

STANFORD UNIVERSITY DIVING SAFETY MANUAL

2002



**Hopkins Marine Station of Stanford University
Pacific Grove CA 93950**

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SECTION 1.00

GENERAL POLICY

1.10 STANFORD UNIVERSITY SCIENTIFIC DIVING STANDARDS

1.11 Purpose

In 1982, OSHA exempted scientific diving from commercial diving regulations (29 CFR Part 1910, Subpart T) under certain conditions which are outlined below in Sections 1.12 and 1.13. 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 scientific diving standard setting organization. The AAUS Standards for Scientific Diving (2001) have been used as minimal guidelines for the development of Stanford University's scientific diving standards.

The standards for diving safety, training, experience, and certification outlined in this manual are designed to ensure that all diving under the auspices of Stanford University is conducted in a manner that will maximize protection of divers from accidental injury and/or illness while furthering research and safety, and to allow a working reciprocity between Stanford University and other institutions with scientific diving programs whose standards meet or exceed those 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:
 - 1.13.5.1 Diving safety manual which includes at a minimum: Procedures covering all diving operations specific to the program; including procedures for emergency care, recompression and evacuation; and the criteria for diver training and certification.
 - 1.13.5.2 Diving control (safety) board, with the majority of its members being active scientific divers, which shall at a minimum have the authority to: approve and monitor diving projects, review and revise the diving safety manual, assure compliance with the manual, certify the depths to which a diver has been trained, take disciplinary action for unsafe

practices, and assure adherence to the buddy system (a diver is accompanied by and is in continuous contact with another diver in the water) for scuba diving.

1.14 Review of Standards

As part of Stanford University's annual report to the AAUS, any recommendations for modification of the AAUS standards shall be submitted to the AAUS for consideration.

1.15 Liability

By adopting the policies set forth in this manual, Stanford University assumes no liability not otherwise imposed by law. Diving activity under the auspices of Stanford University is considered to be voluntary and participation in such activity is not a condition to obtaining any academic degree, nor is it a condition of any employment at the University.

1.20 OPERATIONAL CONTROL

1.21 Stanford University Auspices Defined

For the purposes of these standards the auspices of Stanford University includes any operation in which the University is connected because of ownership of any equipment used, locations selected or relationship with the individual(s) concerned. This includes all cases involving the operations of employees of Stanford University or employees of auxiliary organizations, where such employees are acting within the scope of their employment, and the operations of students and other persons who are engaged in scientific diving associated with Stanford University research or coursework or are diving as members of a University-recognized organization. The administration of the local diving program will reside with Stanford University's Diving Control Board (DCB). The regulations herein shall be observed at all locations where scientific diving is conducted.

1.22 Stanford University's Scientific Diving Standards and Diving Safety Manual

The purpose of the Stanford University Diving Safety Manual is to provide for the development and implementation of policies and procedures that meet requirements of local environments and conditions as well as to comply with the scientific diving standards of the American Academy of Underwater Sciences. The Diving Safety Manual shall include, but not be limited to:

- 1.22.1 Scientific diving standards which use those of the AAUS as a set of minimal guidelines.
- 1.22.2 Emergency procedures which follow the standards of care of the community and must include procedures for evacuation, emergency medical treatment, and recompression for each dive location.
- 1.22.3 The criteria for diver training and certification.
- 1.22.4 Standards written or adopted by reference for each diving mode utilized which include the following:
 - 1.22.4.1 Safety procedures for the diving operation.
 - 1.22.4.2 Responsibilities of the dive team members.
 - 1.22.4.3 Equipment use and maintenance procedures.
 - 1.22.4.4 Emergency procedures.

1.23 The Diving Safety Officer

The Diving Safety Officer (DSO) serves as a member of the Diving Control Board. This person should have broad technical and scientific expertise in research-related diving.

1.23.1 Qualifications

- 1.23.1.1 Shall be appointed by the Director of Hopkins Marine Station or his/her designee, with the advice and counsel of the Diving Control Board.
- 1.23.1.2 Shall be trained as a scientific diver.
- 1.23.1.3 Shall be a full member as defined by the AAUS.
- 1.23.1.4 Shall be an active underwater instructor from a nationally recognized agency.

1.23.2 Duties and Responsibilities

- 1.23.2.1 Shall be responsible, through the DCB, to the Director of Hopkins Marine Station or his/her designee, for the conduct of the scientific diving program of Stanford University. The routine 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 of the membership organization, rests with the Diving Safety Officer.
- 1.23.2.2 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.
- 1.23.2.3 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.
- 1.23.2.4 Shall suspend diving operations which he/she considers to be unsafe or unwise.

1.24 The Diving Control Board

- 1.24.1 The Diving Control Board (DCB) shall consist of a majority of active scientific divers. Voting members shall include:
 - 1.24.1.1 The Diving Safety Officer.
 - 1.24.1.2 The Director of Hopkins Marine Station or his/her designee.
 - 1.24.1.3 A resident member of the Hopkins Marine Station faculty who shall serve as the DCB Chairperson.
 - 1.24.1.4 At least one other faculty or staff member who is an active scientific diver.
 - 1.24.1.5 At least one student representative who is an active scientific diver.
- 1.24.2 Has autonomous and absolute authority over the scientific diving program's operation.
- 1.24.3 Shall approve and monitor diving projects.

- 1.24.4 Shall review and revise the Diving Safety Manual.
 - 1.24.5 Shall assure compliance with the manual.
 - 1.24.6 Shall certify the depths to which a diver has been trained.
 - 1.24.7 Shall take disciplinary action for unsafe practices.
 - 1.24.8 Shall assure adherence to the buddy system for scuba diving.
 - 1.24.9 Shall act as Stanford University's official representative in matters concerning the scientific diving program.
 - 1.24.10 Shall act as a board of appeal to consider diver-related problems.
 - 1.24.11 Shall recommend the issue, reissue, or the revocation of diving certifications.
 - 1.24.12 Shall recommend changes in policy and amendments to the AAUS Standards and Stanford University's Diving Safety Manual as the need arises.
 - 1.24.13 Shall establish and/or approve training programs through which the applicants for certification can satisfy the requirements of Stanford University's Diving Safety Manual.
 - 1.24.14 Shall suspend diving programs which it considers to be unsafe or unwise.
 - 1.24.15 Shall establish criteria for equipment selection and use.
 - 1.24.16 Shall recommend new equipment or techniques.
 - 1.24.17 Shall establish and/or approve facilities for the inspection and maintenance of diving and associated equipment.
 - 1.24.18 Shall ensure that any University-controlled air station(s) meet air quality standards as described in Section 3.60 of this manual.
 - 1.24.19 Shall periodically review the Diving Safety Officer's performance and program.
 - 1.24.20 Shall sit as a board of investigation to inquire into the nature and cause of diving accidents or violations of Stanford University's Diving Safety Manual.
- 1.25 Instructional Personnel
- 1.25.1 Qualifications - All personnel involved in diving instruction under the auspices of Stanford University shall be qualified for the type of instruction being given.
 - 1.25.2 Selection - Instructional personnel will be selected by the Director of Hopkins Marine Station or his/her designee, who will solicit the advice of the DCB in conducting preliminary screening of applicants for instructional positions.

1.26 Lead Diver

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

- 1.26.1 Coordination with other known activities in the vicinity which are likely to interfere with diving operations.

- 1.26.2 Ensuring all dive 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
- 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 on:
 - 1.26.5.1 Dive objectives.
 - 1.26.5.2 Unusual hazards or environmental conditions likely to affect the safety of the diving operation.
 - 1.26.5.3 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 symptoms of pressure-related injuries.

1.27 Reciprocity And Visiting Scientific Diver

- 1.27.1 If any Stanford University scientific diver is engaged jointly in diving activities or in the use of diving resources with any diver(s) of another AAUS organizational member, the DCB of one of the participating institutions must be designated to govern the joint dive project. Stanford divers shall inform the Stanford DSO of their intent to dive with non-Stanford scientific divers so that the DSO of the other institution may be contacted.
- 1.27.2 A scientific diver from another AAUS member institution wishing to apply for permission to dive under the auspices of Stanford shall submit to Stanford's DSO a document containing all the information described in Appendix 9 ("letter of reciprocity") signed by his/her DSO or designee. A Stanford scientific diver wishing to dive with another AAUS member institution should request that the Stanford DSO or designee send a letter of reciprocity to the DSO of the institution he/she is planning to visit.
- 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 10 (checkout dive).
- 1.27.4 If the Stanford University Diving Control Board denies a visiting scientific diver permission to dive, it shall inform the visitor and his/her Diving Control Board of the reason(s) for refusal.

1.28 Waiver of Requirements

The 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 the regulations of Stanford University's Diving Safety Manual (except as stated in Section 2.34) may be cause for the revocation or restriction of the diver's scientific diving certificate by action of the Diving Control Board.

1.30 CONSEQUENCES OF VIOLATION OF AAUS REGULATIONS

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

1.40 RECORD MAINTENANCE

The Diving Safety Officer or his/her 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 Diving Control Board, and other pertinent information deemed necessary.

1.40.1 Availability of Records:

- 1.40.1.1 Medical records shall be available to the attending physician of a diver or former diver when released in writing by the diver.
- 1.40.1.2 Records and documents required by this standard shall be retained for the following period:
 - 1.40.1.2.1 Physician's written reports of medical examinations for divers -5 years.
 - 1.40.1.2.2 Manual for diving safety - current document only.
 - 1.40.1.2.3 Records of dive - 1 year, except 5 years where there has been an incident of pressure-related injury.
 - 1.40.1.2.4 Pressure-related injury assessment - 5 years.
 - 1.40.1.2.5 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 Stanford University's scientific diving program unless he/she holds a current certification issued pursuant to the provisions of this manual.

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 the auspices of Stanford University, the lead diver (see Section 1.26) for a proposed operation must formulate a dive plan (see Appendix 8) which should include the following:

- 2.21.1 Divers qualifications, and the type of certificate or certification held by each diver.
- 2.21.2 Emergency plan with the following information:
 - 2.21.2.1 Name, telephone number, and relationship of person to be contacted for each diver in the event of an emergency.
 - 2.21.2.2 Nearest operational recompression chamber.
 - 2.21.2.3 Nearest accessible hospital
 - 2.21.2.4 Available means of transport
- 2.21.3 Approximate number of proposed dives.
- 2.21.4 Location(s) of proposed dives.
- 2.21.5 Estimated depth(s) and bottom time(s) anticipated.
- 2.21.6 Decompression status and repetitive dive plans, if required.
- 2.21.7 Proposed work, equipment, and boats to be employed.
- 2.21.8 Any hazardous conditions anticipated.

