



UNIVERSITY OF CALIFORNIA, DAVIS
SCIENTIFIC DIVING PROGRAM

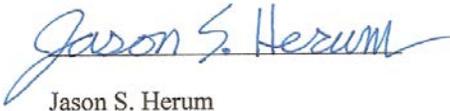
DIVING SAFETY MANUAL

REVISED – AUGUST 2017

FOREWORD

This DIVING SAFETY MANUAL is based upon the American Academy of Underwater Sciences (AAUS) Standards for Scientific Diving and Certification and Operation of Scientific Diving Programs, 2016 revision. This manual and the AAUS revision it is based on, represents the minimal safety standards for state-of-the-art scientific diving. As diving science progresses so shall this manual. It is the responsibility of every scientific diver that this manual always reflects state of the art, safe diving practices.

The Diving Control Board of the University of California, Davis, wishes to acknowledge the fine work of the AAUS, and in the spirit of the AAUS, has used the aforementioned document as a model for our manual. We have tried to retain the format of the AAUS manual (e.g., sections, numbering, etc.) while adding or changing that which we believe to be necessary to fit our local conditions.

A handwritten signature in blue ink that reads "Jason S. Herum". The signature is fluid and cursive, with a long horizontal stroke at the end.

Jason S. Herum

UC Davis Diving Safety Officer

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SECTION 1.00

GENERAL POLICY

1.10 THE SCIENTIFIC DIVING STANDARDS

1.11 Purpose

The purpose of these scientific diving standards is to ensure that all scientific diving under the auspices of the University of California, Davis is conducted in a manner that will maximize protection of scientific divers from accidental injury and/or illness, and to set forth standards for training and certification which will allow a working reciprocity between campuses, other institutions, and state and federal agencies engaged in research diving. Fulfillment of these purposes shall be consistent with the furtherance of research and safety.

The policies, procedures and standards set forth in this Diving Safety Manual are intended to govern the training and diving operations of all personnel participating in the Diving Program at UC Davis. It applies to all dives operating under University auspices, including visiting divers, volunteers, and campus officers responsible for the management and administration of the scientific diving program.

In 1982, OSHA exempted scientific diving from commercial diving regulations (20 CFR Part 1910, Subpart T) under certain conditions which are outlined below. The final guidelines for the exemption became effective in 1985 (Federal Register, Vol.50, No.6, p.1046). The American Academy of Underwater Sciences (AAUS) is recognized by OSHA as the organization that sets scientific diving standards in the US. UC Davis is an organizational member of the AAUS.

1.12 Scientific Diving Definition

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

1.13 Scientific Diving Exemption

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

1.13.1 The Diving Control Board consists of a majority of active scientific divers and has autonomous and absolute authority over the scientific diving program's operation.

1.13.2 The purpose of the project using scientific diving is the advancement of science, therefore, information and data resulting from the project are non-proprietary.

1.13.3 The tasks of a scientific diver are those of an observer and data gatherer. Construction and trouble-shooting tasks traditionally associated with commercial diving are not included within scientific diving.

1.13.4 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.

1.13.5 In addition, the scientific diving program shall contain at least the following elements:

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

1.14 Liability

In adopting the policies set forth in this manual, the University assumes no liability not otherwise imposed by law. Each diver is assumed under this policy to be voluntarily performing activities for which he/she assumes all risks, consequences, and potential liability.

1.15 Release and Waiver

All students and other personnel (other than University employees) diving under University auspices shall execute a release holding the Regents harmless from any claims which might arise.

1.16 Review of Standards

This document will be reviewed and revised by the UCD Diving Control Board annually. Any recommendations for modifications shall be submitted to the AAUS for consideration.

1.20 OPERATIONAL CONTROL

1.21 University Auspices

For the purposes of these standards the auspices of the University includes any scientific diving operation, or training for diving certificate, in which the University is connected because of ownership of any equipment, locations selected, or relationship with the individual(s) concerned.

This includes all cases involving the operations of employees of the University, or of employees or volunteers of auxiliary organizations, where such personnel are acting within the scope of their job duties. This also includes the operations of other persons who are engaged in scientific diving of the University or are diving as a member of an organization recognized by the University.

The regulations herein shall be observed at all locations where scientific diving is conducted.

1.22 The Diving Safety Manual

The purpose of this Diving Safety Manual is to set forth the basic underwater diving safety policy, organization, regulations and procedures for safety in diving operations conducted under University auspices.

1.23 The Diving Safety Officer

1.23.1 Qualifications

- a. Shall be appointed by the Vice Chancellor - Research, with the advice and counsel of the Diving Control Board.
- b. Shall be trained as a scientific diver.
- c. Shall be a full member as defined by the AAUS.
- d. Shall be an active scuba instructor from a nationally recognized training agency.

1.23.2 Duties and Responsibilities

- a. Shall be responsible, through the DCB and the Director of the Bodega Marine Laboratory, to the Vice Chancellor - Research or his/her designee, for the conduct of the scientific diving and diver training programs. The operational authority for this program, including the conduct of training and certification, approval of dive plans, maintenance of diving records, and ensuring compliance with this manual and all relevant regulations rests with the Diving Safety Officer.
- b. May permit portions of this program to be carried out by a qualified delegate, although the Diving Safety Officer may not delegate responsibility for the safe conduct of the local diving program.
- c. Shall be guided in the performance of the required duties by the advice of the DCB, but operational responsibility for the conduct of the local diving program will be retained by the Diving Safety Officer.
- d. Shall suspend diving operations which he/she considers to be unsafe or unwise.

1.24 The Diving Control Board

1.24.1 Mission

The mission of the UCD Diving Control Board is to ensure that University of California, Davis, sanctioned scuba or surface supplied diving is done as safely as possible. The Board will accomplish this mission by ensuring that all diving performed under the auspices of the University adheres to established training and safety standards for scientific diving. The Board will also promote the University's subtidal research programs.

1.24.2 Composition

The DCB shall consist of a majority of active scientific divers. Membership shall consist of three faculty, one staff, and one student representative. The Chair of the Board shall be a

faculty member, and will represent the Vice Chancellor-Research. Other members will be the Diving Safety Officer, a physician who is familiar with diving medicine (The Diving Medical Officer), a representative of the UCD instructional staff, the Senior Divers at the Tahoe Research Group and Bodega Marine Laboratory. A secretary may be chosen from the membership of the board according to DCB procedures.

1.24.3 Authority

The DCB shall have the autonomous authority over the UC Davis Diving Program

1.24.5 Responsibilities

The Diving Control Board shall:

- a. Act as the official representative of the University in matters concerning its diving program.
- b. Report to the Vice Chancellor-Research through the Director, Bodega Marine Laboratory. Copies of meetings, reports, plans, programs, etc., are to be submitted to the Director, Bodega Marine Laboratory and to the Vice Chancellor-Research. These records shall be maintained as stated in Section 1.40.1. The Diving Safety Officer shall be the custodian of records, including training records.
- c. Issue, reissue or revoke scientific diving certifications. When issuing certifications the Board will take into consideration the prospective diver's ocean, pool and classroom experience and demonstrated performance. Other diving experience and the medical and first aid training requirements also shall be considered. The Board may grant reciprocity certification upon application by candidates.
- d. Promulgate the UCD Diving Safety Manual. This shall be kept current and will be reviewed annually, and revised as needed.
- e. Establish and/or approve training programs through which applicants can satisfy the requirements of the Diving Safety Manual.
- f. Approve or revoke approval of and/or suspend diving programs/activities it considers unsafe or imprudent.
- g. Establish criteria for equipment selection and use and ensure that campus equipment is maintained in a safe and prudent manner.
- h. Recommend new equipment, training methods or diving techniques.
- i. Establish and/or approve facilities for the inspection and maintenance of diving equipment.
- j. Ensure that all UCD breathing gas compressors meet appropriate quality standards.

- k. Sit as a board of investigation to inquire into the nature and cause of diving accidents or violations of the University Diving Safety Manual and make appropriate recommendations based upon the findings of the inquiry.
- l. Make recommendations and provide advice to the Diving Safety Officer regarding the performance of his/her required duties. Operational conduct of the Diving Program will be the responsibility of the Diving Safety Officer.
- m. Act as a board of appeal to consider University diver/diving-related problems.
- n. Promote and support the University's subtidal research programs.
- o. Promote and support professional development of campus diving program staff.

1.25 Instructional Personnel

1.25.1 Qualifications

All personnel involved in diving instruction under the auspices of UC Davis shall be qualified for the type of instruction being given, and hold active leadership certification from a nationally recognized training agency.

1.25.2 Selection

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

1.26 Lead Diver

For each dive, one individual shall be designated as the Lead Diver. That person shall be at the dive location during the dive operation. The Lead Diver shall be responsible for:

- 1.26.1 Coordination. Diving shall be coordinated with other known activities in the vicinity which are likely to interfere with diving operations.
- 1.26.2 Ensuring that all team members possess current certification and are qualified for the type of diving operation.
- 1.26.3 Planning dives in accordance with section 2.21 and to include:
 - 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.

1.26.4 Ensuring safety and emergency equipment is in working order and at the dive site.

1.26.5 Briefing. The dive team members shall be briefed on:

- a. Dive objectives.
- b. Unusual hazards or environmental conditions likely to affect the safety of the diving operation.
- c. Modifications to diving or emergency procedures necessitated by the specific diving operation.

1.26.6 Suspending diving operations if in his/her opinion conditions are not safe.

1.26.7 Reporting to the DSO and DCB any physical problems or adverse physiological effects including signs or symptoms of pressure-related injuries.

1.26.8 Dive Planning. Planning of a diving operation shall include considerations of the safety and health aspects of the following:

1.27 Reciprocity and Visiting Scientific Diver

1.27.1 If UCD is engaged in diving activities with another AAUS organizational member, or UC campus, or engaged jointly in use of diving resources, one of the participating Diving Control Boards shall be designated to govern the joint diving project.

1.27.2 A scientific diver from one AAUS organizational member (such as UCD) shall apply for permission to dive under the auspices of another AAUS organizational member by submitting to the Diving Safety Officer of the host organization a document containing all the information described in Appendix 6 (letter of reciprocity), signed by the DSO or Chair of the home Diving Control Board.

1.27.3 A visiting scientific diver may be asked to demonstrate his/her knowledge and skills for the planned diving. An example of items to be demonstrated is presented in Appendix 6A (checkout dive).

1.27.4 If a visiting diver is denied permission to dive, the UCD DCB shall notify the visiting diver and his/her Diving Control Board with an explanation of all the reasons for the denial.

1.28 Waiver of Requirements

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

1.29 Consequence of Violation of Regulations by Scientific Divers

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

1.30 CONSEQUENCES OF VIOLATION OF REGULATIONS BY AAUS ORGANIZATIONAL MEMBERS

Failure to comply with the regulations as set forth in the AAUS' Standards for Scientific Diving Certification and Operation of Scientific Diving Programs, upon which this manual is based, may be cause for the revocation or restriction of UC Davis' Organizational Member recognition by the AAUS.

1.40 RECORD MAINTENANCE

The Diving Safety Officer or designee shall maintain permanent records for each individual scientific diver certified. The file shall include evidence of certification level, log sheets, results of current physical examination, waiver, reports of disciplinary actions by the UCD Diving Control Board, and other pertinent information deemed necessary.

1.40.1 Availability of Records:

- a. Medical records shall be available to the diver, or to the attending physician of a diver or former diver when released in writing by the diver.
- b. Records and documents required by this manual shall be retained by DSO for the following periods:
 - Physician's written reports of medical examinations for dive team members - five (5) years.
 - Diving Safety Manual - current revision only.
 - Dive logs - one (1) year, except five (5) years where there has been an incident of pressure-related injury.
 - Pressure-related injury assessment - five (5) years.
 - Equipment inspection and testing records - current entry or tag, or until equipment is withdrawn from service.

SECTION 2.00

DIVING REGULATIONS FOR SCUBA (OPEN CIRCUIT, COMPRESSED AIR)

2.10 INTRODUCTION

No person shall engage in scientific diving operations under the auspices of the UC Davis scientific diving program unless he/she holds a current certificate issued pursuant to the provisions of this manual.

Scientific diving shall not be conducted unless procedures have been established for basic life support, first aid treatment, and emergency evacuation of the diver(s) to a hyperbaric chamber or appropriate medical facility.

All diving that involves boat operations, requires the filing of a float plan with a responsible party in accordance with the UC Davis Boating Policy and Small Boat Manual. Divers are strongly recommended to file a float plan in all diving operations, whether boating is involved or not.

2.20 PRE-DIVE PROCEDURES

2.21 Dive Plans

Dives should be planned around the competency of the least experienced diver. Before conducting any diving operations under University auspices, the lead diver for a proposed operation must formulate a dive plan which should include the following and shall be presented to the Diving Control Board for approval:

- 2.21.1 Name of project.
- 2.21.2 Name of primary researcher.
- 2.21.3 Research project description and goals.
- 2.21.4 New or reauthorization of an ongoing project.
- 2.21.5 Location of research project.
- 2.21.6 Divers working on the project: (name, UCD certification #, date of last physical, CPR class, and first aid training.)
- 2.21.7 Dive plan expected: number of dives, maximum and average depths, number of dives per day, method (e.g., scuba, surface supplied, bluewater, rebreather, etc.).
- 2.21.8 Subtidal research methods to be used. Describe any special or unusual equipment and/or procedures.
- 2.21.9 Dates of beginning and end of diving operations.
- 2.21.10 Safety procedures to be followed during operations.
- 2.21.11 Emergency procedures, including name and number of nearest hyperbaric chamber facility, nearest hospital, EMS activation method, nearest emergency communications (telephone, marine radio) See Appendix 7.
- 2.21.12 Describe any potentially hazardous conditions (decompression diving, altitude, etc.).

2.21.13 Funding source(s).

2.21.14 Other universities, institutions, or groups involved with the project.

2.21.15 Additional information pertinent to the diving operations.

This information will be presented to the DCB with ample time for Board review and discussion before diving operations begin. The DCB has the authority to suspend diving for all programs that do not obtain approval for the dive plan. A Project Approval Request form is available from the DSO.

2.22 Pre-Dive Safety Checks

2.22.1 Diver's Responsibility:

- a. Each diver shall conduct a functional check of his/her diving equipment in the presence of the diving buddy or tender.
- 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.
- c. No dive team member shall be required to be exposed to hyperbaric conditions against his/her will, except when necessary to prevent or treat a pressure-related injury.
- e. No dive team member shall be permitted to dive for the duration of any known condition which is likely to adversely affect the safety and health of the diver or other dive team members.

2.22.2 Equipment Evaluations

- a. Each diver should perform a check of the submersible pressure gauge, timing device, depth gauge, and compass.
- b. Each diver shall have the capability of achieving and maintaining positive buoyancy.
- c. If gas other than air is used as the breathing media, appropriate diving tables shall be used, and the dive log filled out appropriately.
- d. Closed and semi-closed circuit scuba (rebreathers) shall meet the requirements as outlined in Section 12.00. Use of rebreathers for diving operations must have prior approval of the DCB.

2.22.3 Site Evaluation

The environmental conditions at the dive site will be evaluated by all dive team members.

2.30 DIVING PROCEDURES

2.31 Solo Diving Prohibition

All diving conducted under the auspices of UC Davis shall be planned and executed in such a manner as to ensure that every diver maintains constant, effective communication with at least one other comparably equipped 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, all divers shall surface and re-establish contact (except as specified in Section 11.60).

2.32 Refusal to Dive

2.32.1 The decision to dive is that of the diver. A diver may refuse to dive, without fear of penalty, whenever he/she feels it is unsafe for them to make the dive (see Section 2.22.1).

2.32.2 Safety - The ultimate responsibility for safety rests with the individual diver. It is the diver's responsibility and duty to refuse to dive if, in his/her judgment, conditions are unsafe or unfavorable, or if he/she would be violating the precepts of his/her training or the regulations in this guide.

2.33 Termination of the Dive

2.33.1 It is the responsibility of the diver to terminate the dive, without fear of penalty, whenever he/she feels it is unsafe to continue the dive, unless it compromises the safety of another diver already in the water (see Section 2.22.1).

