATORS**

Donna L. Brown  
Maui Community College  
Marine Option Program  
310 Ka'ahumanu Ave.  
Kahului, HI 96732  
984-3203 (office)

John P. Coney  
University of Hawaii at Hilo  
Marine Sciences Department  
200 W. Kawili St.  
Hilo, HI 96720  
933-3907 (office)

Terry Kerby  
Hawaii Undersea Research Laboratory  
University of Hawaii at Manoa  
Marine Sciences 303  
Honolulu, HI 96822  
259-9991

Derek Smith  
Hawaii Institute of Marine Biology  
P.O. Box 1620  
Kaneohe, HI 96744  
348-7342 (cell)

**SEARCH, RESCUE AND CASUALTY EVACUATION**

**EMT/AMBULANCE, ALL MAIN HAWAIIAN ISLANDS:**

**Call 911**

**U.S. COAST GUARD**

Search and Rescue Operations Center:  
Honolulu, HI

541-2500  
toll free cellular:\*8724 (\*USCG)

**Response Stations:**

Honolulu Harbor, Oahu  
Maalaea Harbor, Maui  
USCGC Point Evans, Nawiliwili Harbor, Kauai  
USCGC Kiska, Hilo Harbor, Big Island  
Air Evacuation Barber's Point NAS, Oahu

541-2454  
244-7235  
246-0390  
933-6944  
(through Ops Center)

**City and County of Honolulu**

Fire and Rescue  
Lifeguard Service

Call 911  
922-3888

**HOSPITAL EMERGENCY ROOMS**

**OAHU:**

Kuakini Hospital  
347 N. Kuakini St., Honolulu

547-9540

Castle Memorial Hospital  
640 Ulukahiki St., Kailua

263-5500

Kahuku Hospital, Kahuku

293-9221

Kapi'olani Medical Center  
1319 Punahou St., Honolulu

973-8511

Queens Hospital  
1301 Punchbowl St., Honolulu

538-9011

Straub Hospital  
888 S. King St., Honolulu

522-4000

Wahiawa General Hospital  
128 Lehua St., Wahiawa

621-8411

**MAUI:**

Maui Memorial Hospital  
221 Mahalani St., Kahului

242-2343

**LANAI:**

Lanai Community Hospital

565-6411

**MOLOKAI:**

Molokai General Hospital

553-5331

**BIG ISLAND (HAWAII):**

Hilo Medical Center  
1190 Waianuenue Ave., Hilo

969-4111

Kona Community Hospital\* 322-9311\*  
Kealahou (Captain Cook)

Kohala Hospital\* 889-6211\*  
Kapaau (Hawi)

North Hawai'i Community Hospital\* 885-4444\*  
67-1125 Mamalahoa Hwy, Kamuela

Honokaa Hospital, Honokaa 775-7211

\* at significant altitude

### **REGIONAL HYPERBARIC TREATMENT CENTERS**

#### **HAWAII:**

University of Hawaii Hyperbaric Treatment Center (808) 587-3425  
Kuakini Hospital  
347 N. Kuakini St.  
Honolulu, HI 96817  
(staffed 24 hours, M.D. on call)

#### **GUAM:**

Apra Harbor U.S. Naval Station (671) 339-7143  
Ship Repair Facility

### **MEDICAL ADVICE AND GUIDANCE**

Dr. Richard Smerz, M.D., University Diving Medical Advisory Panel Chair  
University Hyperbaric Medical Center  
(808) 587-3425 (staffed 24 hours)

Diver's Alert Network (DAN)  
Duke University Medical Center  
Durham, NC  
(919) 684-2948 (General information on diving medicine.)  
(919) 684-8111 (Emergencies only. Call COLLECT and state: ("I am reporting a diving accident"))

## **APPENDIX 13. PHYSICIANS WITH EXPERTISE IN DIVING AND HYPERBARIC MEDICINE**

### **OAHU:**

Dr. Richard Smerz  
Chair, UH Diving Medical Advisory Panel  
Medical Director, HI Hyperbaric Treatment Center  
Kuakini Hospital  
347 N. Kuakini St.  
Honolulu, HI 96817  
phone808-587-3425

Dr. Michael Kusaka  
Straub-Beretania Occupational Medical Clinic  
839 S. Beretania St.  
Honolulu, HI 96813  
phone808-522-4546

### **KAUAI:**

Dr. Paul Esaki  
Kapaa, Kauai  
Phone: 808-822-4333

### **MAUI:**

Dr. Norman Estin  
Dr. David Pearlman  
Doctors On Call  
200 Noheakai Dr., Suite 100  
Lahaina, HI 96761  
phone 808-667-7676  
fax808-667-7678  
**email:docmaui@maui.net**

## **APPENDIX 14. UNIVERSITY NATIONAL OCEANOGRAPHIC LABORATORY SYSTEM RESEARCH VESSEL OPERATING COMMITTEE SHIPBOARD DIVING REGULATIONS**

(Reprinted from the UNOLS Shipboard Safety Standards, RVOC Safety Training Manual)

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

#### **14.0 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.

#### **14.1 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.

#### **13.2 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.

#### **13.4 CRUISE PERSONNEL**

1. The Master has ultimate responsibility for the safety of all activities aboard including diving.
2. The Chief Scientist is responsible for the coordination and execution of the entire scientific mission.
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.

## **APPENDIX 15. AAUS 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. Divers shall periodically review proper ascent techniques to maintain proficiency.
5. Ascent rates shall not exceed 60 feet per minute.
6. A stop in the 10-30 feet zone for 3-5 minutes 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. BC's 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.