2.22 Pre-dive Safety Checks

- 2.22.1 Diver's Responsibility:
 - 2.22.1.1 Each scientific diver shall conduct a functional check of his/her diving equipment in the presence of the diving buddy or tender.
 - 2.22.1.2 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, AAUS standards, or Stanford University's Diving Safety Manual.

2.22.1.3 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.

2.22.1.4 No dive team member shall be permitted to dive for the duration of any known condition which is likely to adversely affect the safety and health of the diver or other dive members.

2.22.2 Equipment Evaluations

2.22.2.1 Each diver shall ensure that his/her equipment is in proper working order and that the equipment is suitable for the type of diving operation.

2.22.2.2 Each diver shall have the capability of achieving and maintaining positive buoyancy.

2.22.3 Site Evaluation - The environmental conditions at the site will be evaluated.

2.30 DIVING PROCEDURES

2.31 Solo Diving Prohibition

All diving activities shall assure adherence to the buddy system (two comparably equipped scuba divers in the water in constant communication) for scuba diving. This buddy system is based upon mutual assistance, especially in the case of an emergency.

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 him/her 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, AAUS standards, or Stanford University's Diving Safety Manual.

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 air source at the decompression station.

2.34 Emergencies and Deviation from Regulations

Any diver may deviate from the requirements of this manual to the extent necessary to prevent or minimize a situation which is likely to cause death, serious physical harm, or major environmental damage. A written report of such actions must be submitted to the 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 If any dive has been conducted beyond 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 hyperbaric chamber if necessary.

2.50 EMERGENCY PROCEDURES

All scientific divers and scientific divers-in-training shall follow the emergency procedures described in Appendix 11. Divers conducting scientific diving operations at locations not included in the local dive emergency plan shall note in their Dive Plan (Appendix 8) as per Section 2.21.2 the available emergency care facilities and appropriate emergency procedures at those sites.

2.60 FLYING AFTER DIVING

Divers should have a minimum surface interval of 12 hours after their last dive before ascending to altitude. A surface interval greater than 12 hours is recommended if repetitive and/or deep dives have been made over several days.

2.70 RECORD-KEEPING REQUIREMENTS

2.71 Stanford University Dive Log

Each Stanford University scientific diver or diver-in-training shall log every dive made under the auspices of Stanford University, and is encouraged to log all other dives. Stanford dive log forms are available from the DSO. Dive logs must be submitted to the DSO each month to be placed in each diver's file. Timely submission of logs is one of the requirements for maintaining active Scientific Diver status. Logs are due as soon as possible after the end of each month, and are considered late after the fifteenth of the next month. The DSO is responsible for maintaining Stanford University diving data and for submitting the data to the American Academy of Underwater Sciences annually. The Stanford University dive log form shall include at least the following:

- 2.71.1 Name of diver and buddies, with Lead Diver noted.
- 2.71.2 Date, time and location.
- 2.71.3 Diving modes used.
- 2.71.4 General nature of diving activities.
- 2.71.5 Approximate surface and underwater conditions.
- 2.71.6 Maximum depths, bottom time and surface interval time.
- 2.71.7 Diving tables or computers used.
- 2.71.8 Detailed report of any near or actual incidents.

2.72 Required Incident Reporting

All diving incidents requiring recompression treatment, or resulting in moderate or serious injury, or death shall be reported to Stanford University's Diving Control Board and the AAUS. Stanford University's regular procedures for incident reporting, including those required by the AAUS, shall be followed. The report will specify the circumstances of the incident and the extent of any injuries or illnesses. Additional information must meet the following reporting requirements:

- 2.72.1 Occupational injuries and illnesses shall be reported 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 with the record of the dive, for a period of 5 years:
 - 2.72.2.1 Complete AAUS Injury / Incident Report (Appendix 12).
 - 2.72.2.2 Written descriptive report to include:
 - 2.72.2.2.1 Name, address, phone numbers of the principal parties involved.
 - 2.72.2.2.2 Summary of experience of divers involved.
 - 2.72.2.2.3 Location, description of dive site and description of conditions that led up to incident.
 - 2.72.2.2.4 Description of symptoms, including depth and time of onset.
 - 2.72.2.2.5 Description and results of treatment.
 - 2.72.2.2.6 Disposition of case.
 - 2.72.2.2.7 Recommendations to avoid repetition of incident.
- 2.72.3 Any incident of pressure-related injury shall be investigated and documented and a report shall be prepared which is to be forwarded to the AAUS during the annual reporting cycle. This report must first be reviewed and released by the organizational member's Diving Control Board.

SECTION 3.00

DIVING EQUIPMENT

3.10 GENERAL POLICY

- 3.11 All equipment shall meet standards as determined by the Diving Safety Officer and the Diving Control Board. Equipment that is subjected to extreme usage under adverse conditions should require more frequent testing and maintenance.
- 3.12 All equipment shall be examined regularly by the person using it.

3.20 EQUIPMENT

3.21 Regulators

- 3.21.1 Approval - Only those makes and models specifically approved by the Diving Safety Officer and the Diving Control Board shall be used.
- 3.21.2 Inspection and testing - Scuba regulators shall be inspected and tested prior to first use and every twelve months thereafter.
- 3.21.3 Regulators will consist of a primary second stage and an alternate air source (such as an octopus second stage or redundant air supply).

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 and 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.

3.23 Scuba Cylinders

- 3.23.1 Scuba cylinders shall 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 DOT standards.
- 3.23.3 Scuba cylinders must have an internal inspection at intervals not to exceed twelve months.
- 3.23.4 Scuba cylinder valves shall be functionally tested at intervals not to exceed twelve months.

3.24 Backpacks

Backpacks without integrated flotation devices and weight systems shall have a quick release device designed to permit jettisoning with a single motion from either hand.

3.25 Gauges

Gauges shall be inspected and tested before first use and every twelve months thereafter.

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.
- 3.26.3 These devices shall be functionally inspected and tested at intervals not to exceed twelve months.

3.27 Timing Devices, Depth and Pressure Gauges

Each member of the dive team must have an underwater timing device, an approved depth indicator, and a submersible pressure gauge.

3.28 Determination of Decompression Status: Dive Tables, Dive Computers

- 3.28.1 A set of diving tables, approved by the Diving Control Board, must be available at each dive location.
- 3.28.2 Dive computers may be utilized in place of diving tables, and must be approved by the Diving Control Board.
- 3.28.3 See Appendix 13 for AAUS recommendations on dive computers.

3.30 AUXILIARY EQUIPMENT

3.31 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 and personnel trained in their use shall be available at every dive site.

3.42 Diver's Flag

A diver's flag shall be displayed prominently whenever diving is conducted under circumstances where required or where water traffic is probable.

3.43 Compressor Systems –University-Controlled

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 if equipped with a volume tank shall have a check valve on the inlet side, 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.

3.50 EQUIPMENT MAINTENANCE

3.51 Record Keeping

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:

- 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 Diving helmets
- 3.51.7 Submersible breathing masks
- 3.51.8 Compressors
- 3.51.9 Gas control panels
- 3.51.10 Air storage cylinders
- 3.51.11 Air filtration systems
- 3.51.12 Analytical instruments
- 3.51.13 Buoyancy control devices
- 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 University-controlled breathing air compressor at regular intervals of no more than 100 hours of operation or six months, whichever occurs first. The results of these tests shall be entered and maintained in a formal log.
- 3.52.2 A log shall be maintained showing operation, repair, overhaul, filter maintenance, and temperature adjustment for each compressor.