2.33.2 The dive shall be terminated while there is still sufficient cylinder pressure to permit the diver to safely reach the surface, including decompression time, or to safely reach an additional breathing gas source at the decompression station and to obtain positive buoyancy.

2.34 Emergencies and Deviations from Regulations

2.34.1 No local or remote scientific diving shall be conducted unless procedures have been established for basic life support, first aid, and emergency evacuation of the divers to a hyperbaric chamber and other appropriate medical facility. All such emergency plans shall be approved by the Diving Safety Officer or Chair of the Diving Control Board.

The Diving Safety Officer will prepare, distribute, and update, as necessary, an emergency diver evacuation plan for local areas utilized by UCD scientific divers.

2.34.2 Any diver may deviate from the requirements of this manual to the extent necessary to prevent or minimize a situation which is likely to cause death, serious physical harm, or major environmental damage. A written report of such actions must be submitted to the Diving Control Board explaining the circumstances and justifications.

2.40 POST-DIVE PROCEDURES

2.41 Post-Dive Safety Checks

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

2.50 EMERGENCY PROCEDURES

Each supervisor for a dive project will develop emergency procedures which follow the current standards of care of the community and must include procedures for emergency care, recompression, and evacuation for each dive location (See Section 2.21 and Appendix 7).

2.60 FLYING AFTER DIVING OR ASCENDING TO ALTITUDE (OVER 1000 FEET)

Following a Single No-Decompression Dive: Divers should have a minimum preflight surface interval of 12 hours.

Following Multiple Dives per Day or Multiple Days of Diving: Divers should have a minimum preflight surface interval of 18 hours.

Following Dives Requiring Decompression Stops: Divers should have a minimum preflight surface interval of 24 hours.

Before ascending to Altitude above (1000 feet) by land transport: Divers should follow the guidelines of their dive computer or tables, if available. Divers whose tables or computer do not provide this information may refer to Table 4.3 "Required Surface Interval Before Ascent to Altitude After Diving" in the NOAA Diving Manual or other source.

2.70 RECORD KEEPING

2.71 Personal Dive Log

- 2.71.1 Each certified scientific diver shall log every dive made under the auspices of the University program, and is encouraged to log all other dives. Log sheets shall be submitted to the DSO to be placed in the diver's permanent file. The diving log shall be in the form specified.

Name:	As in Diving Program records.
Month/year:	In which the diving was performed.
Certification #:	UCD Scientific Diver identification #.
Date:	Date of the day of the dives.
Location:	Simple, accurate description of where diving occurred.
Purpose:	Enter one of the following: "Research" or "Training/Proficiency" or "Other"
Buddy:	Required (See Section 2.31).

Method:	“Scuba” if using open circuit scuba. Otherwise respond accordingly (e.g., bluewater, hookah, surface supplied, saturation, semi or fully closed rebreather).
DC Model:	The method of determining decompression requirements (e.g., tables or computer).
FO ₂ :	(Fraction of oxygen) Leave blank if breathing normal air, otherwise respond accordingly.
Depth:	Record actual maximum depth in feet of fresh or saltwater.
TBT:	Total Bottom Time. Measured from when the diver leaves the surface until he/she arrives at the precautionary (safety) or required decompression stop, or otherwise, back at the surface.
DC Stops:	Either precautionary (safety) or required stop(s) (See Appendix 10).
Comments:	Further description of dive (e.g., altitude, polar, night, etc.).
Incidents:	A detailed report of any near or actual incidents

2.71.2 Report all incidents, equipment failures, or potentially dangerous experiences to the UCD Diving Safety Officer.

2.71.3 If pressure-related injuries are suspected, or if symptoms are evident, the following additional information shall be recorded:

- a. Complete Incident/Accident Report Form (see Appendix 8).
- b. Description of symptoms, including time of onset.
- c. Description and results of treatment.

2.71.4 The DCB shall investigate and document any incident of pressure-related injury and prepare a report that will be forwarded to the AAUS.

2.72 Required Incident/Accident Reporting

All diving accidents requiring recompression, resulting in serious injury, requiring medical evaluation, hospitalization, or exhibiting symptoms consistent with decompression illness (DCI), pulmonary barotrauma, gas embolism (AGE), or near drowning shall be reported to the DSO in a timely manner. All such instances automatically constitute suspension of the diver’s scientific diver certification and require medical clearance by the Diving Medical Officer before resuming diving activities. In addition, UCD must meet the following reporting requirements:

2.72.1 The DSO and the Board shall record and report occupational injuries and illnesses in accordance with requirements of the appropriate Labor Code section.

2.72.2 If pressure-related injuries are suspected, or if symptoms are evident, the following additional information shall be recorded and retained by the DSO/DCB, with the record of the dive, for a period of five (5) years:

- a. Complete AAUS Accident or Incident Report Form (Apdx 8 or www.aaus.org).

- b. Written descriptive report to include:
- Name, address, phone numbers of the principal parties involved.
 - Summary of experience of divers involved.
 - Location, description of dive site and description of conditions that led up to the incident/accident.
 - Description of symptoms, including time of onset.
 - Description of results of treatment.
 - Disposition of case.
 - Recommendations to avoid repetition of incident.

2.72.3 The DCB shall investigate and document any occurrence of pressure-related injury and prepare a report for release. The report shall then be forwarded to the AAUS.

SECTION 3.00

DIVING EQUIPMENT

3.10 GENERAL POLICY

3.10.1 All equipment (whether University or privately owned) shall meet standards as determined by the DSO and the DCB. Equipment that is subject to extreme usage under adverse conditions should require more frequent testing and maintenance.

3.10.2 Divers shall submit proof of service for all privately owned equipment at least once every twelve (12) months.

3.20 EQUIPMENT

3.21 Regulators

3.21.1 Only those makes and models specifically approved by the Diving Safety Officer and the Diving Control Board shall be used

3.21.2 Scuba regulators shall be inspected and tested prior to first use and serviced every twelve (12) months thereafter.

3.21.3 Regulators will consist of a primary second stage and an alternate or redundant air source.

3.22 Breathing Masks and Helmets

Breathing masks and helmets shall have:

3.22.1 A non-return valve at the attachment point between helmet or mask hose, which shall close readily and positively.

3.22.2 An exhaust valve.

3.22.3 A minimum ventilation rate capable of maintaining the diver at the depth to which he/she is diving.

3.22.4 Voice communications to the surface.

3.22.5 Oral mask to prevent carbon dioxide buildup.

3.23 Scuba Cylinders

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

3.23.2 Scuba cylinders must be hydrostatically tested in accordance with Department of Transportation standards.

- 3.23.3 Scuba cylinders must have an internal inspection at intervals not to exceed twelve (12) months.
- 3.23.4 Scuba cylinder valves shall be functionally tested for proper operation at intervals not to exceed twelve (12) months and serviced as needed.
- 3.23.5 Scuba cylinders for use with nitrox shall be oxygen cleaned and have oxygen compatible valve components and lubrication. The cylinders shall be color coded per Section 7.52, be marked "Nitrox", "EANx" or "DNAx," and have a properly filled out contents tag. (Refer to Section 7.50)

3.24 Backpacks and Weight Systems

- 3.24.1 Backpacks with or without integrated flotation devices and weight systems shall have a quick release device designed to permit jettisoning with a single motion from either hand.
- 3.24.2 Backpacks and weight systems shall be regularly examined for function, signs of wear and unsafe condition by the person using them.

3.25 Gauges

Inaccurate gauges shall not be used. Gauges must be tested before first use and every twelve months thereafter. A record of inspections, tests, and repairs shall be maintained.

3.26 Flotation Devices

- 3.26.1 Each diver shall have the capability of achieving and maintaining positive buoyancy.
- 3.26.2 Personal flotation systems, buoyancy compensators, dry suits, or other variable volume buoyancy compensation devices shall be equipped with an exhaust valve. These devices shall be functionally inspected and tested at intervals not to exceed twelve (12) months.

3.27 Timing Devices, Depth and Pressure Gauges, and Compass

Both members of the diving pair must have an underwater time-keeping device, an approved depth indicator, a submersible tank pressure gauge, a compass, and a dive knife or other cutting device.

3.28 Determination of Decompression Status: Dive Tables, Dive Computers

- 3.28.1 A set of diving tables, approved by the DCB, must be available at the dive location.
- 3.28.2 Dive computers may be utilized in place of diving tables.
 - a. Although improvements in dive computer technology continue, not all computers are appropriate for all dive profiles. It is the responsibility of the individual diver to read the owners manual and follow its directions. If a computer is not fully functional (e.g., compute and display actual dive depth and time, no-stop decompression limits, as well as depth and time of required decompression stops corrected for altitude, if necessary) for the diving profile, then it may not be used to determine the diver's decompression obligation.

- b. For dives at an elevation greater than 300 meters only those computers that are fully functional at the dive site altitude are allowed.
- c. Any diver desiring to use dive computers must demonstrate understanding and proficiency in its use to the Diving Safety Officer, or his/her designee.
- d. After the diver has been approved for computer use by the Diving Safety Officer, he/she must agree to follow all policies and procedures as set forth items 3-13 of the AAUS Guidelines for use of Dive Computers.
(see Appendix 9)

3.30 AUXILIARY EQUIPMENT

3.31 Hand held underwater power tools.

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

3.40 SUPPORT EQUIPMENT

3.41 First Aid Supplies

A first aid kit and emergency oxygen shall be available at the dive location.

3.42 Diver's Flag

Diver's flags, either national (red with white diagonal) or alpha, shall be displayed prominently whenever diving is conducted under circumstances where boat traffic is probable, or whenever required by state or federal regulations.

3.43 Compressor Systems

The following will be considered in design and location of compressor systems.

- 3.43.1 Low pressure compressors used to supply air to the diver shall be equipped with a volume tank with a check valve on the inlet side, a pressure gauge, a relief valve, and a drain valve.
- 3.43.2 Compressed air systems over 500 psig shall have slow-opening shut-off valves.
- 3.43.3 All air compressor intakes shall be located away from areas containing exhaust or other contaminants.
- 3.43.4 Non oil-lubricated compressors are required for blending nitrox.
(Refer to Section 7.55)

3.44 Oxygen Systems

3.44.1 Equipment used with oxygen or mixtures containing over forty percent (40%) by volume oxygen shall be designed and maintained for oxygen service, except cylinders as described in Section 3.23.

3.44.2 Components (except umbilicals) exposed to oxygen or mixtures containing over forty percent (40%) by volume oxygen shall be cleaned of flammable materials before being placed into service.

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

3.50 EQUIPMENT MAINTENANCE

3.51 Record Keeping

For University owned equipment, and all regulator first, second and alternate air stages, each equipment modification, repair, test, calibration, or maintenance service shall be logged, including the date and nature of work performed, serial number of the item, and the name of the person performing the work for the following equipment: (Refer to Section 3.10.2)

3.51.1 Regulators.

3.51.2 Submersible pressure gauges.

3.51.3 Depth gauges.

3.51.4 Scuba cylinders.

3.51.5 Cylinder valves.

3.51.6 Buoyancy control devices, including inflator valves.

3.51.7 Diving helmets.

3.51.8 Submersible breathing masks.

3.51.9 Compressors.

3.51.10 Gas control panels.

3.51.11 Gas storage cylinders.

3.51.12 Gas filtration systems.

3.51.13 Analytical instruments.

3.51.14 Dry suits.

3.52 Compressor Operation and Air Test Records

3.52.1 Gas analyses and air tests shall be performed on each breathing gas compressor at regular intervals of no more than 100 hours of operation or six (6) months, whichever occurs first. The results of these tests shall be entered in a formal log, posted, and be maintained by the DSO.

3.52.2 A log shall be maintained showing operation, repair, overhaul, and filter maintenance for each compressor.

3.60 AIR QUALITY STANDARDS

Breathing air for scuba shall meet the following specifications as set forth by the Compressed Gas Association (CGA Pamphlet G-9.1) and referenced in OSHA 29 CFR 1910.134:

CGA Grade E

Breathing air for scuba shall meet the Compressed Gas Association Grade ‘E’ standards

3.60.1 Minimum oxygen.atmospheric

3.60.2 Oxygen content.....Special mixtures must be approved by the DSO.
(Refer to Section 7.20)

3.60.3 Maximum carbon monoxide.. <0.001% (10 ppm)

3.60.4 Maximum carbon dioxide..... <0.050 (500 ppm)

3.60.5 Total Hydrocarbons as Methane25 ppm/v

3.60.6 Dust and droplets of oil and water absent

3.60.7 Dewpoint -40

3.60.8 Odors and vapors absent

3.60.9 Air used for blending nitrox shall meet requirements of “oil-free” air.

SECTION 4.00 SCIENTIFIC DIVER TRAINING REQUIREMENTS

4.10 GENERAL POLICY

Set forth, below, are the training requirements for UCD Scientific Diver certification. No person shall engage in scientific diving activities under the auspices of UCD until the DSO, acting on behalf of the DCB, has issued a Scientific Diving Authorization and approved a submitted UCD Dive Plan.

Submission of documents and participation in aptitude examinations does not automatically result in certification. The applicant must convince the DSO that he/she is sufficiently skilled and proficient to be certified by the DCB. Any applicant who does not possess the necessary judgment, under diving conditions, for the safety of the diver and his/her partner, may be denied UCD Scientific Diver privileges.

4.20 PREREQUISITES

4.21 Eligibility

A. Only persons diving under UCD auspices are eligible for UCD Scientific Diver training and certification. Generally, these people will be affiliated with UCD however non-affiliated trainees may be admitted to the training program with the permission of the DCB.

B. The applicant for training and certification should be at least eighteen years of age, have at least entry level SCUBA training from an internationally recognized agency and at a minimum of 12 logged dives since the entry level training was completed.

4.22 Application

Application for certification should be submitted to the DSO on the UCSB Scientific Diver Application form available online: <https://webdiver.ehs.ucsb.edu/webdiverapplication/UCD>

4.30 Medical Examination

In accordance with American Academy of Underwater Sciences (AAUS) Guidelines and the Diving Safety Manual, each applicant for diver training shall submit a statement signed by a licensed physician to be medically qualified for diving before proceeding with the training as designated in Section 5 (see Section 6.00 and Appendices 1 through 4).

4.40 Swimming and Diving Evaluation

4.12.1 25 yard (23 meters) underwater swim, do not surface.

4.12.2 400 yard (366 meters) swim in less than 12 minutes.

4.12.3 Tread water for 10 minutes, or for 2 minutes without use of hands, ears and chin out of the water.

4.12.4 Demonstrate swimming with snorkel and fins with and without face mask

4.12.5 Surface dive without fins to a depth of 10 feet and recover a 10 lb weight.

4.12.6 Transport another person of equal size a distance of 25 yards (23 meters) in the water without the use of swim aids.

4.50 TRAINING

The diver must complete theoretical and practical training for a minimum cumulative time of 100 hours.

4.51 Theoretical Training

Required topics include, but are not limited to:

4.51.1. Physics and Physiology of diving.

4.51.2. Diving Emergency Care Training.

a. Cardiopulmonary Resuscitation (CPR).

b. Diving First Aid.

c. Recognition, prevention, and management of near drowning, DCS, AGE, CO₂ poisoning, squeezes, O₂ toxicity, nitrogen narcosis, exhaustion and panic, respiratory fatigue, motion sickness, hypothermia, hypoxia/anoxia, and diving hazards.

d. Emergency Oxygen Administration.

4.51.3. Dive Rescue.

4.51.4. Function, care, use, and maintenance of diving equipment.

4.51.5. High pressure cylinder and compressor safety.

4.51.6. Decompression theory, application, and planning.

4.51.7. Altitude and freshwater diving considerations.

4.51.8. Scientific dive planning.

4.51.9. UCD scientific diving regulations and history.

4.51.10. Oceanographic and environmental conditions.

4.51.11. Night and limited visibility diving.

4.51.12. Hazardous marine life.

4.51.13. Scientific methods and data gathering techniques as appropriate.

4.51.14. Diving from small boats and research vessels.

Suggested topics include specialized environments, conditions, gasses, techniques and equipment as described in Volume 2.