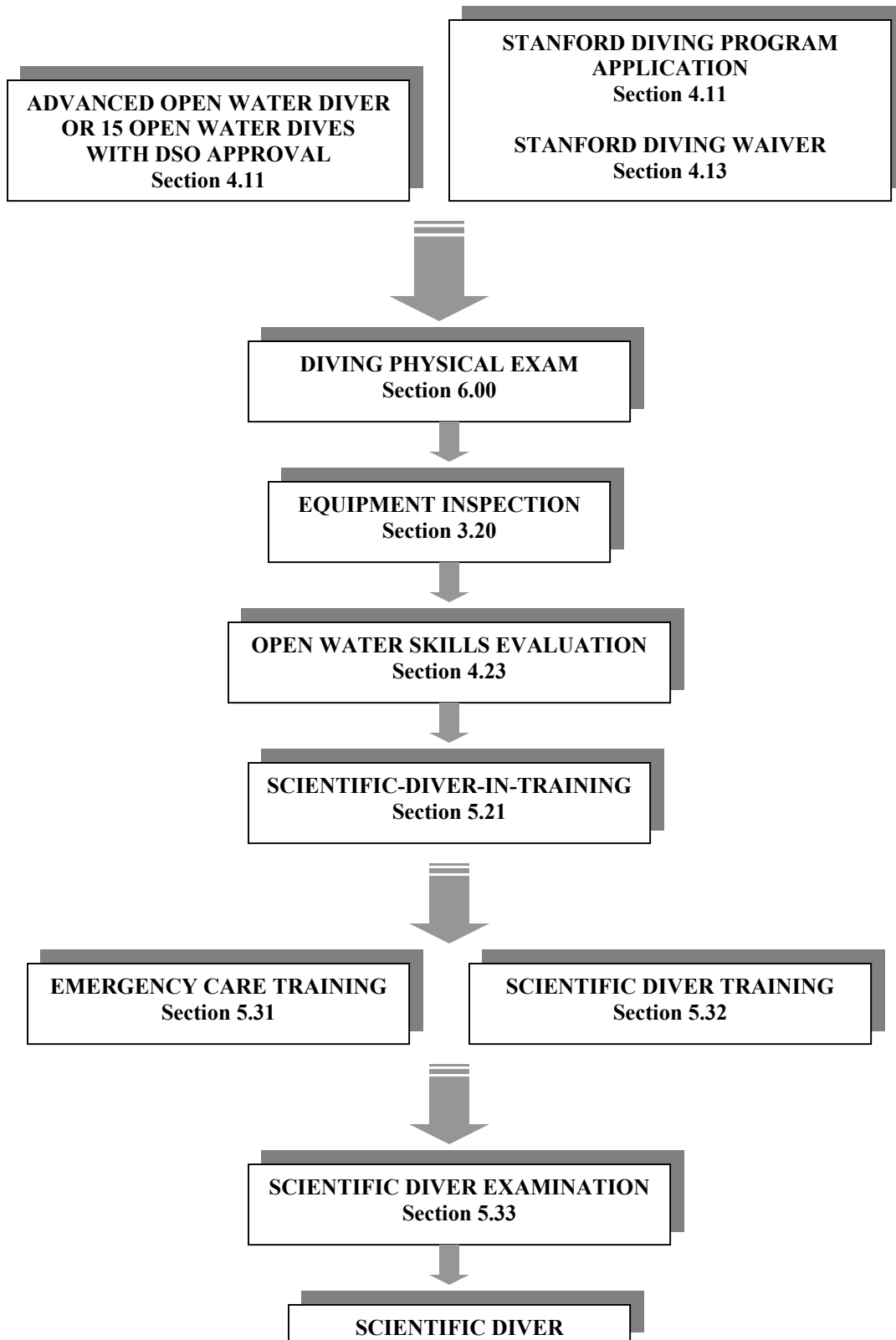
3.60 AIR QUALITY STANDARDS

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

CGA Grade E

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

STANFORD SCIENTIFIC DIVER TRAINING FLOW CHART



SECTION 4.00

ENTRY INTO STANFORD UNIVERSITY'S SCIENTIFIC DIVING PROGRAM

4.10 PREREQUISITES

4.11 Previous Diving Experience

The candidate may enter Stanford's scientific diving program with proof of diving certification by a nationally-recognized agency to the Advanced Open Water level or equivalent, or documentation of at least 15 open water dives, with Diving Safety Officer approval.

4.12 Application

The candidate shall complete and submit a Stanford Diving Program Application (Appendix 7).

4.13 Diving for Research or Coursework

The candidate should indicate to the DSO a valid need to dive for research or coursework. Recreational diving is not conducted under Stanford's auspices.

4.14 Waiver

The candidate shall file a Stanford University "Scuba Waiver Release and Indemnity Agreement" (Appendix 6) with the DSO before conducting any diving activity under the auspices of Stanford University.

4.15 Medical Examination

Before conducting any diving under the auspices of Stanford University the candidate shall be certified by a licensed physician to have passed a current diving physical examination meeting or exceeding AAUS standards and to be fit to engage in diving activities as may be limited or restricted in the medical evaluation report (See Section 6.00 and Appendices 1-4).

4.16 Equipment Examination

All equipment shall be examined and verified to meet standards as determined by the DSO and the DCB (see Section 3.20).

4.17 Open Water Skill Evaluation

In open-water, the candidate must demonstrate to the DSO or designated scientific diver his/her ability to perform the skills outlined in Appendix 10.

4.20 DIVER-IN-TRAINING LEVEL

Upon successful completion of the prerequisites outlined in Section 4.10 the diver is designated a "scientific diver-in-training" and is permitted to conduct scientific training dives under the auspices of Stanford University only in the presence of a currently-certified scientific diver on dives approved by the DSO.

SECTION 5.00

SCIENTIFIC DIVER CERTIFICATION

5.10 CERTIFICATION TYPES

5.11 Scientific Diver Certification

This is a permit to dive, usable only while it is current and for the purpose intended.

5.12 Temporary Diver Permit

This permit constitutes a waiver of the requirements of Section 5.00 and is issued only following a demonstration of the required proficiency in diving. It is valid only for a limited time, as determined by the Diving Safety Officer. This permit is not to be construed as a mechanism to circumvent existing standards set forth in this manual. Requirements of Sections 5.31 and 5.32 may be waived by the Diving Safety Officer if the person in question has demonstrated proficiency in diving and can contribute measurably to a planned dive. A statement of the temporary diver's qualifications shall be submitted to the Diving Safety Officer as a part of the dive plan. Temporary permits shall be restricted to the planned diving operation and shall comply with all other policies, regulations, and standards of this manual, including medical requirements.

5.20 GENERAL POLICY

No person shall engage in scientific diving under the auspices of Stanford University unless authorized by the DSO pursuant to the provisions of this manual. The following are considered minimal standards for a scientific diver certification:

5.21 Diver-in-Training Permit

This permit signifies that a diver has completed and been certified as at least an open water diver through a nationally- or internationally-recognized certifying agency and has met the requirements of Section 4.00.

5.22 Eligibility

Only a person diving under the auspices of Stanford University is eligible for scientific diver certification in Stanford's diving program. The certification is valid only as long as the diver is affiliated with Stanford.

5.23 Medical Examination

Each applicant for scientific diver certification shall submit a statement from a licensed physician, based on an approved medical examination, attesting to the applicant's fitness for diving (see Section 6.00 and Appendices 1 – 4)

5.30 REQUIREMENTS FOR SCIENTIFIC DIVER CERTIFICATION

Submission of documents and participation in aptitude examinations does not automatically result in certification. The candidate must convince the DSO and members of the DCB that he/she is sufficiently skilled and proficient to be certified. This skill will be acknowledged by the signature of the DSO. Any applicant who does not possess the necessary judgment under diving conditions may, for the safety of the diver and his/her partner, be denied Stanford University scientific diving privileges. Minimum documentation and examinations required are as follows:

5.31 Documents

5.31.1 Current medical approval

5.31.2 Proof of Diver-in-Training permit level or equivalent.

5.31.3 Proof of current (as determined by the certifying agency) training in the following:

5.31.3.1 Cardiopulmonary resuscitation (CPR)

5.31.3.2 Standard or basic first aid (details on training and curriculum are found in OSHA CPL 2-2.53 CFR1910.151)

5.31.3.3 Oxygen administration for diving emergencies

5.32 Training

The diver must complete additional theoretical aspects and practical training beyond the diver-in-training permit level for a minimum cumulative time of 100 hours.

5.32.1 Theoretical aspects should include principles and activities appropriate to the intended area of scientific study. Suggested topics may include, but are not limited to: cardiopulmonary resuscitation (CPR), diving first aid, oxygen administration, accident management, field neurological exam, dive rescue, recognition of DCS and AGE, data gathering techniques, collecting, common biota, behavior, installation of scientific apparatus, use of chemicals, site selection, site location and relocation, organism identification, ecology, tagging, photography, archaeology, scientific dive planning, coordination with other agencies, appropriate governmental regulations, AAUS scientific diving regulations, small boat operation, theoretical training in diving technology, specialized equipment to be used, blue water diving, diving in confined spaces, zero visibility diving, research vessel diving, aquarium diving, animal handling, polluted water diving, cold water diving, special gas mixes, decompression theory and its application.

5.32.2 Practical training shall include at least 12 supervised, DSO-approved open water dives in a variety of dive sites and diving conditions, to depths between 25 and 60 feet for a cumulative bottom time of 4 hours. No more than 3 of these dives shall be made in one day.

5.33 Examination

The candidate shall pass a written examination which includes questions on the following topics: physics and physiology of diving; diving equipment; proper use of dive tables and dive computers; diving rescue techniques and emergency management procedures; planning and supervision of scientific diving operations; causes, symptoms, treatment and prevention of diving-related injuries; Stanford diving safety manual; AAUS scientific diving standards.

5.40 DEPTH CERTIFICATIONS

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

5.41 Depth Certification Levels

5.41.1 Certification to 60 Foot Depth - This is the initial permit level. A diver may be certified to a depth of 60 feet upon the completion of requirements listed in Sections 4.00 and 5.30 as well as successfully completing, under supervision, 12 logged DSO-approved training dives to depths between 31 and 60 feet, for a minimum total time of 4 hours.

5.41.2 Certification to 100 and 130 Foot Depths - A diver holding a 60 foot certificate may be certified to depths of 100 and 130 feet respectively, by logging four DSO-approved dives near the maximum depth category with an active scientific diver certified to that depth category. These qualification dives shall be validated by the signature of two authorized individuals who are divers certified to at least the same depth. The diver shall also demonstrate proficiency in the use of the appropriate Decompression Tables.

5.41.3 Certification to Depths Over 130 Feet - A diver with a demonstrated need to dive to depths over 130 feet may be certified to depths of 150 and 190 feet after the completion of four dives near each depth. Dives shall be planned and executed under close supervision of a diver certified to this depth. The diver must also demonstrate a knowledge of the special problems of deep diving, and of special safety requirements.

5.42 Progression To Next Depth Level

A certified diver diving under the auspices of the organizational member may exceed his/her depth certification only if accompanied by a diver certified to a greater depth. Under these circumstances the diver may exceed his/her depth limit by one step.

5.50 CONTINUATION OF CERTIFICATE

5.51 Minimum Activity to Maintain Certification

During any 12 month period, each certified scientific diver must log a minimum of 12 dives. At least one dive must be logged near the maximum depth of the diver's certification during each 6 month period. Divers certified to 150 feet or deeper may satisfy these requirements with dives to 130 feet or over. Failure to meet these requirements may be cause for revocation or restriction of certification.

5.52 Re-qualification of Depth Certificate

Once the initial certification requirements of Sections 5.31 - 5.33 are met, divers whose depth certification has lapsed due to lack of activity may request to be re-qualified. Depending on the individual diver's circumstances, re-qualification dives may be required.

5.53 Medical Examination

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

5.60 REVOCATION OF CERTIFICATION

A diving certificate may be revoked or restricted for cause by the Diving Safety Officer 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 Diving Safety Officer 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 re-certification. 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 RECERTIFICATION

If a diver's certificate expires or is revoked, he/she may be re-certified after complying with such conditions as the Diving Safety Officer or the DCB may impose. The diver shall be given an opportunity to present his/her case to the DCB before conditions for re-certification are stipulated.

SECTION 6.00

MEDICAL STANDARDS

6.10 MEDICAL REQUIREMENTS

6.11 General

- 6.11.1 Stanford University's DSO shall determine that divers 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.
- 6.11.3 The diver should be free of any chronic disabling disease and be free of any conditions contained in the list of conditions for which restrictions from diving are generally recommended (See Section 6.15 and Appendix 1).