4.52 Confined Water Training

At the completion of training the trainee must satisfy the Diving Safety Officer or the instructor of his/her ability to perform the following:

4.52.1 ..Enter water with full equipment.

4.52.2 ..Clear face mask.

- 4.52.3..Demonstrate air sharing, including both buddy breathing and the use of alternate air source, as both donor and recipient, with and without a face mask.
- 4.52.4..Demonstrate ability to alternate between snorkel and scuba while kicking.
- 4.52.5..Demonstrate understanding and use of underwater signs and signals.
- 4.52.6..Demonstrate simulated in-water mouth-to-mouth resuscitation.
- 4.52.7..Rescue and transport, as a diver, a passive simulated victim of an accident.
- 4.52.8..Demonstrate ability to remove and replace equipment while submerged.
- 4.52.9. A simulated emergency swimming ascent.
- 4.52.10. Ability to achieve and maintain neutral buoyancy while submerged
- 4.52.11. Demonstrate watermanship ability which is acceptable to the instructor.

4.53 Open Water Evaluation

The trainee must satisfy an instructor, approved by the Diving Safety Officer, of his/her ability to perform at least the following in open water:

- 4.53.1. Surface dive to a depth of fifteen (15) feet in open water without scuba.
- 4.53.2. Demonstrate proficiency in air sharing, including both buddy breathing and the use of alternate air source, as both donor and receiver.
- 4.53.3. Enter and leave open water or surf, or leave and board a diving vessel, while wearing scuba gear.
- 4.53.4. Kick on the surface 400 yards (366 meters) while wearing scuba gear, but not breathing from the scuba unit.
- 4.53.5. Demonstrate judgment adequate for safe diving.
- 4.53.6. Demonstrate, where appropriate, the ability to maneuver efficiently in the environment, at and below the surface.
- 4.53.7. Complete a simulated emergency swimming ascent.
- 4.53.8. Demonstrate clearing of mask and regulator while submerged.
- 4.53.9. Demonstrate ability to achieve and maintain neutral buoyancy while submerged.
- 4.53.10. Demonstrate techniques of self-rescue and buddy rescue.
- 4.53.11. Navigate underwater.
- 4.53.12. Plan and execute a dive.
- 4.53.13. Successfully complete 12 open water scuba dives for a minimum total time of 6 hours. No more than three training dives, only two of which may be using scuba, shall be made in any one day.

4.54 Written Examination

Before completing training the trainee must pass a written examination that demonstrates knowledge of at least the following:

- 4.54.1. Function, care, use, and maintenance of diving equipment.
- 4.54.2. Physics and physiology of diving.
- 4.54.3. Diving regulations and precautions.
- 4.54.4. Near-shore currents and waves.
- 4.54.5. Dangerous marine animals.
- 4.54.6. Emergency procedures, including buoyant ascent and ascent by air sharing.
- 4.54.7. Currently accepted decompression procedures.
- 4.54.8. Demonstrate the proper use of dive tables.
- 4.54.9. Underwater communications.
- 4.54.10. Aspects of freshwater and altitude diving.
- 4.54.11. Hazards of breath-hold diving and ascents.
- 4.54.12. Planning and supervision of diving operations.
- 4.54.13. Diving hazards.
- 4.54.14. Cause, symptoms, treatment, and prevention of the following: near drowning, air embolism, carbon dioxide excess, squeezes, oxygen poisoning, nitrogen narcosis, exhaustion and panic, respiratory fatigue, motion sickness, decompression sickness, hypothermia, and hypoxia/anoxia.

4.55 Equipment Examination

- 4.55.1. The trainee will be subject to examination/review of:
 - A. Personal diving equipment
 - B. Task specific equipment

SECTION 5.00

SCIENTIFIC DIVER AUTHORIZATION

5.10 AUTHORIZATION TYPES

Only a person diving under UCD auspices is eligible for a scientific diver permit from the UC Davis Diving Control Board.

5.10.1 Diver-In-Training Permit

This permit signifies that a diver has completed and been certified as at least an entry level diver through an internationally recognized certifying agency or scientific diving program, and has the knowledge skills and experience necessary to continue training as a scientific diver under supervision, as approved by the DSO. This diver participates in a supervised training program and shall log twelve additional training dives with an approved certified buddy under normal working conditions. The diver shall have current two-person CPR, oxygen administration, and first aid training, obtain diver rescue techniques training, and have passed a diving specific physical within the previous twelve months. (See Section 4.0) This is a permit to dive, usable only while it is current and for the purpose intended.

5.10.2 Scientific Diver Permit

This is permit to dive, issued by the DSO upon recommendation of the DCB, usable only while it is current, and for the purpose intended.

5.10.3 Temporary Diver Permit

This authorization is issued only following a demonstration of the required proficiency in diving and if the person in question can contribute measurably to a planned dive. It is granted by the DSO and is valid only for a specified time. Temporary diver authorizations shall be restricted to the planned diving operation under UCD auspices and shall comply with all other policies, regulations, and standards of this manual, including medical requirements. This permit is not to be construed as a mechanism to circumvent existing standards set forth in this manual.

5.10.4 Scientific Diving Reciprocity Authorization

This authorization is issued by the DSO for a certified Scientific Diver from an organization that operates, at a minimum, under scientific diving regulations that meet or exceed AAUS scientific diving regulations. The visiting diver must, at a minimum, adhere to the UCD Manual for Diving Safety. Prior to arrival, a Scientific Diving Reciprocity form signed by the DSO or Chairman of the home organization's DCB must be submitted to the UCD's DSO for approval. The visiting diver may be asked to demonstrate their knowledge and skills for the planned dive.

5.20 DENIAL OF CERTIFICATION

Submission of documents and participation in aptitude examinations does not automatically result in certification. The applicant must convince the DSO and members of the DCB that they are sufficiently skilled and proficient to be certified. Any applicant who does not possess the necessary judgment for the safety of the diver and their partner, may be denied organizational member scientific diving privileges.

5.30 WAIVER OF REQUIREMENTS

The UCD DCB may grant a waiver for specific requirements of training, examinations, depth certification, and minimum activity to maintain certification.

5.40 DEPTH LEVELS

The UCD Scientific Diver certification will authorize the holder to dive to the depth indicated in his/her records. A diver certified under the auspices of UC Davis may exceed her/his depth certification only if accompanied by a diver certified to a greater depth. Under these circumstances the diver may exceed her/his depth limit by only one step.

5.41 DEPTH QUALIFICATION LEVELS

5.41.1 Certification to 30 Foot Depth

This is the initial certification, approved upon successful completion of training listed in Section 4.

5.42 Certification to 60 Foot Depth

A diver holding a 30 foot certificate may be certified to a depth of 60 feet after successfully completing, under supervision, 12 logged training dives to depths between 31 and 60 feet for a minimum total time of 4 hours.

5.43 Certification to 100 and 130 Foot Depth

A diver holding a 60 foot certification may be certified to depths of 100 and 130 feet, respectively, by logging a minimum of 4 dives near the maximum planned depth. The diver shall also demonstrate proficiency in the use of the appropriate Dive Tables.

5.44 Certification to Depths Over 130 Feet

A diver may be certified to depths of 150 and 190 feet, respectively, provided there is a scientific need, by logging 4 dives within each depth certification range. The diver must also demonstrate knowledge of the special problems of deep diving, and of special safety requirements.

5.45 Diving on air is not permitted beyond a depth of 190 feet.

5.50 MAINTAINING AUTHORIZATION

5.51 Minimum Activity to Maintain Scientific Diver Authorization

During any twelve month period each scientific diver must log a minimum of twelve dives. At least one dive must be logged near the maximum of the diver's depth level during each six month period. Divers qualified to 150 feet or deeper may satisfy these requirements with dives to 130 feet or deeper. Failure to meet these requirements may be cause for revocation or restriction of authorization.

5.52 Requalification of Depth Level

Once the initial requirements of Section 5.40 are met, divers whose depth qualification has lapsed due to lack of activity may be requalified by procedures to be adopted by the DCB.

5.53 Medical Examination

All scientific divers shall pass an initial medical examination, and thereafter be examined at five year intervals until age 40. After 40, medical examinations will be given every three years until age 60, then every two years. After each major illness or injury, a scientific diver shall submit to medical interview and/or examination before resuming diving activities. See Section 6.00 for examination criteria.

5.54 Emergency Care Training

Each diver shall maintain current status in first aid, 2-person CPR and oxygen administration training. Those volunteering with the scuba training classes shall also be current in first aid for scuba diver training and hold diver rescue certification from a nationally recognized training agency.

5.55 Equipment Service

Divers shall submit proof of regulator service to the DSO annually.

5.60 REVOCATION OF AUTHORIZATION

A diving permit may be revoked or restricted for cause by the DSO or the DCB. Violations of regulations set forth in this manual, or other governmental subdivisions not in conflict with this manual, may be considered cause. The DSO shall inform the diver in writing of the reason(s) for revocation. The diver will be given the opportunity to present his/her case in writing for reconsideration and/or requalification. All such written statements and requests, as identified in this section, are formal documents which will become part of the diver's file.

5.70 REAUTHORIZATION

If a diver's permit expires or is revoked, he/she may be requalified after complying with such conditions as the DSO or the DCB may impose. The diver shall be given an opportunity to present his/her case to the DCB before conditions for requalification are stipulated.

SECTION 6.00

MEDICAL STANDARDS

6.10 MEDICAL REQUIREMENTS OF DIVE TEAM

6.11 General

6.11.1 The DCB shall determine that dive team members who are exposed to hyperbaric conditions have passed a current diving physical examination and have been declared by the examining physician to be fit to engage in diving activities as may be limited or restricted in the medical evaluation report.

6.11.2 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. All medical evaluations are subject to review by the Diving Medical Officer who may require additional examinations/tests to determine the medical suitability for scientific diving.

6.11.3 The diver shall be free of any chronic disabling disease and be free of any conditions contained in the list of conditions for which restrictions from diving are generally recommended. (See Section 6.15)

6.12 Frequency of Medical Evaluations

Medical evaluation shall be completed:

6.12.1 Before a diver may begin diving, unless an equivalent initial medical evaluation has been given within the preceding 5 years (3 years if over the age of 40), the member organization has obtained the results of that examination, and those results have been reviewed and found satisfactory by the member organization.

6.12.2 Thereafter, at five year intervals up to age 40, every three years after the age of 40, and every two years after the age of 60

6.12.3 Clearance to return to diving must be obtained from a physician following any major injury or illness, or any condition requiring hospital care. If the injury or illness is pressure related, then the clearance to return to diving must come from a physician trained in diving medicine.

6.13 Information Provided Examining Physician

The DSO shall provide a copy of the medical evaluation requirements of this standard to the examining physician. (Appendices 1, 2, and 3).

6.14 Content of Medical Evaluations

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

6.14.1 Applicant agreement for release of medical information to the Diving Safety Officer and the DCB (See Appendix 2).

6.14.2 Medical history (See Appendix 3)

6.14.3 Diving physical examination (Section 6.15 and Appendix 2).

6.15 Conditions which may disqualify candidates from diving. (Adapted from Bove, 1998)
(See Appendix 1).

- 6.15.1 Abnormalities of the tympanic membrane, such as perforation, presence of a monomeric membrane, or inability to autoinflate the middle ears.
- 6.15.2 Vertigo including Meniere's Disease.
- 6.15.3 Stapedectomy or middle ear reconstructive surgery.
- 6.15.4 Recent ocular surgery.
- 6.15.5 Psychiatric disorders including claustrophobia, suicidal ideation, psychosis, anxiety states, untreated depression.
- 6.15.6 Substance abuse, including alcohol.
- 6.15.7 Episodic loss of consciousness.
- 6.15.8 History of seizure.
- 6.15.9 History of stroke or a fixed neurological deficit.
- 6.15.10 Recurring neurologic disorders, including transient ischemic attacks.
- 6.15.11 History of intracranial aneurysm, other vascular malformation or intracranial hemorrhage.
- 6.15.12 History of neurological decompression illness with residual deficit.
- 6.15.13 Head injury with sequelae.
- 6.15.14 Hematologic disorders including coagulopathies.
- 6.15.15 Evidence of coronary artery disease or high risk for coronary artery disease.
- 6.15.16 Atrial septal defects.
- 6.15.17 Significant valvular heart disease - isolated mitral valve prolapse is not disqualifying.
- 6.15.18 Significant cardiac rhythm or conduction abnormalities.
- 6.15.19 Implanted cardiac pacemakers and cardiac defibrillators (ICD).
- 6.15.20 Inadequate exercise tolerance.
- 6.15.21 Severe hypertension.
- 6.15.22 History of spontaneous or traumatic pneumothorax.
- 6.15.23 Asthma.
- 6.15.24 Chronic pulmonary disease, including radiographic evidence of pulmonary blebs, bullae or cysts.
- 6.15.25 Diabetes mellitus.
- 6.15.26 Pregnancy.

6.16 Laboratory Requirements for Diving Medical Evaluation and Intervals.

- 6.16.1 Initial examination under age 40:
 - a. Medical History
 - b. Complete Physical Exam, emphasis on neurological and otological components
 - c. Urinalysis
 - d. Any further tests deemed necessary by the physician.
- 6.16.2 Periodic re-examination under age 40 (every 5 years)
 - a. Medical History
 - b. Complete Physical Exam, emphasis on neurological and otological components
 - c. Urinalysis
 - d. Any further tests deemed necessary by the physician

- 6.16.3 Initial exam over age 40:
- a. Medical History
 - b. Complete Physical Exam, emphasis on neurological and otological components
 - c. Detailed assessment of coronary artery disease risk factors using Multiple-Risk-Factor Assessment^{1,2} (age, family history, lipid profile, blood pressure, diabetic screening, smoking history). Further cardiac screening may be indicated based on risk factor assessment.
 - d. Resting EKG
 - e. Chest X-ray
 - f. Urinalysis
 - g. Any further tests deemed necessary by the physician
- 6.16.4 Periodic re-examination over age 40 (every 3 years); over age 60 (every two years):
- a. Medical History
 - b. Complete Physical Exam, emphasis on neurological and otological components
 - c. Detailed assessment of coronary artery disease risk factors using Multiple-Risk-Factor Assessment¹ (age, family history, lipid profile, blood pressure, diabetic screening, smoking history). Further cardiac screening may be indicated based on risk factor assessment.
 - d. Resting EKG
 - e. Urinalysis
 - f. Any further tests deemed necessary by the physician

6.17 Physician's Written Report.

- 6.17.1 After any medical examination relating to the individual's fitness to dive, the organizational member shall obtain 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. This will be reviewed by the DCB.
- 6.17.2 The DCB make a copy of the physician's written report available to the individual.

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

² Bove, A.A. 2011. The cardiovascular system and diving risk. *Undersea and Hyperbaric Medicine* 38(4): 261-269.

Volume 2

Sections 7.00 through 11.00 Required Only When Conducting Described Diving Activities

Certain types of diving, some of which are listed below, require specialized equipment or procedures that require training beyond Scientific Diver. Those needing to use methods listed in these sections shall request, and must have, authorization from the Diving Control Board prior to commencing diving activities. (See Section 2.21)

SECTION 7.00

NITROX GUIDELINES

These guidelines are supplemental to those specified in Sections 1 through 11 of this Diving Safety Manual. All procedures and requirements in those sections of this manual are in effect unless specifically modified or exempted.

7.10 PREREQUISITES

7.11 Eligibility

Only a certified scientific diver, or diver-in-training under the auspices of UC Davis is authorized to engage in nitrox (EANx, or DNAX) dive training and/or operations.

7.12 Application

Application for nitrox use shall be made in writing to the Diving Safety Officer.

7.20 REQUIREMENTS FOR AUTHORIZATION TO USE NITROX.

Submission of documents does not automatically result in nitrox use authorization. The candidate must convince the DSO and members of the DCB that he/she is sufficiently skilled and proficient to be certified. The skills will be acknowledged by the signature of the DSO on the certification form. After completion of nitrox user training and evaluation, diving certification may be denied to any applicant who does not demonstrate, to the satisfaction of the DSO and DCB, the appropriate judgment and/or proficiency to ensure the safety of the diver and dive partner. Minimum certification documentation and examination required are listed in Sections 7.21 and 7.22.

7.20.1 Documentation

The applicant will provide to the DSO, for review by the DCB:

- a. A completed application form.
- b. Proof of UC Davis scientific diver, or diver-in-training status, including current physical exam and emergency care training.
- c. Proof of twelve (12) or more open water scuba dives.
- d. Proof of successful completion of an Nitrox User course, both classroom and open-water sections. (see Section 7.3)

7.20.2 Waiver of Requirements

The DSO and the DCB may grant a waiver for specific requirements of, and experience and training for, applicant certification if evidence of qualifying knowledge and experience for nitrox diving can be demonstrated.

7.21 Examinations

Each prospective nitrox diver shall demonstrate additional theoretical and practical proficiency beyond scientific diver air certification level in examinations covering:

- 7.21.1 Review of information presented in the classroom session(s) (e.g., gas theory, oxygen toxicity, EAD concept, maximum operating depth, gas laws, etc.).
- 7.22.2 Practical examinations covering the information presented in the practical training session(s). (e.g., gas analysis, cylinder and contents tag marking, dive planning, etc.)
- 7.22.3 Two (2) open water checkout dives with the DSO or his/her designee to demonstrate the application of theoretical and practical skills.

7.23 Minimum Activity to Maintain Certification

In addition to standards set forth in section 5.51 at least one nitrox dive must be logged every six months. Failure to meet these criteria may be cause for revocation or restriction of UC Davis nitrox use authorization. (See Section 5.60)

7.30 NITROX TRAINING GUIDELINES

The diver must complete additional theoretical and practical training beyond the Scientific Diver in Training air level, to the satisfaction of the DSO and DCB. (see Section 7.20)

Nitrox training should be in addition to Diver in Training authorization (Section 4.0). It may be included in the Scientific Diver curriculum. (Section 5.32)

7.31 Classroom Instruction

Topics should include, but are not limited to: Review of previous training, physical gas laws pertaining to nitrox, partial pressure calculations and limits, equivalent air depth concept and calculations, oxygen physiology and toxicity, calculation of oxygen exposure and maximum safe operating depth, determination of decompression schedules (both by equivalent air depth and using nitrox dive tables), dive planning and emergency procedures, mixing methods, gas analysis, personnel requirements, equipment marking and maintenance requirements, dive station requirements.

7.32 Practical Training

The practical training will consist of a review of skills listed in Section 4 with additional training as follows:

- 7.32.1 Oxygen analysis of nitrox mixtures
- 7.32.2 Determination of MOD, oxygen partial pressure, and oxygen toxicity time limits for various nitrox mixtures at various depths
- 7.32.3 Determination of nitrogen-based dive limits status by EAD and nitrox dive tables. Nitrox dive computer use may be included.

7.33 Written Examination

Before authorization, the diver shall pass a written examination based on classroom and practical training. The exam shall include at the minimum:

- 7.33.1 Function, care, use and maintenance of nitrox equipment

7.33.2 Physical and physiological considerations of nitrox diving

7.33.3 Diving regulations and procedures as related to nitrox use

7.33.4 Given the proper information, calculation of:

- a. Equivalent air depth (EAD) for a given FO_2 and depth
- b. PO_2 exposure and time limit for any given FO_2 and depth
- c. Optimal nitrox mixture for a given PO_2 exposure limit and depth
- d. Maximum Operating Depth (MOD) for any mix and PO_2 limit

7.33.5 Decompression table and dive computer selection and use.

7.33.6 Oxygen analysis

7.33.7 Nitrox guidelines (Section 7.40), dive planning, equipment marking

7.34 Openwater Dives

A minimum of two supervised openwater dives using nitrox is required for authorization. If the MOD for the mix being used can be exceeded at the training location, direct, in-water supervision is required.

7.40 SCIENTIFIC NITROX DIVING REGULATIONS

7.41 Dive Personnel Requirements

7.41.1 Diver in Training – A diver in training who has completed the requirements of Section 4.0 may be authorized to by the DSO to use nitrox under the direct supervision of a nitrox qualified Scientific Diver. Dive depth limits are restricted to 3 atmospheres absolute.

7.41.2 Scientific Diver – A scientific diver who has completed nitrox training and is current with requirements of Section 5.0 may be authorized by the DSO to use nitrox. Depth authorization would be the same as those specified in the diver's authorization, as described in Section 5.40, or the MOD of the mix used, whichever is shallower.

7.41.3 Lead Diver – On any dive where nitrox is being used by any team member, the Lead Diver should be authorized to use nitrox. Lead Diver authorization for nitrox dives by the DSO and DCB should occur as part of the dive plan approval process.

- a. As part of the dive planning process, verify that all divers using nitrox on a dive are properly qualified and authorized.
- b. As part of the pre-dive procedures, confirm with each diver the nitrox mixture being used, its MOD and time limits, according to the shortest time limit or shallowest depth limit among the team members.
- c. The Lead Diver should also reduce the maximum allowable PO_2 exposure limit for the dive team if on-site conditions so indicate (Section 7.42.1.b)

7.42 Dive Parameters

7.42.1 Oxygen Exposure Limits

- a. If using the equivalent air depth (EAD) method, the maximum depth of a dive shall be based on the partial pressure of the oxygen for the specific breathing mixture to be used. The oxygen partial pressure experienced at depth shall not exceed 1.45 ATA.
- b. An exception to 7.42.1.a is that for precautionary or required decompression stops the partial pressure of oxygen shall not exceed 1.6 ATA. These mixes must be either diver carried in a separate, independent scuba system (pony bottle), or if surface supplied, come from a separate source cylinder.
- c. The maximum allowable exposure limits should be reduced in cases where cold or strenuous dive conditions or extended exposures are expected. The DCB should consider this in review of any dive plan application. The Lead Diver should also review on-site conditions and reduce the allowable PO₂ exposure if conditions indicate.

7.42.2 Bottom Time Limitations

- a. Maximum bottom time shall be based on the depth of the dive and the nitrox breathing mixture being used.
- b. Bottom time of a single dive shall not exceed the NOAA maximum allowable "Single Exposure Limit" for a given partial pressure of oxygen, as listed in Section 7.43.3.

7.42.3 Decompression Tables and Gases

- a. A set of appropriate decompression tables must be available at the dive site.
- b. When using the EAD method, dives shall be conducted using decompression tables that are equal to, or more conservative than the current US Navy tables. An air-based dive computer may also be used.
- c. If nitrox is used to increase the safety margin of air-based tables or dive computer, the MOD and oxygen exposure limits for the mix being used shall not be exceeded.
- d. Breathing gases used during either precautionary or required decompression stops, as a transit mix, or for bail out purposes, shall contain the same or greater oxygen content as that used during the dive, within the confines of depth limitations of Section 7.31 and the oxygen partial pressure limits set forth in Section 7.32.
- e. It is the responsibility of each individual diver to determine their own decompression obligation, EAD, Maximum Operating Depth (MOD) and CNS dose for the oxygen content of the cylinder(s) they use.

7.42.4 Nitrox Dive Computers

- a. Dive computers may be used to compute decompression status during nitrox dives. Manufacturers' guidelines and instructions shall be followed.
- b. Use of all computers shall comply with dive computer guidelines included in Appendix 9.

- c. Computer users must demonstrate a clear understanding of the display, operations, and manipulation of the unit being used for nitrox diving prior to using the computer, to the satisfaction of the DSO or his/her designee.
- d. Dive computers capable of PO₂ limit and FO₂ adjustment should be checked by the diver prior to the start of each dive to assure compatibility with the mix being used.

7.42.5 Repetitive Diving

- a. Repetitive diving using nitrox mixtures shall be performed in compliance with procedures required of the specific decompression tables used.
- b. Residual nitrogen time shall be based on the EAD for the specific nitrox mixture to be used for the repetitive dive and not on that of the previous dive.
- c. The total exposure to a partial pressure of oxygen in a given 24 hour period shall not exceed the “Total Exposure per Twenty-four (24) Hour Period” given in Section 7.43.2.
- d. When repetitive dives expose divers to different partial pressures of oxygen from dive to dive, divers should account for accumulated oxygen exposure from previous dives when determining acceptable exposures for repetitive dives. Both CNS and pulmonary oxygen toxicity should be addressed.
- e. When doing repetitive dives with different nitrox mixtures it is suggested to use the mix that gives the deepest EAD first, the next shallower second, etc.

7.43 Oxygen Parameters

7.43.1 Authorized Mixtures

Other mixtures of 22% to 50% oxygen meeting the criteria outlined in Sections 7.42.1 and 7.43.2 may be used. There are special requirements for equipment that is used with oxygen percents higher than 40% by volume (Section 7.51).

7.43.2 Purity Standards

- a. Oxygen used for mixing nitrox shall meet the purity levels for “Medical Grade” (USP) standards at the minimum.
- b. Air purity shall meet standards for oil-free air as shown in Section 7.43.2.c. The use of an “non-oil lubricated” or “oil-less” compressor is required.
- c. Oil-Free Compressor: A non-oil lubricated compressor is required when mixing Nitrox using compressed air and oxygen. The compressor shall meet or exceed these “oil free air” standards for air purity:

Carbon Monoxide	≤10 ppm
Carbon Dioxide	≤500 ppm
gaseous hydrocarbon (methane)	≤25 ppm
condensed hydrocarbons	≤ 0.5 mg/M ³
moisture/water vapor dewpoint	<- 40 C
solid/particulate matter	≤1 mg/M ³

7.43.3 Oxygen Partial Pressure Limits (CNS Dose).

All dives performed using nitrox breathing mixtures shall comply with the following NOAA Oxygen Partial Pressure Limits for “normal” exposures:

Oxygen PO ₂ (ATA)	Single Exposure Limit (min)	24 Hour Maximum Limit (min)
1.60	45	150
1.45	135	180
1.40	150	180
1.30	180	210
1.20	210	240
1.10	240	270
1.00	300	300
0.90	360	360
0.80	570	570
0.70	570	570
0.60	720	720

Source: NOAA Diving Manual, 4th edition, 2001, Page 15.5, Table 15.2

7.44 Gas Mixing and Analysis

7.44.1 Personnel Requirements

- a. Individuals responsible for mixing and analyzing mixtures shall be trained, have proof of certification and experience in all aspects of the technique.
- b. Only those individuals approved by the DSO shall be responsible for blending and analyzing mixtures.

7.44.2 Mixing Methods

It is the responsibility of the DSO or his/her designee to approve which of the various methods of blending is utilized.

7.44.3 Analysis Verification

- a. It is the responsibility of each diver to confirm, by direct observation the oxygen content of his/her scuba cylinder and acknowledge, in writing on both the Nitrox Validation sheet and the cylinder contents tag the following:
 - The percents of oxygen ($\pm 1\%$) and nitrogen.
 - The Maximum Operating Depth (MOD) for the mix.
 - The cylinder pressure.
 - The date of analysis.
 - The diver’s signature (validation sheet) and initials (contents tag).
 - The cylinder serial number (on validation sheet).
- b. Gases shall be analyzed for O₂ content to an accuracy of $\pm 1\%$ total. This analysis shall be performed both by the person preparing the mixture and by the diver.
- c. If a greater variance exists, the cylinder will not be used for that dive or, at the discretion of the Lead Diver, the dive plan modified to meet the limits and restrictions corresponding to the actual oxygen content.

7.50 NITROX DIVING EQUIPMENT

All the designated equipment and stated requirements regarding scuba equipment in these standards also apply to nitrox scuba operations. Additional minimal equipment necessary and requirements are shown below.

7.51 Oxygen Cleaning and Maintenance Requirements

7.51.1 Diver-worn and Support Equipment:

All diver-worn and support equipment used (in contact) with high pressure oxygen or oxygen mixtures greater than 40% by volume should be prepared, maintained, and designated for oxygen service in compliance with ASTM Pamphlet G88-84, "Designing Systems for Oxygen Service."

7.51.2 Nitrox Containers

All containers used for the storing, mixing or dispensing (including scuba cylinders) of nitrox shall be designated "Nitrox," "EANx" or "DNAx" and color coded yellow with; a 4 inch green band with yellow lettering beginning at the shoulder curvature of the cylinder or a 4 inch green band with 1 inch yellow borders, or a green cap on the top quarter of the cylinder, with green lettering on the yellow bottom 3/4 of the cylinder. The cylinders shall be cleaned for oxygen service and have oxygen compatible components and lubrication.

7.51.3 Scuba Regulators

Scuba regulators can be used with any oil-free breathing gas (air or nitrox). It is required that regulators that are used with blends of more than 40% by volume have the first stages cleaned for oxygen service. It is recommended that first stages of regulators that have been used with air derived from an oil lubricated compressor not be used for nitrox (of 22% to 40%) service.

7.51.4 Other Equipment

All other diving and auxiliary equipment shall be cleaned, maintained, and stored in compliance with this manual.

7.52 Dedicated cylinders, (storage and scuba): Shall be oxygen clean and compatible. Cylinders shall be marked "Nitrox," "DNAx" or "EANx," shall be color coded as per Section 7.51.2. The cylinders shall have a contents tag affixed. The tag will be permanently marked with the cylinder's serial number. The user shall record: Percent oxygen, percent nitrogen, cylinder pressure, Maximum Operating Depth, date of analysis, and user/analyzer's initials. The cylinders are restricted for use with nitrox only. Cylinders not so designated or prepared shall not be used with nitrox blends.

7.53 Dedicated regulators: When using a nitrox scuba cylinder containing more than 40% oxygen the diver must also use an oxygen clean and compatible regulator. The regulator shall be marked for nitrox use only. Dedicated regulators used with cylinders filled by an oil-lubricated compressor cannot be used with mixtures over 40% again until they have been cleaned.

7.54 Oxygen analyzers: An oxygen analyzer capable of determining the oxygen content in the diver's cylinder prior to diving is required. The analyzer must be accurate to within plus or minus one percent. The use of two analyzers in parallel is recommended for comparative and verification purposes.

- 7.55 Oil-Free Compressor: A non-oil lubricated compressor is required when mixing nitrox using compressed air and oxygen. The compressor shall meet or exceed “oil free air” standards for air purity as shown in Section 7.43.2.c.
- 7.56 Fill Station: The fill station shall be equipped with oxygen clean components (e.g., fill whips, gauges, valves, regulators, etc.) Nitrox components shall be clearly marked as such.

SECTION 8.00 AQUARIUM DIVING OPERATIONS

8.10 General Policy

Section 8.00 applies to scientific aquarium divers only.

Definition - A scientific aquarium diver is a scientific diver who is diving solely within an aquarium. An aquarium is a shallow, confined body of water, which is operated by or under the control of an institution and is used for the purposes of specimen exhibit, education, husbandry, or research. It is recognized that within scientific aquarium diving there are environments and equipment that fall outside the scope of those addressed in this standard. In those circumstances it is the responsibility of the organizational member's Dive Control Board to establish the requirements and protocol under which diving will be safely conducted.

Note: All of the standards set forth in other sections of this standard shall apply, except as otherwise provided in this section.

8.20 The Buddy System In Scientific Aquarium Diving

All scuba diving activities in the confined environment of an aquarium shall be conducted in accordance with the buddy system, whereby both divers, or a diver and a tender as provided below, are always in visual contact with one another, can always communicate with one another, and can always render prompt and effective assistance either in response to an emergency or to prevent an emergency.

A diver and tender comprise a buddy team in the confined environment of an aquarium only when the maximum depth does not exceed 30 feet, and there are no overhead obstructions or entanglement hazards for the diver, and the tender is equipped, ready and able to conduct or direct a prompt and effective in-water retrieval of the diver at all times during the dive.

8.30 Diving Equipment

Section 3.20 is modified to read as follows:

In an aquarium of a known maximum obtainable depth:

A depth indicator is not required, except that a repetitive diver shall use the same computer used on any prior dive.

Only one buddy must be equipped with a timing device.

The maximum obtainable depth of the aquarium shall be used as the diving depth.

8.40 Scientific Aquarium Diver Certification

A Scientific Aquarium Diver is a certification enabling the qualified diver to participate in scientific diving in accordance with Section 8.00 as provided below.