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, 2 years if over the age of 60), the DSO has obtained the results of that examination, and has reviewed and found them satisfactory.
- 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 examining physician shall be provided with a copy of the medical evaluation requirements of this standard (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 3).
- 6.14.2 Medical history (See Appendix 2)
- 6.14.3 Diving physical examination (Section 6.15 and Appendix 3).

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

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

6.16 Laboratory Requirements and Intervals for Diving Medical Evaluation

6.16.1 Initial examination under age 40:

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

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

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

6.16.3 Initial exam over age 40:

- Medical History
- Complete Physical Exam, emphasis on neurological and otological components
- Assessment of coronary artery disease using Multiple-Risk-Factor Assessment¹ (age, lipid profile, blood pressure, diabetic screening, smoker)
- Resting EKG
- Chest X-ray
- Spirometry
- Urinalysis
- Hematocrit or Hemoglobin
- Any further tests deemed necessary by the physician
(Exercise stress testing may be indicated based on risk factor assessment)²

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

- Medical History
- Complete Physical Exam, emphasis on neurological and otological components
- Assessment of coronary artery disease using Multiple-Risk-Factor Assessment¹ (age, lipid profile, blood pressure, diabetic screening, smoker)
- Resting EKG
- Urinalysis
- Hematocrit or Hemoglobin
- Any further tests deemed necessary by the physician
(Exercise stress testing may be indicated based on risk factor assessment)²

6.17 Physician's Written Report

6.17.1 After any medical examination relating to the individual's fitness to dive, the DSO 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. In any case other than approval, this will be reviewed by the DCB.

6.17.2 The DSO shall make a copy of the physician's written report available to the individual.

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

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

SECTION 7.00

NITROX DIVING GUIDELINES

The following guidelines address the use of nitrox by scientific divers under the auspices of an AAUS Organizational Member. Nitrox is defined for these guidelines as breathing mixtures composed predominately of nitrogen and oxygen, most commonly produced by the addition of oxygen or the removal of nitrogen from air.

7.10 PREREQUISITES

7.11 Eligibility

Only a certified Scientific Diver or Scientific Diver In Training (see AAUS Standards Sections 4.00 and 5.00) diving under the auspices of a member organization is eligible for authorization to use nitrox. After completion, review and acceptance of application materials, training and qualification as per Section 7.12 of these guidelines, an applicant will be authorized to use nitrox within his/her depth authorization, as specified in AAUS Standards Sec 5.40.

7.12 Application and Documentation

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

7.20 REQUIREMENTS FOR AUTHORIZATION TO USE NITROX

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

7.21 Training

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

7.22 Examinations

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

- 7.22.1 Written examinations covering the information presented in the classroom training session(s) (i.e., gas theory, oxygen toxicity, partial pressure determination, etc.)
- 7.22.2 Practical examinations covering the information presented in the practical training session(s) (i.e., gas analysis, documentation procedures, etc.)
- 7.22.3 Open water checkout dives, to appropriate depths, to demonstrate the application of theoretical and practical skills learned.

7.23 Minimum Activity to Maintain Authorization

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

7.30 NITROX TRAINING GUIDELINES

Training in these guidelines should be in addition to training for Diver-In-Training authorization (AAUS Standards Section 4.00). It may be included as part of training to satisfy the Scientific Diver training requirements (AAUS Standards Section 5.32).

7.31 Classroom Instruction

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

7.32 Practical Training

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

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

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

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

- 7.33.1 Function, care, use, and maintenance of equipment cleaned for nitrox use
- 7.33.2 Physical and physiological considerations of nitrox diving (ex.: O₂ and CO₂ toxicity)
- 7.33.3 Diving regulations and procedures as related to nitrox diving, either scuba or surface-supplied (depending on intended mode)
- 7.33.4 Given the proper information, calculation of:

- 7.33.4.1 Equivalent air depth (EAD) for a given fO₂ and actual depth
- 7.33.4.2 pO₂ exposure for a given fO₂ and depth
- 7.33.4.3 Optimal nitrox mixture for a given pO₂ exposure limit and planned depth
- 7.33.4.4 Maximum operational depth (MOD) for a given mix and pO₂ exposure limit
- 7.33.4.5 For nitrox production purposes, percentages/psi of oxygen present in a given mixture, and psi of each gas required to produce a fO₂ by partial pressure mixing
- 7.33.5 Decompression table and dive computer selection and usage
- 7.33.6 Nitrox production methods and considerations
- 7.33.7 Oxygen analysis
- 7.33.8 Nitrox operational guidelines (Section 7.40), dive planning, and dive station components
- 7.34 Open Water Dives

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

7.35 Surface-Supplied Training

All training as applied to surface-supplied diving (practical, classroom, and open water) will follow Stanford University's surface-supplied diving standards, including additions listed in Sections 7.21 and 7.22.

7.40 SCIENTIFIC NITROX DIVING REGULATIONS

7.41 Dive Personnel Requirements

- 7.41.1 Nitrox Diver In Training - A Diver In Training, who has completed the requirements of AAUS Standards Section 4.00 and the training and authorization sections of these guidelines, may be authorized by the DSO to use nitrox under the direct supervision of a Scientific Diver who also holds nitrox authorization. Dive depths should be restricted to those specified in the diver's authorization.
- 7.41.2 Scientific Diver - A Scientific Diver who has completed the requirements of AAUS Standards Section 5.00 and the training and authorization sections of these guidelines, may be authorized by the DSO to use nitrox. Depth authorization to use nitrox should be the same as those specified in the diver's authorization, as described in Section 5.40.
- 7.41.3 Lead Diver - On any dive during which nitrox will be used by any team member, the Lead Diver should be authorized to use nitrox, and hold appropriate authorizations required for the dive. Lead Diver authorization by the DSO and/or DCB for nitrox dives should occur as part of the dive plan approval process. In addition to responsibilities listed in Section 1.26, the Lead diver should:
 - 7.41.3.1 As part of the dive planning process, verify that all divers using nitrox on a dive are properly qualified and authorized

- 7.41.3.2 As part of the pre-dive procedures, confirm with each diver the nitrox mixture the diver is using, and establish dive team maximum depth and time limits, according to the shortest time limit or shallowest depth limit among the team members.
- 7.41.3.3 Reduce the maximum allowable pO₂ exposure limit for the dive team if on-site conditions so indicate (see Section 7.42.1.2).

7.42 Dive Parameters

7.42.1 Oxygen Exposure Limits

- 7.42.1.1 The inspired oxygen partial pressure experienced at depth should not exceed 1.6 ATA. All dives performed using nitrox breathing mixtures should comply with the current *NOAA Diving Manual* “Oxygen Partial Pressure Limits for ‘Normal’ Exposures”
- 7.42.1.2 The maximum allowable exposure limit should be reduced in cases where cold or strenuous dive conditions, or extended exposure times are expected. The DCB should consider this in the review of any dive plan application which proposes to use nitrox. The Lead Diver should also review on-site conditions and reduce the allowable pO₂ exposure limits if conditions indicate.
- 7.42.1.3 If using the equivalent air depth (EAD) method the maximum depth of a dive should be based on the oxygen partial pressure for the specific nitrox breathing mix to be used.

7.42.2 Bottom Time Limits

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

7.42.3 Decompression Tables and Gases

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

7.42.4 Nitrox Dive Computers

- 7.42.4.1 Dive Computers may be used to compute decompression status during nitrox dives. Manufacturers’ guidelines and operations instructions should be followed.

- 7.42.4.2 Use of Nitrox dive computers should comply with dive computer guidelines included in the AAUS Standards (Appendix 13).
- 7.42.4.3 Nitrox Dive computer users should demonstrate a clear understanding of the display, operations, and manipulation of the unit being used for nitrox diving prior to using the computer, to the satisfaction of the DSO or his/her designee.
- 7.42.4.4 If nitrox is used to increase the safety margin of an air-based dive computer, the MOD and oxygen exposure and time limits for the nitrox mixture being dived should not be exceeded.
- 7.42.4.5 Dive computers capable of pO₂ limit and fO₂ adjustment should be checked by the diver prior to the start each dive to assure compatibility with the mix being used.

7.42.5 Repetitive Diving

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

7.43 Oxygen Parameters

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

7.43.2 Purity

- 7.43.2.1 Oxygen used for mixing nitrox breathing gas should meet the purity levels for “Medical Grade” (U.S.P.) or “Aviator Grade” standards.
- 7.43.2.2 In addition to the AAUS Air Purity Guidelines (Section 3.60), the following standard should be met for breathing air that is either
 - a. placed in contact with oxygen concentrations greater than 40%, or
 - b. used in nitrox production by the partial pressure mixing method with gas mixtures containing greater than 40% oxygen as the enriching agent:

Air Purity:	CGA Grade E (Section 3.60)	
	Condensed Hydrocarbons:	5mg/m ³
	Hydrocarbon Contaminants:	No greater than 0.1 mg/m ³

7.44 Gas Mixing and Analysis

7.44.1 Personnel Requirements

- 7.44.1.1 Individuals responsible for producing and/or analyzing nitrox mixtures should be knowledgeable and experienced in all aspects of the technique.
- 7.44.1.2 Only those individuals approved by the DSO and/or DCB should be responsible for mixing and/or analyzing nitrox mixtures.
- 7.44.2 Production Methods - It is the responsibility of the DCB to approve the specific nitrox production method used.
- 7.44.3 Analysis Verification by User
 - 7.44.3.1 It is the responsibility of each diver to analyze prior to the dive the oxygen content of his/her scuba cylinder and acknowledge in writing the following information for each cylinder: fO₂, MOD, cylinder pressure, date of analysis, and user's name.
 - 7.44.3.2 Individual dive log reporting forms should report fO₂ of nitrox used, if other than 21%.

7.50 NITROX DIVING EQUIPMENT

All of the designated equipment and stated requirements regarding scuba equipment required in Stanford's Diving Safety Manual should apply to nitrox scuba operations. Additional minimal equipment necessary for nitrox diving operations includes:

- a. Labeled SCUBA Cylinders
- b. Oxygen Analyzers

7.51 Oxygen Cleaning and Maintenance Requirements

7.51.1 Requirement for Oxygen Service

- 7.51.1.1 All equipment which during the dive or cylinder filling process is exposed to oxygen concentrations greater than 40% at pressures above 150 psi should be cleaned and maintained for oxygen service.
- 7.51.1.2 Equipment used with oxygen or mixtures containing over 40% by volume oxygen shall be designed and maintained for oxygen service.
- 7.51.1.3 Oxygen systems over 125 psig including scuba cylinders, cylinder valves, scuba and other regulators, cylinder pressure gauges, hoses, diver support equipment, compressors, and fill station components and plumbing shall have slow-opening shut-off valves.

7.52 Scuba Cylinder Identification Marking

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

- 7.52.1 Cylinders should be marked "NITROX", or "EANx", or "Enriched Air".
- 7.52.2 Nitrox identification color coding should include a 4-inch wide green band around the cylinder, starting immediately below the shoulder curvature. If the cylinder is not yellow, the green band should be bordered above and below by a 1-inch yellow band.

- 7.52.3 The alternative marking of a yellow cylinder by painting the cylinder crown green and printing the word "NITROX" parallel to the length of the cylinder in green print is acceptable.
- 7.52.4 Other markings which identify the cylinder as containing gas mixes other than air may be used with DCB approval.
- 7.52.5 A contents label which includes the current fO₂, date of analysis, and MOD should be affixed.
- 7.52.6 The cylinder should be labeled to indicate whether the cylinder is prepared for oxygen or nitrox mixtures containing greater than 40% oxygen.

7.53 Regulators

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

7.54 Other Support Equipment

- 7.54.1 An oxygen analyzer is required which is capable of determining the oxygen content in the scuba cylinder. Two analyzers are recommended to reduce the likelihood of errors due to a faulty analyzer. The analyzer should be capable of reading a scale of 0 to 100% oxygen, within 1% accuracy.
- 7.54.2 All diver and support equipment should be suitable for the fO₂ being used.

7.55 Compressor and Fill Station

7.55.1 Compressor System

- 7.55.1.1 The compressor/filtration system MUST produce oil-free air.
- 7.55.1.2 An oil-lubricated compressor placed in service for a nitrox system should be checked for oil and hydrocarbon contamination at least quarterly.

- 7.55.2 Fill Station Components - All components of a nitrox fill station that will contact nitrox mixtures containing greater than 40% oxygen should be cleaned and maintained for oxygen service. This includes cylinders, whips, gauges, valves, and connecting lines.

SECTION 8.00

SCIENTIFIC AQUARIUM DIVING

8.10 GENERAL POLICY

Section 8.00 applies to Scientific Aquarium Divers only. All of the standards set forth in other sections of this manual shall apply, except as otherwise provided in this section.

8.11 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 manual. In those circumstances the DCB shall establish the requirements and protocol under which diving will be safely conducted.

8.20 THE BUDDY SYSTEM IN SCIENTIFIC AQUARIUM DIVING

8.21 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.

8.22 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

8.31 In an aquarium of a known maximum obtainable depth:

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

8.31.2 One member of the buddy team must be equipped with a timing device.

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

8.40 SCIENTIFIC AQUARIUM DIVER CERTIFICATION

Scientific Aquarium Diver is a certification enabling the qualified diver to participate in scientific diving in accordance with the standards of Section 8.00. All of the standards set forth in Sections 4.00 and 5.00 of this manual shall apply, except that 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 one day.

8.50 SCIENTIFIC AQUARIUM DIVING USING OTHER DIVING TECHNOLOGY

8.51 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.

- 8.51.1 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:
 - a. there are no overhead obstructions or entanglements, and
 - b. the diver is proficient in performing a Controlled Emergency Swimming Ascent from at least as deep as the maximum depth of the aquarium, and
 - c. the diver is proficient in performing out of air emergency drills, including ascent and mask/helmet removal.
- 8.51.2 Each surface supplied diver shall be hose-tended by a separate dive team member while in the water, unless the tender is monitoring only one air source, there is mutual assistance between divers and there are no overhead obstructions or entanglements.
- 8.51.3 Divers using the surface supplied mode shall maintain communication with the surface tender.
- 8.51.4 During surface supplied scientific aquarium diving operations when only one diver is in the water, there must be a standby diver in attendance at the dive location, unless 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.
- 8.51.5 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.
- 8.51.6 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.
- 8.51.7 The volume and intermediate pressure of 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.

SECTION 9.00

OTHER DIVING TECHNOLOGY

Certain types of diving, some of which are listed below, involve equipment or procedures which require training. Supplementary guidelines for these technologies are in development by the AAUS, and may be adopted by Stanford University's Diving Control Board. Divers using other diving technology must follow DCB-established guidelines. Divers shall comply with all scuba diving procedures in this manual unless specified.

9.10 STAGED DECOMPRESSION DIVING

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

9.20 SATURATION DIVING

If using open circuit compressed air scuba in saturation diving operations, Stanford scientific divers shall comply with the saturation diving guidelines of the host organizational member.

9.30 HOOKAH

- 9.31 Divers using the hookah mode shall be equipped with a diver-carried independent reserve breathing gas supply.
- 9.32 Each hookah diver shall be hose-tended by a separate dive team member while in the water.
- 9.33 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.

9.40 SURFACE SUPPLIED DIVING

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 190 fsw (58 msw).

- 9.41 Divers using the surface supplied mode shall be equipped with a diver-carried independent reserve breathing gas supply.
- 9.42 Each surface supplied diver shall be hose tended by a separate dive team member while in the water.
- 9.43 Divers using the surface supplied mode shall maintain voice communication with the surface tender.
- 9.44 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.
- 9.45 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.

9.50 CLOSED AND SEMI-CLOSED CIRCUIT SCUBA (REBREATHERS)

Closed and semi-closed circuit scuba (rebreathers) shall meet the following requirements:

- 9.51 Oxygen partial pressure in the breathing gas shall not exceed values approved by the DCB. The generally accepted maximum value is 1.5 atmospheres ppO₂ at depths greater than 25 fsw (7.6 msw).
- 9.52 Chemicals used for the absorption of carbon dioxide shall be kept in a cool, dry location in a sealed container until required for use
- 9.53 The designated person-in-charge shall determine that the carbon dioxide absorption canister is used in accordance with the manufacturer's instructions.
- 9.54 Closed and semi-closed diving equipment will not be used at a depth greater than that recommended by the manufacturer of the equipment.

9.60 MIXED GAS DIVING

If using mixed gas in diving operations, divers shall comply with the diving guidelines of the organizational member. Nitrox diving operations are covered in Section 7.00.

9.70 BLUE WATER DIVING

Blue water diving is defined as diving in open water where the bottom is generally >200 feet deep. It requires special training and the use of multiple-tethered diving techniques. Specific guidelines that should be followed are outlined in "Blue Water Diving Guidelines" (California Sea Grant Publ. No. T-CSGCP-014).

9.80 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.

9.90 OVERHEAD ENVIRONMENTS

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.

APPENDIX 1

Stanford University Diving Control Board
Hopkins Marine Station of Stanford University
Pacific Grove CA 93950

DIVING MEDICAL EXAM OVERVIEW FOR THE EXAMINING PHYSICIAN

TO THE EXAMINING PHYSICIAN:

This person, _____, requires a medical examination to assess his/her fitness to scuba dive in Stanford University's Scientific Diving program. His /her answers on the attached Diving Medical History Form may indicate potential health or safety risks as noted. Your evaluation is requested on the attached Diving Fitness Medical Evaluation form. If you have questions about diving medicine, you may wish to consult one of the references on the list which follows. Please contact Stanford's Diving Safety Officer at Hopkins Marine Station if you have any questions or concerns about Stanford University's medical standards for scientific diving. Thank you for your assistance.

Diving Safety Officer

Phone, fax, e-mail

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. Most fatalities involve deficiencies in prudence, judgment, emotional stability or physical fitness.

Please consult the following list of conditions which usually restrict candidates from diving.

(Adapted from Bove, 1998: 61-63. 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 disease¹ [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. Asthma² [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]

¹ **“Assessment of Cardiovascular Risk by Use of Multiple-Risk-Factor Assessment Equations.”**

Grundy et al, 1999

AHA/ACC Scientific Statement.

<http://www.acc.org/clinical/consensus/risk/risk1999.pdf>

² **“Are Asthmatics Fit to Dive?”**

D.H. Elliott, ed., 1996

Undersea and Hyperbaric Medical Society, Kensington, MD

SELECTED REFERENCES IN DIVING MEDICINE

Most of the following are available from Best Publishing Company, P.O. Box 30100, Flagstaff, AZ 86003-0100, Divers Alert Network (DAN), or the Undersea and Hyperbaric Medical Association (UHMS), Bethesda, MD:

ACC/AHA Guidelines for Exercise Testing. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing).

R.J. Gibbons et al, 1997

Journal of the American College of Cardiology. 30: 260-311

<http://www.acc.org/clinical/guidelines/exercise/exercise.pdf>

Alert Diver Magazine

<http://www.diversalertnetwork.org/medical/articles/index.asp>

DIVING MEDICINE, Third Edition

A. Bove and J. Davis, 1997

W.B. Saunders Company, Philadelphia

DIVING AND SUBAQUATIC MEDICINE, Third Edition

C. Edmonds, C. Lowery and J. Pennefather, 1994

Butterworth-Heinemann Ltd. Oxford

MEDICAL EXAMINATION OF SPORT SCUBA DIVERS

Alfred Bove, M.D., Ph.D. ed., 1998

Medical Seminars, Inc. San Antonio, TX

NOAA DIVING MANUAL, Fourth Edition

Superintendent of Documents

U.S. Government Printing Office, Washington, D.C.

U.S. NAVY DIVING MANUAL

Superintendent of Documents

U.S. Government Printing Office, Washington, D.C.

APPENDIX 2

DIVING MEDICAL HISTORY FORM
(To be completed by the applicant diver)

Name _____ Sex ____ Age ____ Wt. ____ Ht. ____
 Sponsor _____ Date ____/____/____
 (Lab P.I. or course instructor) (Mo / Day / Yr)

TO THE APPLICANT:

Scuba diving makes considerable demands on you, both physically and mentally. Diving with certain medical conditions may be asking for trouble not only for yourself, but also for anyone coming to your aid if you get into difficulty in the water. Therefore, it is prudent to meet certain medical and physical requirements before beginning a diving or training program.