All of the standards set forth in sections 4.0 and 5.0 of this standard shall apply, except that Section 5.30 of this standard is modified to read as follows:

Practical training shall include at least 12 supervised aquarium dives for a cumulative bottom time of 6 hours. No more than 3 of these dives shall be made in 1 day.

8.50 Scientific Aquarium Diving Using Other Diving Technology

Surface Supplied Scientific Aquarium Diving

Definition: For purposes of scientific aquarium diving, surface supplied diving is described as a mode of diving using open circuit, surface supplied compressed gas which is provided to the diver at the dive location and may or may not include voice communication with the surface tender.

- a) Divers using the surface supplied mode shall be equipped with a diver-carried independent reserve breathing gas supply.

Scientific aquarium divers using conventional scuba masks, full-face masks, or non-lockdown type helmets are exempt from this standard provided:

There are no overhead obstructions or entanglements.

The diver is proficient in performing a Controlled Emergency Swimming Ascent from at least as deep as the maximum depth of the aquarium.

The diver is proficient in performing out of air emergency drills, including ascent and mask/helmet removal.

Each surface supplied diver shall be hose-tended by a separate dive team member while in the water. Scientific aquarium divers are exempt from this standard, provided the tender is monitoring only one air source, there is mutual assistance between divers and there are no overhead obstructions or entanglements.

Divers using the surface supplied mode shall maintain communication with the surface tender. The surface supplied breathing gas supply (volume and intermediate pressure) shall be sufficient to support all surface supplied divers in the water for the duration of the planned dive.

During surface supplied diving operations when only one diver is in the water, there must be a standby diver in attendance at the dive location. Scientific aquarium divers are exempt from this standard, provided the tender is equipped, ready and able to conduct a prompt and effective in-water retrieval of the diver at all times during the dive.”

Surface supplied equipment must be configured to allow retrieval of the diver by the surface tender without risk of interrupting air supply to the diver.

All surface supplied applications used for scientific aquarium diving shall have a non-return valve at the attachment point between helmet or mask hose, which shall close readily and positively.

SECTION 9.00

STAGED DECOMPRESSION DIVING

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

The following procedures shall be observed when conducting dives requiring planned decompression stops.

9.10 MINIMUM EXPERIENCE AND TRAINING REQUIREMENTS

Divers wishing to perform staged deco diving must get prior approval from the DSO/DCB.

- a) Prerequisites:
 1. Scientific Diver qualification according to Section 5.00.
 2. Minimum of 100 logged dives.
 3. Demonstration of the ability to safely plan and conduct dives deeper than 100 feet.
 4. Nitrox certification/authorization according to Section 7.00 recommended.

- b) Training shall be appropriate for the conditions in which dive operations are to be conducted.

- c) Minimum Training shall include the following:
 1. 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 method, emergency procedures.
 2. It is recommended that at least one training session be conducted in a pool or sheltered water setting, to cover equipment handling and familiarization, swimming and buoyancy control, to estimate gas consumption rates, and to practice emergency procedures.
 3. At least 6 open-water training dives simulating/requiring decompression shall be conducted, emphasizing planning and execution of required decompression dives, and including practice of emergency procedures.
 4. Progression to greater depths shall be by 4-dive increments at depth intervals as specified in Section 5.40.
 5. No training dives requiring decompression shall be conducted until the diver has demonstrated acceptable skills under simulated conditions.
 6. 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 use as pertinent to planned diving operation
 - Buddy skills
 - Gas management
 - Time management
 - Task loading
 - Emergency skills

7. Divers shall demonstrate to the satisfaction of the DSO or the DSO's designee proficiency in planning and executing required decompression dives appropriate to the conditions in which diving operations are to be conducted.
8. Upon completion of training, the diver shall be authorized to conduct required decompression dives with DSO approval.

9.20 MINIMUM EQUIPMENT REQUIREMENTS:

- a) Valve and regulator systems for primary (bottom) gas supplies 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.
- b) Cylinders with volume and configuration adequate for planned diving operations.
- c) 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.
- d) Minimum dive equipment shall include:
 1. Snorkel is optional at the DCB's discretion, as determined by the conditions and environment.
 2. Diver location devices adequate for the planned diving operations and environment.
 3. Compass
- e) Redundancy in the following components is desirable or required at the discretion of the DCB or DSO:
 1. Decompression Schedules
 2. Dive Timing Devices
 3. Depth gauges
 4. Buoyancy Control Devices
 5. Cutting devices
 6. Lift bags and line reels

9.30 MINIMUM OPERATIONAL REQUIREMENTS

- a) Approval of dive plan applications to conduct required decompression dives shall be on a case-by-case basis.
- b) The maximum PO_2 to be used for planning required decompression dives is 1.45. A PO_2 of no more than 1.6 may be used at decompression stops.
- c) Divers gas supplies shall be adequate to meet planned operational requirements and foreseeable emergency situations.
- d) Decompression dives may be planned using dive tables, dive computers, and/or PC software approved by the DSO/DCB.
- e) Breathing gases used while performing in-water decompression shall contain the same or greater oxygen content as that used during the bottom phase of the dive.

- f) The dive team prior to each dive shall review emergency procedures appropriate for the planned dive.
- g) If breathing gas mixtures other than air are used for required decompression, their use shall be in accordance with those regulations set forth in the appropriate sections of this standard.
- h) The maximum depth for required decompression using air as the bottom gas shall be 190 fsw (6.7 atm absolute).
- i) Use of additional nitrox and/or high-oxygen fraction decompression mixtures as travel and decompression gases to decrease decompression obligations is encouraged.
- j) Use of alternate inert gas mixtures to limit narcosis is encouraged for depths greater than 150 fsw (5.5 atm absolute).
- k) 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 prior to the start of project diving operations are recommended.
- l) Mission specific workup dives are recommended.
- m) Only one dive with required decompression stop(s) is allowed in any twenty-four (24) hour period
- n) For required decompression diving there will be surface personnel support, a staged decompression station with the proper stops clearly marked and adequate breathing gas supply. Each diver must carry a redundant breathing gas supply appropriate to the depth and conditions of the dive, and adequate to complete the full decompression schedule. An emergency float that may be inflated at depth and attached to a reel with sufficient line to reach the surface from the maximum dive depth is recommended.
- o) Divers who unintentionally enter required decompression mode on a dive are exempted from the equipment requirements but must complete their decompression obligation. If required decompression was omitted, or the diver experienced an out of control, rapid ascent, divers should breathe 100 percent oxygen for at least thirty (30) minutes (providing there is enough oxygen on board to handle any possible subsequent emergency), be monitored for DCI symptoms, and contact the DSO. They may not dive again for twenty-four (24) hours.

SECTION 10.00

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.

Divers wishing to perform mixed gas diving must get prior approval from the DSO/DCB.

10.10 MINIMUM EXPERIENCE AND TRAINING REQUIREMENTS

- a) Prerequisites:
 - 1. Nitrox certification and authorization. (Section 7.00)
 - 2. If the intended use entails required decompression stops, divers will be previously certified and authorized in decompression diving (Section 9.00).
 - 3. Divers shall demonstrate to the DSO/DCB's satisfaction skills, knowledge, and attitude appropriate for training in the safe use of mixed gases.

- b) Classroom training including:
 - 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. 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

- c) Practical Training:
 - 1. Confined water session(s) 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 feet and the planned operational depth.
 - 5. Planned operational depth for initial training dives shall not exceed 260 feet.
 - 6. Diving operations beyond 260 fsw (8.7 atm absolute) requires additional training dives.

10.20 EQUIPMENT AND GAS QUALITY REQUIREMENTS

- a) Equipment requirements 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.

- b) The quality of inert gases used to produce breathing mixtures shall be of an acceptable grade for human consumption.
- c) Equipment and gas mixtures shall be appropriate to the depth and degree of technical difficulty of the dive.

10.30 MINIMUM OPERATIONAL REQUIREMENTS

- a) Approval of dive plan applications to conduct mixed gas dives shall be on a case-by-case basis.
- b) All applicable operational requirements for nitrox and decompression diving shall be met.
- c) Maximum partial pressure of oxygen shall be 1.45 ATA operational, 1.6 ATA decompression and 2.0 ATA for bailout. Maximum partial pressure of nitrogen shall be 5 ATA.
- d) Maximum planned Oxygen Toxicity Units (OTU) will be considered based on mission duration.
- e) Divers decompressing on high-oxygen concentration mixtures shall closely monitor one another for signs of acute oxygen toxicity.
- f) Breathing gases shall be analyzed such that the concentration of the various component gases is known. The oxygen component shall be known within $\pm 1\%$ of the total mixture.
- g) Adequate surface support and in-water safety divers shall be present. The number of safety divers shall be appropriate to the depth and purpose of operations.
- h) Provisions for emergency treatment and evacuation shall be a part of the dive plan.

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 prior to the start of project diving operations are recommended.

SECTION 11.00

OTHER DIVING TECHNOLOGY

Certain types of diving, some of which are listed below, require specialized equipment or procedures, and require training beyond Scientific Diver. Those needing to use methods listed in this section (and sections 7, 9, & 10) shall request, and must have, authorization from the Diving Control Board prior to commencing diving activities. (See Section 2.21)

11.10 BLUEWATER DIVING

Bluewater diving is defined as any area where divers cannot see the bottom for visual orientation nor any of the fixed objects that normally aid in focal readjustment of the eye. Usually this applies to open water where depths are extreme.

In certain situations it may be desirable for a person to engage in blue water diving in the course of their research. This mode of diving has many unique problems, and thorough training in safety and blue water diving procedures are required. A separate manual for operation of a blue water dive and the training requirements is available from the Diving Safety Officer. "Blue Water Diving Guidelines" (California Sea Grant Publication # T-CSGCP-014).

11.20 ICE AND POLAR DIVING

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

11.30 OVERHEAD ENVIRONMENT DIVING

a) Enclosed spaces

1. Where an enclosed or confined space is not large enough for two divers, a diver shall be stationed at the underwater point of entry and an orientation line shall be used.
2. Both divers shall be in visual or physical contact with the orientation line during the dive.

b) Cave Diving

1. Divers planning operations in caverns or caves must have specialized training in the unique conditions and problems associated with cave diving.
2. Dive plans and diver training must be approved by the DCB before diving operations begin.
3. See AAUS "SCIENTIFIC CAVE AND CAVERN DIVING STANDARD"

11.40 SATURATION DIVING

Saturation divers shall comply with the saturation diving standards of the organization under which the saturation diving is to be done.

11.50 HOOKAH DIVING

Hookah divers shall comply with all scuba diving procedures in this manual, including the buddy system.

- a) Divers using the hookah mode shall be equipped with a diver-carried independent reserve breathing gas supply sufficient to reach the surface, including any decompression stops.
- b) Each hookah diver shall be hose-tended by a dive team member at the surface.
- c) The hookah breathing gas supply shall be sufficient to support all hookah divers in the water for the duration of the planned dive, including decompression.

11.60 SURFACE SUPPLIED DIVING

- a) Surface supplied divers shall comply with all scuba diving procedures in this manual (except Section 2.31). Surface supplied diving shall not be conducted at depths greater than 6.7 ATA (190 fsw).
- b) Divers using the surface supplied mode shall be equipped with a diver-carried independent reserve breathing gas supply adequate to allow the diver to reach the surface, including decompression time.
- c) While in the water, each surface supplied diver shall be hose tended by a separate dive team member on the surface.
- d) Divers using the surface supplied mode shall maintain voice communication with the surface tender or dive supervisor. If voice communications fail, divers/tenders will switch to line pull signals and terminate the dive immediately. Divers using Hookah method are exempt from voice communication requirements.
- e) 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.
- f) During surface supplied diving operations, when only one diver is in the water, there must be a standby diver in attendance, in addition to the tender, at the dive location. The standby diver shall be able to enter the water appropriately suited and equipped in less than one (1) minute.

11.70 ALTITUDE DIVING

Dives at altitudes greater than 3,000 meters (10,000') require prior approval of the Diving Control Board.

11.71 Training Requirements

Persons diving at sites with elevations greater than 300 meters (1,000') must have specialized training in the unique conditions and problems associated with high altitude diving. This training shall include at least:

- a) Effects of the lower atmospheric pressure on equipment and human physiology.

- b) Selection, modification, and use of appropriate decompression tables.
- c) Dive planning; including acclimatization periods, altitude adjustments, table and computer review and/or corrections, limitations, ascent rates, and decompression stops.
- d) Buoyancy changes.
- e) Hypothermia
- f) Dehydration.
- g) Causes, signs, symptoms, and first aid for decompression illness, gas embolism, and altitude sickness.
- h) Emergency procedures, area EMS activation methods, location of and transport method to nearest hospital, and hyperbaric chamber.
- i) Ascending in elevation after diving.

11.72 Dive Tables and Computers

- a) A set of appropriate dive tables, correct for the altitude, must be at the dive site.
 1. Each diver shall have either an altitude adjustable depth gauge or dive computer.
 2. Students under direct supervision of an instructor approved by the DCB are exempted, but they must determine and carry corrections for the depth gauge used.
- b) Only those makes and models of dive computers that are fully functional at the altitude of the dive may be used to determine decompression obligation.
 1. “Fully functional at altitude” means those computers that record and display actual depth and time, compute no-stop decompression limits as well as decompression times and stop depths for the actual altitude of the dive. The computers should also take into account the amount of time passed since the diver’s arrival at altitude and his/her acclimatization period (residual nitrogen time). There are some dive computers that do not compute residual nitrogen upon arrival, and the diver must wait eighteen (18) to twenty-four (24) hours before using these computers to figure decompression obligation.
 2. Divers must read and understand the owner’s manual for the computer being used before diving

11.83 Buoyancy Check

Each person diving for the first time in fresh water will conduct a buoyancy check and adjust their weight system as needed before commencing diving operations.

11.84 Regulators

Due to colder air and water temperature often encountered at altitude, only those scuba regulators that meet or exceed the breathing (inhalation and exhalation resistance) standards formerly set by the US Navy for class ‘A’ service, and are capable of being “environmentally sealed,” shall be used by UCD divers at altitudes greater than 1000 meters and in water temperatures of less than 7 C.

SECTION 12.00

REBREATHERS

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

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

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

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

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

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

12.10 Definition

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

B. There are three classes of rebreathers:

1. 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 limited in depth of use due to the physiological limits associated with oxygen toxicity
2. 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
3. Closed-Circuit Rebreathers: Closed-circuit mixed gas rebreathers (CCR) recycle all of the exhaled gas. Electronically controlled CCRs (eCCR) replace metabolized oxygen via an electronically controlled valve, governed by oxygen sensors. Manually controlled CCR (mCCR) rely on mechanical oxygen addition and diver monitoring to control oxygen partial pressure (ppO₂). Depending on the design, manual oxygen addition may be available on eCCR units as a diver override, in case of electronic system failure. Systems are equipped with two cylinders; one with oxygen, the other with a diluent gas source used to make up gas volume with depth increase and to dilute oxygen levels. CCR systems operate to maintain a constant ppO₂ during the dive, regardless of depth

12.20. Prerequisites for use of any rebreather.

A. Active scientific diver status, with depth qualification sufficient for the type, make, and model of rebreather, and planned application.

B. Completion of a minimum of 25 open-water dives on open circuit SCUBA. The DCB may require increased dive experience depending upon the intended use of the rebreather system for scientific diving.

C. For SCR or CCR, a minimum 60-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.

12.30. Training

A. 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). (See training section for details.)

B. 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.

C. Post training supervised dives are required before the Scientific rebreather diver is authorized to use rebreather for research dives. (see training section for details).