Your answers to the questions are as important as your physical examination in determining your fitness. You must give accurate information in order for the medical screening procedure to be of any value.

This form shall be kept confidential. 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 and he/she 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, his/her written authorization will be required in order for further consideration to be given your application. If your physician concludes that diving would involve risk for you, remember that he/she is concerned only with your well-being and safety. Please respect his/her advice and the intent of this medical history form.

*Have you ever had or do you presently have any of the following?
 (please check yes or no)*

	<i>Yes</i>	<i>No</i>	<i>Comments</i>
1 Trouble with your ears, including ruptured eardrum, difficulty clearing your ears, or surgery			
2 Trouble with dizziness			
3 Eye surgery			
4 Depression, anxiety, claustrophobia, etc.			
5 Substance abuse, including alcohol			
6 Loss of consciousness			
7 Epilepsy or other seizures, convulsions or fits			
8 Stroke or a fixed neurological deficit			
9 Recurring neurologic disorders, including transient ischemic attacks			
10 Aneurysms or bleeding in the brain			
11 Decompression sickness or embolism			
12 Head injury			
13 Disorders of the blood, or easy bleeding			
14 Heart disease, diabetes, high cholesterol			
15 Anatomical heart abnormalities including patent foramen ovale, valve problems, etc.			
16 Heart rhythm problems			
17 Need for a pacemaker			

18	Difficulty with exercise			
19	High blood pressure			
20	Collapsed lung			
21	Asthma			
22	Other lung disease			
23	Diabetes mellitus			
24	Pregnancy			
25	Surgery (If yes, explain below)			
26	Hospitalizations (If yes, explain below)			
<i>Please check yes or no for the following:</i>		<i>Yes</i>	<i>No</i>	<i>Comments</i>
27	Do you take any medications? (If yes, list below)			
28	Do you have any allergies to medications, foods, environmental? (If yes, explain below)			
29	Do you smoke?			
30	Do you drink alcoholic beverages?			
31	Is there a family history of high cholesterol?			
32	Is there a family history of heart disease or stroke?			
33	Is there a family history of diabetes?			
34	Is there a family history of asthma?			

Please explain any “yes” answers to the above questions.

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

Signature

Date

APPENDIX 3

MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING

Name of Applicant (Print or Type)

Date (Mo/Day/Year)

TO THE PHYSICIAN:

This person is an applicant for training or is presently certified to engage in scuba diving. This is an activity which puts unusual stress on the individual in several ways. 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. An absolute requirement is the ability of the lungs, middle ear and sinuses to equalize pressure. Any condition that risks the loss of consciousness should disqualify the applicant.

TESTS: Please initial that the following tests were completed.

[] Initial Examination (and first re-examination over age 40)

[] Re-examination (every 5 years under age 40, every 3 years over age 40, every 2 years over age 60)

- Medical History reviewed with applicant
Complete Physical Exam with emphasis on neurological and otological components
Chest X-Ray
Spirometry
Hematocrit or Hemoglobin
Urinalysis
Any further tests deemed necessary by the physician

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

[] Additional testing for all examinations over age 40

- Resting EKG
Assessment of coronary artery disease using Multiple-Risk-Factor Assessment1 (age, lipid profile, blood pressure, diabetic screening, smoker)
Note: Exercise stress testing may be indicated based on Risk Factor Assessment2

RECOMMENDATION:

- [] APPROVAL - I find no medical condition(s) which I consider incompatible with diving.
[] RESTRICTED ACTIVITY APPROVAL - The applicant may dive in certain circumstances as described in REMARKS.
[] FURTHER TESTING REQUIRED - I have encountered a potential contraindication to diving. Additional medical tests must be performed before a final assessment can be made. See REMARKS.
[] REJECT - This applicant has medical condition(s) which, in my opinion, clearly would constitute unacceptable hazards to health and safety in diving. See REMARKS.

(Continued on next page) ->

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

(Continued from previous page)

REMARKS:

I have discussed the patient's medical condition(s) which would not seriously interfere with diving but which may seriously compromise subsequent health. The patient understands the nature of the hazards and the risks involved in diving with these defects.

Signature M.D. _____
Date

Name (please print or type)

Address

Telephone number

My familiarity with applicant is:

With this exam only

Regular Physician for _____ years

Other (describe)

My familiarity with diving medicine is:

.....
APPLICANT'S RELEASE OF DIVING MEDICAL EXAM INFORMATION

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

Signature of Applicant _____

APPENDIX 4

RECOMMENDED PHYSICIANS WITH EXPERTISE IN DIVING MEDICINE

Diver candidates who are matriculated undergraduates, graduate students or post doctoral students with a Stanford University I.D. are eligible for diving medical exams at Vaden Health Center on campus, with prior notification by the Diving Safety Officer.

Vaden Health Center
870 Campus Drive
Stanford, CA

Appointments: (650) 724-2273

Diver candidates who are unable to obtain diving physical exams at Vaden are encouraged to call **Divers Alert Network** (1-800-446-2671) to request a list of physicians with expertise in diving medicine in their area.

APPENDIX 5

DEFINITION OF TERMS

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

ATA(s) - Abbreviation for “Atmosphere(s) Absolute”, defined as the total pressure exerted on an object by a gas or mixture of gases, at a specific depth or elevation, including normal atmospheric pressure.

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

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

Buddy diver - Second member of the dive team.

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

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

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

Certified Diver - A diver who holds a recognized valid certification from an organizational member or recognized certifying agency.

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

Cylinder - A pressure vessel for the storage of gases.

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

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

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

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

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

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

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

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

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

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

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

Diving Control Board (DCB) - The group of individuals which acts as the official representative of the member organization in matters concerning the scientific diving program (see Section 1.24).

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

EAD - An abbreviation for Equivalent Air Depth (see below).

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

Enriched Air (EANx) - a name for a breathing mixture of air and oxygen when the percent of oxygen exceeds 21%. This term is considered synonymous with the term “nitrox” (see Section 7.00).

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

fN₂ - fraction of nitrogen in a gas mixture, expressed as either a decimal or percentage, by volume.

fO₂ - fraction of oxygen in a gas mixture, expressed as either a decimal or percentage, by volume.

fsw - Feet of seawater, or equivalent static head.

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

Hyperbaric Chamber - See decompression chamber.

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

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

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

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

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

MOD - Maximum Operating Depth, usually determined as the depth at which the pO₂ for a given gas mixture reaches a predetermined maximum.

msw - Meters of seawater or equivalent static head.

Nitrox - Any gas mixture comprised predominately of nitrogen and oxygen, most frequently containing between 21% and 40% oxygen. Also be referred to as Enriched Air Nitrox, abbreviated EANx.

NOAA Diving Manual - refers to the *NOAA Diving Manual, Diving for Science and Technology*, 2001 edition. National Oceanic and Atmospheric Administration, Office of Undersea Research, US Department of Commerce.

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 60 feet per minute or slower.

Oxygen Clean - All combustible contaminants have been removed.

Oxygen Compatible - A gas delivery system that has components (O-rings, valve seats, diaphragms, etc.) that are compatible with oxygen at a stated pressure and temperature.

Oxygen Service - A gas delivery system that is both oxygen clean and oxygen compatible.

Oxygen Toxicity - Any adverse reaction of the central nervous system (acute or CNS oxygen toxicity) or lungs (chronic, whole-body, or 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, ruptured eardrum.

Pressure Vessel - See cylinder.

pN₂ - Inspired partial pressure of nitrogen, usually expressed in units of atmospheres absolute.

pO₂ - Inspired partial pressure of oxygen, usually expressed in units of atmospheres absolute.

psi - Abbreviation for the unit of pressure “pounds per square inch”.

Psig - Abbreviation for the unit of pressure “pounds per square inch gauge”.

Recompression Chamber - see decompression chamber.

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

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

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

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

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

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.

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

APPENDIX 6

ASSUMPTION OF INJURY RISKS ASSOCIATED WITH STANFORD UNIVERSITY SCUBA AND SKIN DIVING AND RELATED ACTIVITIES

Skin diving and compressed-gas diving including scuba diving, and related activities can be strenuous and hazardous. There is a risk of injury, both serious and minor, associated with participation in Stanford University Scuba and Skin Diving and Related Activities. The risks include, but are not limited to: pressure-related injuries to the ears, sinuses or lungs; decompression illness; injury to the head, neck or spine (including paralysis); injury to the muscular or skeletal systems; injury to internal or external organs; loss or damage to sight, hearing or teeth; death; long or short-term disability; loss of income, career opportunities, or the enjoyment of life; pain; and scarring or disfigurement.

IT IS THE RESPONSIBILITY OF EACH INDIVIDUAL, STUDENT and/or NON-AFFILIATED PARTICIPANT to know his or her own general state of health and well being, and therefore to be able to certify knowledgeably that he or she is physically fit to participate in Stanford University Scuba and Skin Diving and Related Activities.

IT IS ALSO THE RESPONSIBILITY OF EACH INDIVIDUAL, STUDENT and/or NON-AFFILIATED PARTICIPANT to have health insurance coverage sufficient to provide for medical or dental services and/or equipment regarding any injury, minor or catastrophic, sustained or incurred as a result of participating in Stanford University Scuba and Skin Diving and Related Activities, and to certify to that effect.

Therefore, **AS A PRE-CONDITION TO BEING PERMITTED TO PARTICIPATE IN STANFORD UNIVERSITY SCUBA AND SKIN DIVING AND RELATED ACTIVITIES, EACH PARTICIPANT** shall read the **AGREEMENT** set forth on the following page in order to make an educated choice to participate or not to participate. Your signature will signify your recognition of the possible health risks involved and your informed consent to them.

To that end, *and before* releasing The Board of Trustees of the Leland Stanford Junior University, its officers, agents and employees from all actions, claims, or demands related to any injury you may sustain as a result of participating in any Stanford University Scuba and Skin Diving and Related Activities *please* give serious consideration to the possible ramifications. You should understand that the possible causes of injury are many, but among them are: lifting, moving, or dropping heavy equipment including scuba cylinders and weights; slipping, falling, or tripping on boat, beach, rocky shore, dive locker or other surfaces, regardless of physical or environmental conditions; pressure on descent or at depth or release of pressure on ascent; aquatic organisms and environmental hazards; diving-related equipment; warming up, practicing, or training for Stanford University Scuba and Skin Diving and Related Activities; injury due to supervision by Stanford employees or agents or student volunteers, paid or unpaid, or to rules, regulations, and instructions (or lack thereof) regarding the use of equipment or tools or to the nature of the activity itself, particularly for Stanford University Scuba and Skin Diving and Related Activities; poor health or inadequate physical fitness of the participant; or injury due to a disparity between and among other participants with respect to experience level, health, strength, height, weight, age, ability, and the relative activities or maturity of, between, or among other participants.

**AGREEMENT FOR VOLUNTARY PARTICIPATION IN
STANFORD UNIVERSITY SCUBA AND SKIN DIVING AND RELATED ACTIVITIES**

I _____ have read the preceding **ASSUMPTION OF INJURY RISKS ASSOCIATED WITH STANFORD UNIVERSITY SCUBA AND SKIN DIVING AND RELATED ACTIVITIES** and understand its contents. I acknowledge the risk of injury that may result from participation in Stanford University Scuba and Skin Diving and Related Activities, and am willing to and hereby do voluntarily assume all risks of harm associated with my participation. I certify that to the best of my knowledge, I am physically fit and able to participate in Stanford University Scuba and Skin Diving and Related Activities and that I am in good health, and that I am unaware of any medical condition which might make my participation inadvisable.
() *initials*

I am aware that participating in Stanford University Scuba and Skin Diving and Related Activities may expose me to a risk of injury, minor or serious, including but not limited to those listed in **ASSUMPTION OF INJURY RISKS ASSOCIATED WITH STANFORD UNIVERSITY SCUBA AND SKIN DIVING AND RELATED ACTIVITIES**. I accept and assume all risks, known or unknown, listed or unlisted, that may result from my voluntary participation in Stanford University Scuba and Skin Diving and Related Activities, regardless of the cause of the injury.
() *initials*

I acknowledge my responsibility to acquire health insurance coverage sufficient to provide for all medical or dental services and/or equipment associated with any injury, minor or catastrophic, related to my participation in Stanford University Scuba and Skin Diving and Related Activities, **AND HEREBY CERTIFY** that on the date noted below, I have such insurance coverage in effect.
() *initials*

In consideration of The Board of Trustees of the Leland Stanford Junior University, its officers, agents and employees permitting me to participate in its Stanford University Scuba and Skin Diving and Related Activities, I agree, for myself, my heirs, or my legal representatives, to release The Board of Trustees of the Leland Stanford Junior University, its officers, agents and employees, their trustees, officers, agents, employees, students, participants, guests, spectators, officials or insurers, from any action, claim, or demand that I, my heirs, or my legal representatives have or may have, for any and all personal injuries I may suffer or sustain, regardless of cause or fault, as a result of my voluntary participation in Stanford University Scuba and Skin Diving and Related Activities, on or off campus.
() *initials*

In consideration of The Board of Trustees of the Leland Stanford Junior University, its officers, agents and employees permitting me to participate in Stanford University Scuba and Skin Diving and Related Activities, I knowingly and intentionally give up any legal right that I, my heirs, or legal representatives have or may have against The Board of Trustees of the Leland Stanford Junior University, its officers, agents and employees, their trustees, officers, agents, employees, students, participants, guests, spectators, officials or insurers, from any action, claim, or demand that I, my heirs, or my legal representatives, have or may have for any and all personal injuries I may suffer or sustain, regardless of cause or fault a result of my voluntary participating in Stanford University Scuba and Skin Diving and Related Activities, on or off campus.
() *initials*

I knowingly intend my signature on this Agreement to be a complete defense to any legal proceeding that may be brought by anyone on their own or on my behalf for any injury I may suffer or sustain as a result of voluntarily participating in Stanford University Scuba and Skin Diving and Related Activities, and further intend this Agreement to be a complete and total release of liability for all negligent acts, failures to act, or breaches of duty owed to me, which result in my personal injury or death as a result of my voluntary participation in Stanford University Scuba and Skin Diving and Related Activities, on or off campus.
() *initials*

I CERTIFY that I am 18 years of age or older, that I am legally competent and capable of executing this Agreement on my own behalf, that I have read the foregoing and have made a conscious decision to sign it of my own free will.

SIGNATURE _____

DATE _____

PRINT NAME _____

Name and phone # of person to be contacted in case of emergency: _____

APPENDIX 7

STANFORD DIVING PROGRAM APPLICATION

Name: _____ Date of birth: _____

Address: _____

Telephone: _____

E-mail: _____

Please circle one:

Undergraduate Graduate Post doc Faculty Staff Non-matriculated

Diving for a course? Course & instructor: _____

Diving for research? Lab & advisor / P.I.: _____

(Note: file Scientific Diving Plan for Diving Control Board approval)

Person to notify in case of emergency:

Name: _____

Telephone: _____

Address: _____

CERTIFICATIONS	ORGANIZATION	DATE	LOCATION
Basic scuba			
Advanced Open Water			
Other (incl. CPR / 1 st Aid / O ₂)			

Total # dives to date: _____ Maximum depth: _____ Average depth: _____

Number of dives in past 12 months: _____ Date of most recent SCUBA dive: _____

Diving Experience:

Please list briefly the geographic areas and types of environments in which you have dived and describe the nature of your diving (e.g. photography, research, recreation...).

I agree to carry out all diving under the auspices of Stanford University in accordance with the regulations of the Stanford University scientific diving program.

Diver's signature: _____

Date: _____

APPENDIX 8

STANFORD UNIVERSITY SCIENTIFIC DIVING PLAN

Name:

Title of project:

Principal investigator (or sponsor if independent student research):

Department / lab:

Lead diver & affiliation:

Planned dive buddies (must be active scientific divers; please list affiliations):

Start date:

Anticipated completion date:

Brief description of planned diving activity: please specify (on a separate sheet if necessary) the project location, the kinds of activities that will be carried out underwater, the diving environment (e.g. open coast, protected bay, freshwater lake, etc.), what kind of equipment you'll be using, types of boats, and the planned diving schedule including number, frequency, and depths of dives. If this information is included in a project/grant proposal please attach a copy of the relevant portion.

Describe the diving accident management plan(s) at the proposed location(s):

If diving with another facility:

Host Facility:

DSO:

AAUS organizational member? yes / no

phone/fax/e-mail:

Approvals for specified diving activity:

DCB Chair _____

Date _____

DSO _____

Date _____

APPENDIX 9
REQUEST FOR DIVING RECIPROCITY:
VERIFICATION OF DIVER TRAINING AND EXPERIENCE

A scientific diver who is currently certified under the auspices of an organizational member institution of the American Academy of Underwater Sciences (AAUS) shall be recognized by any other organizational member of AAUS and may apply for reciprocity in order to dive with the host organization. Stanford University is an organizational member in good standing with the AAUS and operates at a minimum under the AAUS Standards for Scientific Diving (2001 edition). The visiting diver will comply with the diving regulations of the host organization's Diving Safety Manual unless previously arranged by both organizations' Diving Control Boards.

The DSO for the visiting scientific diver has confirmed the following information:

Diver's name:

Most recent checkout dive:

Written scientific diving exam date:

Depth certification:

Date of most recent dive:

Number of dives completed within
previous 12 months:

Completed:

Renewal due:

Medical exam:

Equipment service/test:

CPR training:

First aid:

Oxygen administration:

Specialty training / certifications:

<input type="checkbox"/> Dry suit	<input type="checkbox"/> Rescue	<input type="checkbox"/> Blue water
<input type="checkbox"/> Dive computer	<input type="checkbox"/> Divemaster	<input type="checkbox"/> Altitude
<input type="checkbox"/> Nitrox	<input type="checkbox"/> Instructor	<input type="checkbox"/> Ice/Polar
<input type="checkbox"/> Mixed gas	<input type="checkbox"/> EMT	<input type="checkbox"/> Cave
<input type="checkbox"/> Closed circuit	<input type="checkbox"/> Dive Accident Management	<input type="checkbox"/> Night
<input type="checkbox"/> Saturation	<input type="checkbox"/> Chamber operator	<input type="checkbox"/> Other:
<input type="checkbox"/> Decompression	<input type="checkbox"/> Lifesaving	

Person to be notified in an emergency:

Name:

Phone:

Address:

Comments:

The diver is currently a certified scientific diver in Stanford University's research diving program.

The diver is no longer an active Stanford scientific diver, but copies of his/her pertinent Stanford records are available upon request for the host DSO's consideration.

Diving Safety Officer:

Date:

831 655-6245; fax: 831 375-0793
Hopkins Marine Station, Pacific Grove, CA 93950

APPENDIX 10

CHECKOUT DIVE AND TRAINING EVALUATION

Each Stanford scientific diving program candidate should be able to demonstrate the following skills prior to certification as a Scientific Diver-in-Training (Section 4.17):

- 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
- Surface dive to 10 ft. without scuba gear
- Demonstrate watermanship and snorkel skills
- Entry and exit (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 mid-water)
- Proper descent and ascent with B.C.
- Remove and replace weight belt at the surface and while submerged
- Remove and replace scuba cylinder at the surface and 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
- Accident management and evacuation procedures
- Self rescue techniques
- Tows of conscious and unconscious victim

Each Stanford Scientific Diver-in-Training should be able to demonstrate the following skills and knowledge prior to certification as a Scientific Diver:

- 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
- Knowledge of AAUS diving standards and regulations
- Small boat handling (optional)

Certified Scientific Divers from AAUS organizational member institutions may be asked to demonstrate proficiency in the above skills during checkout dives or training evaluation dives with the host Diving Safety Officer or his/her designee (Section 1.27.3).

APPENDIX 11

DIVING EMERGENCY MANAGEMENT PROCEDURES

Introduction

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

General Procedures

Depending on 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.