II. Individual Equipment Requirements

Individual Equipment Requirements			
Key: X = include, IA = If Applicable			
	O2	SCR	CCR
DCB approved rebreather make and model	X	X	X
Bottom timer, and depth gauge	X	X	X
Dive computer (separate from rebreather unit)		X	X
Approved dive tables		IA	IA
SMB (surface marker buoy) and line reel or spool with sufficient line to deploy an SMB from the bottom in the training environment	IA	IA	IA
Access to an oxygen analyzer	X	X	X
Cutting implement	X	X	X
BCD capable of floating a diver with a flooded loop and/or dry suit at the Surface	X	X	X
Bailout gas supply of sufficient volume for planned diving activities	X	X	X
Approved CO2 absorbent and other consumables	X	X	X

12.40. Equipment Requirements

A. General

1. Only those models of rebreathers specifically approved by DCB shall be used
2. Rebreathers should meet the quality control/quality assurance protocols of the International Organization for Standardization (ISO) requirements: ISO 9004: 2009 or the most current version, AND successful completion of CE (Conformité Européenne) or DCB approved third party testing
3. Rebreather modifications (including consumables and operational limits) that deviate from or are not covered by manufacturer documentation should be discussed with the manufacturer and approved by the DCB prior to implementation

B. Equipment Maintenance Requirements

1. The DCB or their designee will establish policies for the maintenance of rebreathers and related equipment under their auspices. Rebreathers should be maintained in accordance with manufacturer servicing recommendations
2. Field repairs and replacement of components covered in rebreather diver training is not annual maintenance and may be performed by the rebreather diver in accordance with DCB policy
3. A maintenance log will be kept and will minimally include:
 - a) Dates of service
 - b) Service performed
 - c) Individuals or company performing the service

12.50. Operational Requirements

A. Dive Plan

1. In addition to standard dive plan components, at a minimum all dive plans that include the use of rebreathers must include:
 - a) Information about the specific rebreather model(s) to be used

- b) Type of CO₂ absorbent material
- c) Composition and volume(s) of supply gasses d)

Bailout procedures

- e) Other specific details as required by the DCB
 - f) Particular attention should be paid to using rebreathers under conditions where vibration or pulsating water movement could affect electronics or control switches and systems
 - g) Particular attention should be paid to using rebreathers under conditions where heavy physical exertion is anticipated
- B. Ideally, respired gas densities should be less than 5 g·L⁻¹, and should not exceed 6 g·L⁻¹ under normal circumstances.
 - C. User replaceable consumable rebreather components should be replaced per manufacture recommendations or as defined by the DCB
 - D. If performed, periodic field validation of oxygen cells should be conducted per DCB designated procedure
 - E. Diver carried off-board bailout is not required under conditions where the onboard reserves are adequate to return the diver to the surface while meeting proper ascent rate and stop requirements, and the system is configured to allow access to onboard gas. These calculations must take into consideration mixed mode operations where an open circuit diver could require assistance in an out of gas situation
 - F. Use and reuse of CO₂ scrubber media should be per manufacture recommendations or as defined by the DCB
 - G. Planned oxygen partial pressure in the breathing gas shall not exceed 1.4 atmospheres at depths greater than 30 feet, or 1.6 at depths less than 30feet
 - H. Both CNS and Oxygen Tolerance Units (OTUs) should be tracked for each diver. Exposure limits should be established by the DCB
 - I. The DCB or their designee will:
 - 1. Establish policies for the use of checklists related to rebreather operations

2. Establish policies for pre and post dive equipment checks to be conducted by their divers
3. Establish policies for disinfection of rebreathers to be used by their divers
4. Establish policies for pre-breathing of rebreathers used by their divers
5. Establish policies for the use of mixed mode and mixed rebreather platform dive teams under their auspices.
 - a) Mixed mode and/or mixed platform dive teams are permitted.
 - b) At minimum, divers must be cross briefed on basic system operations for establishing positive buoyancy, closing a rebreather diver's breathing loop, and procedures for gas sharing
6. Establish policies for the maximum depth of dives conducted using a particular class of rebreather within the auspices of their diving operations
7. Establish policies for depth progression/depth certification/depth certification maintenance for divers using rebreathers
8. Establish policies for implementing workup dives within program
 - a) Pre-operation workup dives, including review and practice of emergency recognition and response skills, and management of task loading are required for operations defined by the DCB as beyond the scope of normal operating conditions.
9. Establish policies for the minimum use of rebreathers to maintain proficiency.
 - a) The minimum Annual rebreather diving activity should be 12 rebreather dives, with a minimum of 12 h underwater time.
 - b) To count, dives should be no less than 30 min in duration. A required element of maintaining proficiency is the periodic performance and reevaluation of skills related to in-water problem recognition and emergency procedures
- J. Establish policies for reauthorization for the use of rebreathers if minimum proficiency requirements are not met
 1. Reestablishment of authorization to use rebreathers must require more than just performing a dive on a particular make or model of rebreather
 2. At minimum demonstrated skills included in the required training elements for the level of rebreather operation must be performed and reevaluated.

REBREATHER TRAINING SECTION

A. Entry Level Training

1. The training area for O2 Rebreather should not exceed 20 fsw in depth
2. Entry level CCR and SCR training is limited in depth of 130fsw and shallower
3. Entry level CCR and SCR training is limited to nitrogen/oxygen breathing media
4. Divers at the CCR and SCR entry level may not log dives that require a single decompression stop longer than 10 minutes
5. Who may teach: Individuals authorized as a CCR, SCR, or O2 Rebreather Instructor by the DCB; in all cases, the individual authorized must have operational experience on the rebreather platform being taught, and where applicable the individual being authorized should be authorized as an instructor by the respective rebreather manufacturer or their designee.
6. Maximum Student/Instructor Ratio: 4 to 1. This ratio is to be reduced as required by environmental conditions or operational constraints
7. Upon completion of practical training, the diver must demonstrate proficiency in pre-dive, dive, and post-dive operational procedures for the particular model of rebreather to be used
8. Supervised dives target activities associated with the planned science diving application. Supervisor for these dives is the DSO or designee, experienced with the make/model rebreather being used

Rebreather Entry Level Training Requirements			
Key: X = include, IA = If Applicable, ISE = If So Equipped			
	O2	SCR	CCR
Required Training Topic			
Academic			
History of technology	X	X	X
Medical & physiological aspects of:			
Oxygen toxicity	X	X	X
chemical burns & caustic cocktail	X	X	X

Hypoxia – insufficient O ₂	X	X	X
Hypercapnia – excessive CO ₂	X	X	X
Arterial gas embolism	X	X	X
Middle Ear Oxygen Absorption Syndrome (oxygen ear)	X	X	X
Hygienic concerns	X	X	X
Nitrogen absorption & decompression sickness		X	X
CO ₂ retention	X	X	X
Hyperoxia-induced myopia	X	X	X
System design, assembly, and operation, including:			
Layout and design	X	X	X
Oxygen control systems	X	X	X
Diluent control systems		ISE	ISE
Use of checklists	X	X	X
Complete assembly and disassembly of the unit	X	X	X
Canister design & proper packing and handling of chemical absorbent	X	X	X
Decompression management and applicable tracking methods		ISE	X
Oxygen and high pressure gas handling and safety	X	X	X
Fire triangle	X	X	X
Filling of cylinders	X	X	X
Pre-dive testing & trouble shooting	X	X	X
Post-dive break-down and maintenance	X	X	X
Trouble shooting and manufacturer authorized field repairs	X	X	X
Required maintenance and intervals	X	X	X
Manufacturer supported additional items (ADV, temp stick, CO ₂ monitor, etc.)	ISE	ISE	ISE
Dive planning:			
Operational planning	X	X	X
Gas requirements	X	X	X
Oxygen exposure and management	X	X	X
Gas density calculations		X	X
Oxygen metabolizing calculations	X	X	X
Scrubber limitations	X	X	X
Mixed mode diving (buddies using different dive modes)	X	X	X
Mixed platform diving (buddies using different rebreather platforms)	X	X	X
Problem Recognition & Emergency Procedures:			
Applicable open circuit emergency procedures for common gear elements	X	X	X
Loss of electronics	ISE	ISE	X
Partially flooded loop	X	X	X
Fully flooded loop	X	X	X
Cell warnings		ISE	X
Battery warnings	ISE	ISE	X
High O ₂ warning	ISE	ISE	X
Low O ₂ warning	ISE	ISE	X
High CO ₂ warning	ISE	ISE	ISE
Recognizing issues as indicated by onboard scrubber monitors	ISE	ISE	ISE
Recognizing hypercapnia signs and symptoms in self or others	X	X	X

Excluded O2 cell(s)	ISE	ISE	ISE
Loss of Heads Up Display	ISE	ISE	ISE
Loss of buoyancy	X	X	X
Diluent manual add button not functioning		ISE	ISE
O2 manual add button not functioning	ISE	ISE	ISE
Exhausted oxygen supply	X	X	X
Exhausted diluent supply		ISE	ISE
Lost or exhausted bailout	ISE	ISE	ISE
Handset not functioning	ISE	ISE	ISE
Solenoid stuck open	ISE	ISE	ISE
Solenoid stuck closed	ISE	ISE	ISE
ADV stuck open	ISE	ISE	ISE
ADV stuck closed	ISE	ISE	ISE
Isolator valve(s) not functioning	ISE	ISE	ISE
Oxygen sensor validation	ISE	ISE	X
CO ₂ sensor validation	IA	IA	IA
Gas sharing	X	X	X
Diver assist and diver rescue	X	X	X
Other problem recognition and emergency procedures specific to the particular unit, environment, or diving conditions	X	X	X
Practical Training and Evaluations			
Demonstrated skills shall include, at a minimum:			
Use of checklists	X	X	X
Carbon dioxide absorbent canister packing	X	X	X
Supply gas cylinder analysis and pressure check	X	X	X
Test of one-way valves	X	X	X
System assembly and breathing loop leak testing	X	X	X
Oxygen control system calibration	ISE	ISE	X
Proper pre-breathe procedure	X	X	X
In-water bubble check	X	X	X
Proper buoyancy control during descent, dive operations, and ascent	X	X	X
System monitoring & control during descent, dive operations, and ascent	X	X	X
Proper interpretation and operation of system instrumentation	X	X	X
Proper buddy contact and communication	X	X	X
Use of a line reel or spool to deploy an SMB from planned dive depth and while controlling buoyancy in the water column	X	X	X
Proper management of line reel or spool, and SMB during ascents and safety or required stops	X	X	X
Unit removal and replacement on the surface	X	X	X
Bailout and emergency procedures for self and buddy, including:			
System malfunction recognition and solution	X	X	X
Manual system control	ISE	ISE	ISE
Flooded breathing loop recovery	IA	IA	IA
Absorbent canister failure	X	X	X
Alternate bailout options	X	X	X
Manipulation of onboard and offboard cylinder valves	X	X	X

Manipulation of bailout cylinders (removal, replacement, passing and receiving while maintaining buoyancy control)	ISE	ISE	ISE
Manipulation of quick disconnects, isolator valves, and manual controls specific to the unit and gear configuration	ISE	ISE	ISE
Proper system maintenance, including:			
Breathing loop disassembly and disinfection	X	X	X
Oxygen sensor replacement	ISE	ISE	ISE
Battery removal and replacement or recharging	ISE	ISE	ISE
Other tasks as required by specific rebreather models	X	X	X
Written Evaluation	X	X	X
Supervised Rebreather Dives	X	X	X
Entry Level Training – Minimum Underwater Requirements			
	Pool/Confined Water	Openwater	Supervised Dives
O2	1 Dive, 90 – 120 minutes	4 dives, 120 minute cumulative	2 Dives, 120 minute cumulative
SCR	1 Dive, 90 – 120 minutes	4 dives, 120 minute cumulative	4 dives, 120 minute cumulative
CCR	1 Dive, 90 – 120 minutes	8 dives, 380 minute cumulative	4 dives, 240 minute cumulative

B. Rebreather Required Decompression, Mixed Gas, and Hypoxic Mix Training

9. Required Decompression and Mixed Gas Training may be taught separately or combined. If combined, open water and supervised dive requirements are added together to equal the total of the courses if taught separately

10. Prerequisites:

a) Required Decompression 25 rebreather dives for a minimum cumulative dive time of 25 hours

b) Mixed Gas:

(1) Non-hypoxic Mixes – 25 rebreather dives for a minimum cumulative dive time of 25 hours

(2) Hypoxic Mixes – Rebreather Required Decompression Certification and Mixed Gas Certification and 25 dives for a minimum cumulative dive time of 40 hours on dives requiring decompression

11. Who may teach: Individuals authorized as a CCR/SRC required decompression and/or Mixed Gas and/or Hypoxic Mix instructor by the DCB or their designee (this is in addition to the original authorization from section A #5)

12. Maximum Student/Instructor Ratio: 2 to 1. This ratio is to be reduced as required by environmental conditions or operational constraints

13. Upon completion of practical training, the diver must demonstrate proficiency in pre-dive, dive, and post-dive operational procedures for the particular model of rebreather to be used
14. Supervised dives target activities associated with the planned science diving application. Supervisor for these dives is the DSO or designee, experienced with the make/model rebreather being used

Rebreather Required Decompression, Mixed Gas & Hypoxic Mix Training Requirements			
Key: X = include, IA = If Applicable, ISE = If So Equipped			
	Deco	Mixed Gas	Hypoxic Mixes
Required Training Topic			
Academic			
Review of applicable subject matter from previous training	X	X	X
Medical & physiological aspects of:			
Hypercapnia, hypoxia, hyperoxia	X	X	X
Oxygen limitations	X	X	X
Nitrogen limitations	X	X	X
Helium absorption and elimination		X	X
High Pressure Nervous Syndrome (HPNS)			X
System design, assembly, and operation, including:			
Gear considerations and rigging	X	X	X
Gas switching	X	X	X
Dive planning:			
Decompression calculation	X	X	X
Gradient Factors	X	X	X
Scrubber duration and the effects of depth on scrubber function	X	X	X
Gas requirements including bailout scenarios	X	X	X
Bailout gas management – individual vs team bailout	X	X	X
Gas density calculations	X	X	X
Operational Planning	X	X	X
Equivalent narcosis depth theory		X	X
Gas selection, gas mixing and gas formulas		X	X
Problem Recognition & Emergency Procedures:			
Applicable open circuit emergency procedures for common gear elements	X	X	X
Flooded loop	X	X	X
Cell warnings	X	X	X
Battery warnings	X	X	X
Hypercapnia, hypoxia, hyperoxia	X	X	X
Practical Training and Evaluations			
Demonstrated skills shall include, at a minimum:			
Proper demonstration of applicable skills from previous training	X	X	X
Proper manipulation of DSV and/or BOV	X	X	X

Proper descent and bubble check procedures	X	X	X
Proper monitoring of setpoint switching and pO2 levels	X	X	X
Proper interpretation and operation of system instrumentation	X	X	X
System monitoring & control during descent, dive operations, and ascent	X	X	X
Demonstrate the ability to manually change setpoint and electronics settings during the dive	ISE	ISE	ISE
Demonstrate buoyancy control; ability to hover at fixed position in water column without moving hands or feet	X	X	X
Onboard and offboard valve manipulation for proper use, and reduction of gas loss	X	X	X
Diagnosis of and proper reactions for a flooded absorbent canister	X	X	X
Diagnosis of and proper reactions for CO ₂ breakthrough	X	X	X
Diagnosis of and proper response to Cell Errors	X	X	X
Diagnosis of and proper reactions for Low oxygen drills	X	X	X
Diagnosis of and proper reactions for Flooded Loop	X	X	X
Diagnosis of and proper reactions for High Oxygen Drills	X	X	X
Diagnosis of and proper reactions for electronics and battery failure	X	X	X
Operation in semi-closed mode	X	X	X
Properly execute the ascent procedures for an incapacitated dive buddy	X	X	X
Demonstrate controlled ascent with an incapacitated diver including surface tow at least 30 metres / 100 feet with equipment removal on surface, in water too deep to stand	X	X	X
Proper buddy contact and communication	X	X	X
Use of a line reel or spool to deploy an SMB from planned dive depth and while controlling buoyancy in the water column	X	X	X
Proper management of line reel or spool, and SMB during ascents and safety or required stops	X	X	X
Demonstrate the ability to maintain minimum loop volume	X	X	X
Demonstrate comfort swimming on surface and at depth carrying a single bailout/decompression cylinder/bailout rebreather	X		
Demonstrate ability to pass and retrieve a single bailout/decompression cylinder or bailout rebreather while maintaining position in the water column	X		
Demonstrate ability to pass and retrieve multiple bailout/decompression cylinders or bailout rebreather while maintaining position in the water column	IA	X	X
Demonstration of the ability to perform simulated decompression stops at pre-determined depths for scheduled times	X	X	X
Demonstration of the ability to perform decompression stops at pre-determined depths for scheduled times	X	X	X
Demonstrate competence managing multiple bailout cylinders, including drop and recovery while maintaining position in the water column	IA	X	X
Demonstrate appropriate reaction to simulated free-flowing deco regulator	X	X	X
Gas share of deco gas for at least 1 minute	X	X	X
Demonstrate oxygen rebreather mode at appropriate stop depth		X	X
Complete bailout scenarios from depth to include	X	X	X

decompression obligation on open circuit				
Written Evaluation		X	X	X
Supervised Rebreather Dives		X	X	X
Minimum Underwater Requirements				
	Pool/Confined Water	Openwater		Supervised Dives**
Deco	1 Dive / 60 min	7 Dives / 420 min*		4 Dives / 240 min.*
Mixed Gas	1 Dive / 60 min	7 Dives / 420 min*		4 Dives / 240 min.*
Hypoxic Mixes		7 Dives / 420 min		4 Dives / 240 min.
*If Deco and Mixed Gas training are done concurrently, a minimum of three mixed gas dives for a minimum cumulative time of 180 minutes must be conducted; a minimum of 4 supervised dives is required				
**A minimum of three supervised dives should comply with certification parameters				

B. Rebreather Crossover Training

1. Crossover training to a new rebreather platform requires a minimum of 4 training dives for a minimum cumulative dive time of 240 min.
2. Advanced level certification on a new rebreather platform may be awarded upon successful demonstration of required skills using the new platform

APPENDIX 1

DIVING MEDICAL EXAM OVERVIEW FOR THE EXAMINING PHYSICIAN

TO THE EXAMINING PHYSICIAN:

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

Diving Safety Officer	Date
Jason S Herum	(707) 875-2032
Printed Name	Phone Number

Scuba and other modes of compressed-gas diving can be strenuous and hazardous. A special risk is present if the middle ear, sinuses, or lung segments do not readily equalize air pressure changes. The most common cause of distress is eustachian insufficiency. Recent deaths in the scientific diving community have been attributed to cardiovascular disease. Please consult the following list of conditions that usually restrict candidates from diving. (Adapted from Bove, 1998: bracketed numbers are pages in Bove)

CONDITIONS WHICH MAY DISQUALIFY CANDIDATES FROM DIVING

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

SELECTED REFERENCES IN DIVING MEDICINE

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

- Elliott, D.H. ed. 1996. *Are Asthmatics Fit to Dive?* Kensington, MD: Undersea and Hyperbaric Medical Society.
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- NOAA DIVING MANUAL, NOAA. Superintendent of Documents. Washington, DC: U.S. Government Printing Office.
- U.S. NAVY DIVING MANUAL. Superintendent of Documents, Washington, DC: U.S. Government Printing Office, Washington, D.C.

APPENDIX 2
AAUS MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING REPORT

Name of Applicant (Print or Type)

Date of Medical Evaluation (Month/Day/Year)

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

TESTS: THE FOLLOWING TESTS ARE REQUIRED:

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

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

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

- Chest x-ray (Required only during first exam over age 40)
- Resting EKG
- Assessment of coronary artery disease using Multiple-Risk-Factor Assessment¹
(age, lipid profile, blood pressure, diabetic screening, smoking)
Note: Exercise stress testing may be indicated based on Multiple-Risk-Factor Assessment²

PHYSICIAN'S STATEMENT:

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

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

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

_____ MD or DO _____
Signature Date

Name (Print or Type)

Address

Telephone Number

E-Mail Address

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

My familiarity with diving medicine is: _____

APPENDIX 2b
AAUS MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING REPORT
APPLICANT'S RELEASE OF MEDICAL INFORMATION FORM

Name of Applicant (Print or Type) _____

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

Signature of Applicant _____

Date _____

REFERENCES

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

APPENDIX 3 DIVING MEDICAL HISTORY FORM

(To Be Completed By Applicant-Diver)

Name _____ Sex ____ Age ____ Wt. ____ Ht. ____

Sponsor _____ Date ____/____/____
(Dept./Project/Program/School, etc.) (Mo/Day/Yr)

TO THE APPLICANT:

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

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

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

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

	Yes	No	Please indicate whether or not the following apply to you	Comments
18			Wear glasses or contact lenses	
19			Bleeding disorders	
20			Alcoholism	
21			Any problems related to diving	
22			Nervous tension or emotional problems	
23			Take tranquilizers	
24			Perforated ear drums	
25			Hay fever	
26			Frequent sinus trouble, frequent drainage from the nose, post-nasal drip, or stuffy nose	
27			Frequent earaches	
28			Drainage from the ears	
29			Difficulty with your ears in airplanes or on mountains	
30			Ear surgery	
31			Ringing in your ears	
32			Frequent dizzy spells	
33			Hearing problems	
34			Trouble equalizing pressure in your ears	
35			Asthma	
36			Wheezing attacks	
37			Cough (chronic or recurrent)	
38			Frequently raise sputum	
39			Pleurisy	
40			Collapsed lung (pneumothorax)	
41			Lung cysts	
42			Pneumonia	
43			Tuberculosis	

	Yes	No	Please indicate whether or not the following apply to you	Comments
44			Shortness of breath	
45			Lung problem or abnormality	
46			Spit blood	
47			Breathing difficulty after eating particular foods, after exposure to particular pollens or animals	
48			Are you subject to bronchitis	
49			Subcutaneous emphysema (air under the skin)	
50			Air embolism after diving	
51			Decompression sickness	
52			Rheumatic fever	
53			Scarlet fever	
54			Heart murmur	
55			Large heart	
56			High blood pressure	
57			Angina (heart pains or pressure in the chest)	
58			Heart attack	
59			Low blood pressure	
60			Recurrent or persistent swelling of the legs	
61			Pounding, rapid heartbeat or palpitations	
62			Easily fatigued or short of breath	
63			Abnormal EKG	
64			Joint problems, dislocations or arthritis	
65			Back trouble or back injuries	
66			Ruptured or slipped disk	
67			Limiting physical handicaps	
68			Muscle cramps	
69			Varicose veins	

	Yes	No	Please indicate whether or not the following apply to you	Comments
70			Amputations	
71			Head injury causing unconsciousness	
72			Paralysis	
73			Have you ever had an adverse reaction to medication?	
74			Do you smoke?	
75			Have you ever had any other medical problems not listed? If so, please list or describe below;	
76			Is there a family history of high cholesterol?	
77			Is there a family history of heart disease or stroke?	
78			Is there a family history of diabetes?	
79			Is there a family history of asthma?	
80			Date of last tetanus shot? Vaccination dates?	

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

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

Signature

Date

APPENDIX 4

RECOMMENDED PHYSICIANS WITH EXPERTISE IN DIVING MEDICINE

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

1. Karega Paisley, M.D.
Name
Occupational Health Services
Address
University of California, Davis

(530) 752-6051 (530) 797-6691
Telephone urgent/emergencies

2. Thomas March, M.D.
Name
Dignity Health Medical Foundation - Woodland Memorial Hospital
Address
632 W Gibson Rd. Woodland, CA 95695

(530) 668-2600 (530) 666-1631
Telephone

APPENDIX 5

DEFINITION OF TERMS

AAUS - American Academy of Underwater Sciences.

Air sharing - The sharing of an air supply between divers

ATA - Atmospheres Absolute, defined as the total pressure exerted on an object, by a gas or gases, at a specific depth or elevation, including normal atmospheric pressure. One atmosphere is equal to one Bar (14.7 pounds per square inch) or 10 meters (33 feet) seawater.

ATM - abbreviation for atmospheres

Bounce Dive - A dive of relatively short duration. Generally less than 10 minutes.

Bottom Time - The total elapsed time measured in minutes from the time when the diver leaves the surface in descent to the time that the diver arrives at a safety or decompression stop, or if no stop is made, at the surface.

Breath-hold Diving - A diving mode in which the diver uses no self-contained or surface-supplied air or oxygen supply. Also known as snorkeling or free diving.

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

Buddy Diver - Second member of the dive team.

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

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

Certified Diver - A diver who holds a recognized valid certificate from a member organization or recognized certifying agency.

CNS - Central Nervous System

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

Cylinder - A pressure vessel for the storage of gases. Also referred to as a tank or bottle.

DCB - Diving Control Board.

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

Decompression Illness - A condition with a variety of symptoms which may result from gas and bubbles in the tissues of divers after pressure reduction as in a return to the surface, or ascent in elevation after diving.

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

DIT - Diver-in-training.

Dive - An underwater diving activity utilizing compressed gas.

Dive Location - A surface or vessel where a diving operation is conducted.

Dive Location Reserve Breathing Gas - A supply of air or mixed gas (as appropriate) at the dive location which is independent of the primary air and sufficient to support divers during a planned or unplanned decompression dive.

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

Dive Team - Divers and support individuals who are exposed to or control the exposure of others to pressure conditions. (In water or in a chamber.)

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

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

Diver-Carried Reserve Breathing Gas - A supply of air independent of the primary air source carried by the diver consisting of air or mixed gas (as appropriate) sufficient under standard operating conditions to allow the diver to reach the surface, other breathing gas supply or another diver. Such as a pony or bail-out bottle.

Diving Mode - A type of diving requiring specific equipment, procedures, and techniques, (i.e., snorkeling, scuba, surface-supplied air, or mixed gas).

Diving Control Board - or DCB. The group of individuals who act as the official representative of UC Davis in matters concerning the scientific diving program. (see Section 1.31)

Diving Safety Officer - The individual responsible for the safe conduct of the scientific diving program of the University of California, Davis (see Section 1.32)

DSO - Diving Safety Officer.

Emergency Ascent - An ascent made under emergency conditions where the diver may exceed the normal ascent rate.

EAD - Equivalent Air Depth (see below)

Nitrox - A breathing gas mix of air and oxygen in which the percent of oxygen exceeds 21%. Also called "Nitrox."

Equivalent Air Depth - The depth at which air will have the same nitrogen partial pressure as the Nitrox mixture being used. This number, expressed in feet of fresh or seawater, will always be less than the actual physical depth for any nitrox mixture.

FO₂ - Fraction of Oxygen - The percent by volume of oxygen present in a gas.

FFW - Feet of freshwater, or equivalent static head.

FSW - Feet of seawater, or equivalent static head.

Hookah Diving - A type of surface-supplied diving where there is no helmet worn and no voice communication with the surface. The diver uses a dive mask and air is supplied by a surface hose to a standard regulator second stage.

Hyperbaric Chamber - See decompression chamber.

Hyperbaric Conditions - Pressure conditions in excess of normal atmospheric pressure at the dive location, or in a decompression chamber.

Lead Diver - The scientific certified diver with experience and training to conduct the diving operations.

Maximum Operating Depth - The depth for any given gas mix, at which the partial pressure of oxygen in that mix is equal to 1.45 ATA.

Maximum Working Pressure - The maximum pressure to which a pressure vessel may be exposed under standard operating conditions.

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

MFW - Meters of freshwater or equivalent static head.

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

MOD - Maximum Operating Depth.

MSW - Meters of seawater or equivalent static head.

Nitrox - A gas mixture of nitrogen (or air) and oxygen. For use within the context of this Diving Safety Manual, the mixture will have a lower percent concentration of nitrogen than air (78.05%).

NOAA - National Oceanic and Atmospheric Administration

No-Decompression limits - The depth-time limits of the “no-decompression limits and repetitive dive group designations table for no-decompression air dives” of the U.S. Navy Diving Manual or equivalent limits.

Normal Ascent - An ascent made with an adequate air supply at a rate of 40 feet per minute or less.

Oxygen Toxicity - Any adverse reaction of the central nervous system (acute oxygen toxicity) or lungs (pulmonary oxygen toxicity) brought on by exposure to an increased (above atmospheric levels) partial pressure of oxygen.

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

Pressure Vessel - See cylinder.

psi - A unit of pressure: “pounds per square inch.”

Psig - pounds per square inch gauge.

Recompression Chamber - see decompression chamber.

Research Diving - All diving performed by individuals necessary to and part of scientific, research, or educational activity, in conjunction with a project or study under the jurisdiction of any public or private research or educational institution or similarly recognized organization, department, or group.

Scientific Diving - All diving performed by individuals necessary to and part of scientific, research or educational activity, in conjunction with a project or study under the jurisdiction of any public or private research or educational institution or similarly recognized organization, department, or group.

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

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

Surface Supplied Diving - A diving mode in which the diver in the water is supplied by hoses from the dive location with compressed gas for breathing, and wears a diving helmet complete with communications to the surface.

Swimming Ascent - An ascent which can be done under normal conditions accomplished by simply swimming to the surface.

Treatment Table - A depth-time and breathing gas profile designed to treat decompression sickness or air embolism in a hyperbaric chamber.

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

U.S.P. - United States Pharmacopoeia, American Medical Association.

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

Working Pressure - The normal pressure at which the system is designed to operate safely.

APPENDIX 6

AAUS REQUEST FOR DIVING RECIPROCITY FORM
VERIFICATION OF DIVER TRAINING AND EXPERIENCE

Diver: _____

Date: _____

This letter serves to verify that the above listed person has met the training and pre-requisites as indicated below, and has completed all requirements necessary to be certified as a (Scientific Diver / Diver in Training) as established by the (Organizational Member) Diving Safety Manual, and has demonstrated competency in the indicated areas. (Organizational Member) is an AAUS OM and meets or exceeds all AAUS training requirements.

The following is a brief summary of this diver's personnel file regarding dive status at

(Date)
_____ Original diving authorization
_____ Written scientific diving examination
_____ Last diving medical examination Medical examination expiration date _____
_____ Most recent checkout dive
_____ Scuba regulator/equipment service/test
_____ CPR training (Agency) _____ CPR Exp. _____
_____ Oxygen administration (Agency) _____ O2 Exp. _____
_____ First aid for diving _____ F.A. Exp.

_____ Date of last dive _____ Depth
Number of dives completed within previous 12 months? _____ Depth Certification _____ fsw
Total number of career dives? _____

Any restrictions? (Y/N)_____ if yes, explain:

Please indicate any pertinent specialty certifications or training:

Emergency Information:

Name: Relationship:
Telephone: (work) (home)
Address:

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

Diving Safety Officer:

(Signature) _____ (Date) _____
(Print) _____

APPENDIX 6A
AAUS CHECKOUT DIVE AND TRAINING EVALUATION

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

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

Additional Training (optional)

- _____ Compressor/Fill station orientation and usage
- _____ Small boat handling

APPENDIX 7

UC DAVIS DIVING EMERGENCY MANAGEMENT PROCEDURES

Introduction

A diving accident victim could be any person who has been breathing compressed gas underwater regardless of depth. It is essential that emergency procedures are pre-planned and that medical treatment be initiated as soon as possible. It is the responsibility of each dive project lead diver or dive supervisor to develop procedures for diving emergencies including evacuation and medical treatment for each dive location.

General Procedures

Depending on, and according to, the nature of the diving accident, stabilize the patient, administer 100% oxygen, contact local Emergency Medical System (EMS) for transport to medical facility, contact diving accident coordinator as appropriate. Explain the circumstances of the dive incident to the 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 treatment may be necessary.

1. Make appropriate contact with victim, rescue as required.
2. Establish ABCs (Airway, Breathing, Circulation) as required.
3. Call local Emergency Medical System (911 in the most of US) for transport to nearest medical treatment facility.
4. Administer 100% oxygen, if appropriate (in suspected cases of decompression illness, barotrauma, shock, or near drowning).
5. Call UC Davis Occupational Health at (530) 797-6691 for advice and to coordinate possible hospital to chamber transportation. They will need to know: Destination of the ambulance, telephone number at the ambulance's destination, patient's signs and symptoms, first aid administered, patient's name, age, sex, usual physical condition, what happened and any contributing factors involved or suspected.
6. Contact DSO Jason Herum (work 707-875-2032, cell 707-774-5052) or his designee.
7. If the injured person is diving under UC Davis auspices, a report must also be made to UCD's Workman's Compensation carrier within 24 hours. Report to your Department Personnel Manager. At BML contact (707) 875-2011, Fax (707) 875-2009.
8. Complete and submit AAUS Incident Report Form (Appendix 8 of the Diving Safety Manual) to the UCD Diving Control Board (As required in Section 2.72).