- Make appropriate contact with victim, or rescue as required.
- Establish (A)irway, (B)reathing, (C)irculation as required.
- Administer 100% oxygen.
- Call local Emergency Medical System (EMS) for transport to nearest medical treatment facility.
- Notify Diving Safety Officer or his/her designee.
- Complete and submit Diving Injury / Incident Report (Appendix 12) to the DCB and the AAUS (As required in Section 2.72).

Procedures at Monterey Peninsula Dive Locations Including Hopkins

Planning for emergencies:

1. Know the nearest phone location at each shore site (a cell phone is recommended if a public phone is not near the dive site). Make sure public phones work and that cell phones have reception.
2. Have an oxygen system and first aid kit on site, and personnel trained to use them.
3. Have a “beach master” or boat tender present whenever possible.

EMS activation:

In case of a diving emergency: call **911** from a public phone. From HMS office phones, dial **9-911**. If on the water with a marine VHF radio, call the Coast Guard on **Channel 16**.

Local emergency protocol requires the diver to be evaluated at Community Hospital of the Monterey Peninsula (CHOMP, 23625 Holman Highway) before referral to the recompression chamber. The nearest chamber is located at 600 Pine Ave. in Pacific Grove, but DO NOT transport divers there directly.

If feasible note the condition of the diver and details of the events leading up to the accident, including dive profiles.

Report any diving-related accident/injury to the DSO as soon as possible.

Procedures at Other Dive Locations

Follow local procedures as detailed in the diving accident management plan for evacuation and medical treatment established as part of the Scientific Diving Plan (Appendix 8).

APPENDIX 13

DIVE COMPUTER WORKSHOP

Michael A. Lang and R.W. Bill Hamilton, Co-Chairs
September 26-28, 1988
USC Catalina Marine Science Center

Co-Sponsors:
American Academy of Underwater Sciences
California Sea Grant College Program
USC Sea Grant Institutional Program

Dive Computer Guidelines

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 their diving.
7. Once the dive computer is in use, it must not be switched off until it indicates complete out gassing has occurred or 18 hours have elapsed, whichever comes first.
8. When using a dive computer, non emergency ascents are to be at a rate specified for the make and model of dive computer being used.
9. Ascent rates shall not exceed 40 fsw/min in the last 60 fsw.
10. Whenever practical, divers using a dive computer should make a stop between 10 and 30 feet for 5 minutes, especially for dives below 60 fsw.
11. Only 1 dive on the dive computer in which the NDL of the tables or dive computer has been exceeded may be made in any 18 hour period.
12. Multiple deep dives require special consideration.

APPENDIX 14

BIOMECHANICS OF SAFE ASCENTS WORKSHOP

Michael A. Lang and Glen H. Egstrom, Co-Chairs
September 25-27, 1989
WHOI/MBL, Woods Hole, MA

Co-Sponsors:
American Academy of Underwater Sciences
NOAA Office of Undersea Research
DEMA

Safe Ascent Recommendations

It has long been the position of the American Academy of Underwater Sciences that the ultimate responsibility for safety rests with the individual diver. The time has come to encourage divers to slow their ascents.

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

APPENDIX 15

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.

Recreational Diving, Peter B. Bennett, Moderator.

1. Scientific diving programs provide continuous training, re-certification and dive site supervision, which helps maintain established safe diving protocols. Recreational divers, who may lack such direct supervision, need to be aware of their need to stay within established protocols, especially when making repetitive dives over multiple days, in which the risk of DCS may be higher.
2. It is recommended that attention of divers be directed with emphasis on the ancillary factors to decompression risk such as fitness to dive, adequate rest, hydration, body weight, age and especially rate of ascent which should not be more than 60 feet per minute.
3. Divers are encouraged to learn and remember the signs and symptoms of decompression illness and report them promptly so as to receive effective treatment as rapidly as possible to prevent residual injury.
4. The use of oxygen breathing on the surface, whenever possible via a demand regulator mask system, to insure the highest percentage of oxygen to the patient, is recommended while awaiting treatment if decompression illness is thought to be present. The use of 100% oxygen in the water while awaiting treatment is not recommended for recreational diving.
5. There is a strong need for more controlled data on the relationship of decompression illness to multi-level, multi-day diving, especially with the provision of baseline data. Such a study could be made from information gathered from closed groups such as certain island areas and liveaboard fleets where heavy recreational diving activities occur.
6. To help obtain information, dive computer manufacturers are encouraged to provide data loggers to computers so that a permanent record is available of dive depth, dive time, rate of ascent, etc. as close as every minute. This should be coupled with detailed accident reporting forms (e.g. DAN form) in the case of an accident.

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 enriched air 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.

Commercial Diving, Gary L. Beyerstein, Moderator.

1. Repetitive diving, multi-level and multi-day diving modes are considered normal, routine and essential practices in the commercial diving industry. They are performed safely and efficiently.
2. The use of surface decompression using oxygen is also essential to the safe and efficient conduct of commercial diving operations. Alternate methods to date have shown increased risk to the diver and have not reduced the incidence of DCS.
3. The quality of decompression (i.e. the effectiveness of the decompression table in controlling decompression stress) is much more important than the mode used when considering DCS risk.
4. A zero bends incidence rate is desirable but not thought to be achievable in all types of commercial diving. Given the commercial situation, with the ability to treat immediately and effectively, an incidence rate of 1 type I case of DCS per 1,000 to 2,000 dives is considered currently tolerable.
5. Current commercial practices and tables were developed from need and have been modified for safety. We feel they are currently tolerable. We look forward to a new generation of safer tables that will also

increase our operational efficiency. Such tables will have longer bottom times at deeper depths without higher levels of risk. Such tables will need field validation. This will be greatly assisted by advanced dive profilers, field Doppler units, and an industry data base. We look forward to industry standard tables and therapy procedures.

Dive Computers, John E. Lewis, Moderator.

1. No data were presented that warrant revision of the recommendations of the 1988 AAUS Dive Computer Workshop.
2. Data presented indicate that limiting dives to the no-stop (No-D) range, plus training and experience adds up to a one hundred fold decrease in the incidence of DCS.
3. Multi-level diving is a commonly accepted practice, and it appears to be less stressful than square wave profile diving.
4. Repetitive NoD (no-stop) diving with dive computers within the tested envelope is a valid practice. Deep repetitive dives with short surface intervals should be given special consideration.
5. No data were presented that indicate multi-day diving requires any special rules.
6. To assist in the analysis of decompression illness, dive computer manufacturers should consider working with the Divers Alert Network to provide an indication of inert gas loading by profile recovery, group letter, or other simple technique.

Dive Recorders, Karl E. Huggins, Moderator.

1. Because of limited analysis of the existing profile database, no conclusions have been reached regarding repetitive diving limits.
2. Paper databases are too cumbersome, it is considered essential that future profile recorders have the ability to download dive profile information directly to personal computer (through standard I/O ports).
3. The following desirable dive recorder features were identified:
 - a. ascent/descent rate record;
 - b. long storage capacity (commercial diver suggested one month);
 - c. for data points collected in large time intervals (i.e. 2.5-3 minutes), the average depth during the interval as well as the maximum depth attained during the interval should be recorded;
 - d. depth resolution should be at least 0.3 msw (1 fsw);
 - e. "low" tech recorder (inexpensive, requiring daily dumps);
 - f. date/time stamps on each dive; and,
 - g. diver/recorder identification.
4. Possible dive recorder enhancements:
 - a. two-way communication with personal computer (i.e. allows adjustment in sampling rate, initialization of program variables, setting of recorders' internal clock, etc.); and

- b. data compression techniques (i.e. store rate of depth change instead of depth) for both the recorder and final computer storage.
5. A standardization of information and file formats would be advantageous, with PENNDEC or CANDID databases as possible starting points.
6. There is a need to obtain a list, from end users, of the minimal "header" information required. Suggested were:
 - a. DAN incident form information; and
 - b. time of incident to time of resolution.

Physiology, Medicine and Environment, Richard D. Vann, Moderator.

1. Investigate the arterialization of gas emboli (VGE) as a potential mechanism for spinal and cerebral DCS.
2. Investigate the ability of reduced ascent rate and short decompression stops to reduce the incidence of VGE.
3. Dose-response curves for direct decompression are of fundamental importance to the development of decompression procedures.
4. Classification of decompression illness should be by specific signs/symptoms to guide therapy and prognosis and provide improved data for analysis.
5. There is a potential risk of bone necrosis for long shallow dives followed by inadequate decompression.
6. Multiple decompressions per day for multiple days can be potentially hazardous. The number of dives per day and the number of consecutive days during which diving can be conducted with reasonable safety is uncertain at present and depends upon the decompression procedures that are used.

Data Analysis and Procedure Calculation, R.W. Bill Hamilton, Moderator.

1. Maximum likelihood and other statistical techniques are useful for evaluation and assessment of new procedures based on past experience.
2. Predictive models are sensitive to the data set used to determine the parameter estimates of the model.
3. Field data can be useful and data exchange should be encouraged.

Decompression Trials, Ronald Y. Nishi, Moderator.

1. After all these years, we still do not know much about DCS. None of the table or dive computer developers really have decompression "models". What they actually have are decompression calculation methods as stated by Brian Hills in his book "Decompression Sickness".
2. There are two primary methods for developing decompression tables and designing decompression trials. The first is the traditional approach, where tables are developed from some model and selected profiles are dived to test whether or not DCS occurs. A variation on this approach is to include risk analysis. Dives are tested, either by following printed tables or by following dive computers. It is

necessary to use other tools such as Doppler and complement analysis to determine decompression stress.

3. The second approach to designing trials is the probabilistic method. In this case, a large amount of carefully documented (well-calibrated) dive data is required to estimate the risk of DCS, compute optimum profiles and test with appropriate criteria for rejecting or accepting profiles. With the proper design of sequential tests, the total decompression time can be minimized and the number of trials and cases of DCS can also be minimized. The probabilistic method appears to be the way of the future but still needs further development. To make it work, accurate dive data and DCS information are required, which the military, scientific, commercial and recreational diving communities must supply.
4. What does this all mean for the scientific, recreational and commercial diving communities? Although designers and testers of decompression trials may talk about incidences or risks of DCS which are much higher than the different communities are willing to accept, the eventual tables will probably be more effective than those commonly in use now. It must be kept in mind that DCS is a probabilistic event.

APPENDIX 16

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)