List additional emergency contact numbers appropriate for dive location:

(See Appendix 7A and 7B for local emergency contact information)

Divers Alert Network (DAN) 24 hour EMERGENCIES (919) 684-9111

DAN non-emergency medical information (919) 684-2948 or 1-800-446-2671

DAN Website www.diversalertnetwork.org

**APPENDIX 7A
BODEGA MARINE LABORATORY
EMERGENCY SERVICES CONTACT INFORMATION**

Sonoma/Mendocino counties Emergency Medical Services, (EMS) Standards.....	911
Sheriff Department Dispatch (cell phone)	(707) 565-2121
Bodega Bay Fire Department, (Paramedics)	(707) 875-3700 or 567-1365 or 911
Palm Drive Hospital, 501 Petaluma Ave, Sebastopol (nearest).....	(707) 823-8511
Memorial Hospital, 1165 Montgomery Dr, Santa Rosa (Helicopter destination)	(707) 546-3210
Sonoma Medical West Center, 501 Petaluma Ave, Sebastopol (nearest)	(707) 823 -8511
UC Davis Occupational Health Services	(530) 752-6051
Dr. Karega Paisley, MD (UCD Diving Physician, Lifeflight Coordinator)	(530) 797-6691
.....	kpaisley@ucdavis.edu
Lifeflight (UCD Med Center helicopter -- Hospital to Chamber transport)	1-800-862-5433
Jason Herum, (DSO). ..	Office (707) 875-2032
.....	jsherum@ucdavis.edu Cell (707) 774-5052
UCD Police Department Emergency hotline	1-800-4 UCDAVIS or 1-800-482-2847
Hyperbaric Treatment Chambers:	
Travis AFB, business hours	(707) 423-3987
Travis AFB; Weekends, after hours.....	(707) 423-3829
Pacific Grove - Monterey area	(831) 375-3147
Divers Alert Network (DAN) - General & medical information	(919) 684-2948
DAN --- 24 hour EMERGENCIES	(919) 684-9111
DAN Website	www.diversalertnetwork.org
DAN Fax.....	(919) 490-6630
US Coast Guard Station Bodega Bay	(707) 875-3596
USCG VHF radio frequency	Channel 16
Doran Beach County Park Ranger Station.....	(707) 875-3540
Salt Pt State Park Ranger Station	(707) 847-3221
Ft Ross Ranger Station.. ..	(707) 847-3286
BML research vessel VHF radio call sign (channel 16)	WTV 3405

Report any diving-related accident and/or injury to the DSO and Dr. Paisley immediately.

Dive teams must have an oxygen unit and first aid kit available.

Oxygen units and a small first aid kit are stored in Room 200, the Dive Locker.

Research vessels must have a VHF radio, or some other form of communication with shore, and all other USCG, State & UC required safety equipment on board when underway.

**APPENDIX 7B
LAKE TAHOE EMERGENCY SERVICES
CONTACT INFORMATION
RESEARCH DIVING PROGRAM
TAHO ENVIRONMENTAL RESEARCH CENTER**

EMERGENCY SERVICES CONTACT INFORMATION

Tahoe Basin emergency medical services (EMS).....	911
Give exact location of accident	
Truckee EMS	911
Truckee-Tahoe Medical Group (nearest) 24 hours	(530) 581-8864
Tahoe Forest Hospital (in Truckee) 24 hours	(530) 587-6011 or 800-733-9953
UC Davis Occupational Health Services	(530) 752-6051
Dr. Karega Paisley, MD (UCD Diving Physician, Lifeflight Coordinator)	(530) 797-6691
.....	kpaisley@ucdavis.edu
Life flight (Hospital to Chamber Transportation).....	1-800-862-5433
Hyperbaric Treatment Chamber - Travis Air Force Base:	
Weekdays, 8:00 - 5:00	707 423-3987
Weekends & after hours.....	423-3828
Divers Alert Network (DAN) - General & medical information	(919) 684-2948
DAN --- 24 hour EMERGENCIES	(919) 684-9111
DAN Website	www.diversalertnetwork.org
US Coast Guard Station, Lake Tahoe	(530) 583-4433
UCSG VHF radio frequency	Channel 16
TERC – Field Lab Director, Brant Allen. (530) 604-6551, cell (530) 582-5794 hm, bcallen@ucdavis.edu	
TERC – Director, Geoff Schladow.....	(530) 902-2272 gschladow@ucdavis.edu
TRG Research Vessel Descriptions:	
R/V John Le Conte -	37' aluminum cabin/hull with 'A' frame # CF 1288 XS Radio Call Sign WYK 3721
R/V Bob Richards -	27' aluminum cabin/hull (Munson) # CF 9519 XS

There is an oxygen unit at the Tahoe City Hatchery scuba locker and it must be taken to all dive sites and returned to the hatchery after use. Each vessel contains a small first aid kit.

APPENDIX 9

AMERICAN ACADEMY OF UNDERWATER SCIENCES GUIDELINES FOR USE OF DIVE COMPUTERS

Dive computer users must demonstrate to the DSO that they have read the dive computer owners manual and understand how to use the instrument, including dealing with unexpected electronics failure.

From AAUS Dive Computer Workshop. Lang & Hamilton (Eds.) USC Sea Grant Program, Los Angeles, CA 1989.

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

APPENDIX 10

AAUS 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 (AAUS) that the ultimate responsibility for safety rests with the individual diver.

The time has come to encourage divers to slow their ascents. In accordance with recommendations of the AAUS, a stop during ascent should be made in the 25 to 15-foot depth range on every dive, especially those approaching zero decompression limits or any dive over the 50-foot depth.

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, weighing and a controlled ascent, including a “hovering” stop.
4. Ascent rates shall not exceed 40 fsw per minute.
5. A stop in the 10-30 fsw zone for 3-5 minutes is recommended on every dive.
6. When using a dive computer or tables, non-emergency ascents are to be at the rate specified for the system being used.
7. Each diver shall have instrumentation to monitor ascent rates.
8. Divers using dry suits shall have training in their use.
9. Dry suits shall have a hands-free exhaust valve.
10. BC’s shall have a reliable rapid exhaust valve which can be operated in a horizontal swimming position.
11. A buoyancy compensator is required with dry suit use for ascent control and emergency flotation.
12. Breathing 100% oxygen above water is preferred to in-water air procedures for omitted decompression.

APPENDIX 11

REPETITIVE DIVING WORKSHOP

Michael A. Lang and Richard D. Vann, Co-Chairs
March 18-19, 1991
Duke University Medical Center, NC

Co-Sponsors:
American Academy of Underwater Sciences
Divers Alert Network and Duke University Medical Center
NOAA
DEMA
Association of Diving Contractors

Repetitive Diving Recommendations

Although diving is a relatively safe activity, all persons who dive must be aware that there is an inherent risk to this activity. Currently, the risk of decompression illness in the United States is estimated at 1-2 incidents per 1,000-2,000 dives for the commercial diving sector, 2 incidents per 10,000 dives for recreational diving activities and 1 incident in 100,000 dives for the scientific diving community.

Scientific Diving, Glen H. Egstrom, Moderator.

1. The position of recommending slower ascent rates seems to have gained support.
2. Increasing knowledge regarding the incidence of DCS indicates that our ability to predict the onset of DCS on multi-level, multi-day diving is even less sensitive than our ability to predict DCS on single square dives.
3. Although there is little evidence supporting either a pro or con position on multi-level, multi-day dives and a higher probability of DCS, there is sufficient evidence to encourage additional research on the problem.
4. There appears to be good evidence that there are many variables which can affect the probability of the occurrence of DCS symptoms. The ability to mitigate these variables through education, good supervision and training appears to be possible in such variables as hydration, fitness, rate of ascent, fatigue et al. and should continue to be promoted. Divers are subject to a host of specific conditions which may increase risk if precautions are not taken.
5. There appears to be support for the use of nitrox nitrox and surface oxygen breathing in scientific diving where higher gas loadings are anticipated in multi-level, multi-day dives. Adequate technical support is fundamental.
6. Since there seems to be little likelihood that we can avoid all decompression illness in multi-level, multi-day diving, we should focus educational objectives on:
 - a. the development of an appreciation for the realities of risk for DCS;
 - b. encouraging maximal prevention strategies; and,
 - c. define, as clearly as possible, the conditions under which problems are known to occur.
7. There are techniques used in commercial diving applications which may be appropriate for some scientific diving applications which require unusual exposures.
8. The incidence of DCS in scientific diving appears to be about 1:100,000, in recreational diving at about 2:10,000 and in commercial diving at about 1:1,000-2,000. These levels are not unreasonable.

APPENDIX 12

REVERSE DIVE PROFILES WORKSHOP

Michael A. Lang and Charles E. Lehner
Co-Chairs
Smithsonian Institution
October 29 - 30, 1999

Co-Sponsors:
Smithsonian Institution
Divers Alert Network
American Academy of Underwater Sciences
Diving Equipment and Marketing Association
Dive Training Magazine

Workshop Findings

Historically neither the U.S. Navy nor the commercial sector have prohibited reverse dive profiles. Reverse dive profiles are being performed in recreational, scientific, commercial, and military diving. The prohibition of reverse dive profiles by recreational training organizations cannot be traced to any definite diving experience that indicates an increased risk of DCS. No convincing evidence was presented that reverse dive profiles within the no-decompression limits lead to a measurable increase in the risk of DCS.

Workshop Conclusion

We find no reason for the diving communities to prohibit reverse dive profiles for no-decompression dives less than 40 msw (130 fsw) and depth differentials less than 12 msw (40 fsw).

Note:

For full workshop proceedings contact DSO or the American Academy of Underwater Sciences at <http://www.aaus.org/>.

APPENDIX 13

AAUS STATISTICS COLLECTION CRITERIA ANDEFINITIONS

COLLECTION CRITERIA:

The "Dive Time in Minutes", "The Number of Dives Logged", and the "Number of Divers Logging Dives" will be collected for the following categories.

- Dive Classification
- Breathing Gas
- Diving Mode
- Decompression Planning and Calculation Method
- Depth Ranges
- Specialized Environments
- Incident Types

Dive Time in Minutes is defined as the surface to surface time including any safety or required decompression stops.

A Dive is defined as a descent into water, an underwater diving activity utilizing compressed gas, an ascent/return to the surface, and a surface interval of greater than 10 minutes.

Dives will not be differentiated as openwater or confined water dives. But openwater and confined water dives will be logged and submitted for AAUS statistics classified as either scientific or training/proficiency.

A "Diver Logging a Dive" is defined as a person who is diving under the auspices of your scientific diving organization. Dives logged by divers from another AAUS Organization will be reported with the divers home organization. Only a diver who has actually logged a dive during the reporting period is counted under this category.

Incident(s) occurring during the collection cycle. Only incidents occurring during, or resulting from, a dive where the diver is breathing a compressed gas will be submitted to AAUS.

DEFINITIONS:

Dive Classification:

- Scientific Dives: Dives that meet the scientific diving exemption as defined in 29 CFR 1910.402. Diving tasks traditionally associated with a specific scientific discipline are considered a scientific dive. Construction and trouble-shooting tasks traditionally associated with commercial diving are not considered a scientific dive.
- Training and Proficiency Dives: Dives performed as part of a scientific diver training program, or dives performed in maintenance of a scientific diving certification/authorization.

Breathing Gas:

- Air: Dives where the bottom gas used for the dive is air.
- Nitrox: Dives where the bottom gas used for the dive is a combination of nitrogen and oxygen other than air.
- Mixed Gas: Dives where the bottom gas used for the dive is a combination of oxygen, nitrogen, and helium (or other "exotic" gas), or any other breathing gas combination not classified as air or nitrox.

Diving Mode:

- Open Circuit Scuba: Dives where the breathing gas is inhaled from a self contained underwater breathing apparatus and all of the exhaled gas leaves the breathing loop.
- Surface Supplied: Dives where the breathing gas is supplied from the surface by means of a pressurized umbilical hose. The umbilical generally consists of a gas supply hose, strength member, pneumofathometer hose, and communication line. The umbilical supplies a helmet or full-face mask. The diver may rely on the tender at the surface to keep up with the divers' depth, time and diving profile.
- Hookah: While similar to Surface Supplied in that the breathing gas is supplied from the surface by means of a pressurized hose, the supply hose does not require a strength member, pneumofathometer hose, or communication line. Hookah equipment may be as simple as a long hose attached to a standard scuba cylinder supplying a standard scuba second stage. The diver is responsible for the monitoring his/her own depth, time, and diving profile.
- Rebreathers: Dives where the breathing gas is repeatedly recycled in the breathing loop. The breathing loop may be fully closed or semi-closed. Note: A rebreather dive ending in an open circuit bailout is still logged as a rebreather dive.

Decompression Planning and Calculation Method:

- Dive Tables
- Dive Computer
- PC Based Decompression Software

Depth Ranges:

Depth ranges for sorting logged dives are 0-30, 31-60, 61-100, 101-130, 131-150, 151-190, and 191->. Depths are in feet seawater. A dive is logged to the maximum depth reached during the dive. Note: Only "The Number of Dives Logged" and "The Number of Divers Logging Dives" will be collected for this category.

Specialized Environments:

- Required Decompression: Any dive where the diver exceeds the no-decompression limit of the decompression planning method being employed.
- Overhead Environments: Any dive where the diver does not have direct access to the surface due to a physical obstruction.

- Blue Water Diving: Openwater diving where the bottom is generally greater than 200 feet deep and requiring the use of multiple-tethered diving techniques.
- Ice and Polar Diving: Any dive conducted under ice or in polar conditions. Note: An Ice Dive would also be classified as an Overhead Environment dive.
- Saturation Diving: Excursion dives conducted as part of a saturation mission are to be logged by "classification", "mode", "gas", etc. The "surface" for these excursions is defined as leaving and surfacing within the Habitat. Time spent within the Habitat or chamber shall not be logged by AAUS.
- Aquarium: An aquarium is a shallow, confined body of water, which is operated by or under the control of an institution and is used for the purposes of specimen exhibit, education, husbandry, or research. (Not a swimming pool)

Incident Types:

- Hyperbaric: Decompression Sickness, AGE, or other barotrauma requiring recompression therapy.
- Barotrauma: Barotrauma requiring medical attention from a physician or medical facility, but not requiring recompression therapy.
- Injury: Any non-barotrauma injury occurring during a dive that requires medical attention from a physician or medical facility.
- Illness: Any illness requiring medical attention that can be attributed to diving.
- Near Drowning/ Hypoxia: An incident where a person asphyxiates to the minimum point of unconsciousness during a dive involving a compressed gas. But the person recovers.
- Hyperoxic/Oxygen Toxicity: An incident that can be attributed to the diver being exposed to too high a partial pressure of oxygen.
- Hypercapnea: An incident that can be attributed to the diver being exposed to an excess of carbon dioxide.
- Fatality: Any death accruing during a dive or resulting from the diving exposure.
- Other: An incident that does not fit one of the listed incident types

Incident Classification Rating Scale:

- Minor: Injuries that the OM considers being minor in nature. Examples of this classification of incident would include, but not be limited to:
 - Mask squeeze that produced discoloration of the eyes.
 - Lacerations requiring medical attention but not involving moderate or severe bleeding.
 - Other injuries that would not be expected to produce long term adverse effects on the diver's health or diving status.
- Moderate: Injuries that the OM considers being moderate in nature. Examples of this classification would include, but not be limited to:

- DCS symptoms that resolved with the administration of oxygen, hyperbaric treatment given as a precaution.
 - DCS symptoms resolved with the first hyperbaric treatment.
 - Broken bones.
 - Torn ligaments or cartilage.
 - Concussion.
 - Ear barotrauma requiring surgical repair.
- Serious: Injuries that the OM considers being serious in nature. Examples of this classification would include, but not be limited to:
 - Arterial Gas Embolism.
 - DCS symptoms requiring multiple hyperbaric treatment.
 - Near drowning.
 - Oxygen Toxicity.
 - Hypercapnea.
 - Spinal injuries.
 - Heart attack.
 - Fatality.