

HANDBOOK FOR DIVING SAFETY



UNIVERSITY *of* NEW HAMPSHIRE

School of Marine Science and Ocean Engineering

**REVISED IN CONFORMANCE WITH THE GUIDELINES, PROCEDURES,
AND STANDARDS OF THE AMERICAN ACADEMY OF UNDERWATER SCIENCES**

January 1998, February 1999, August 2001, September 2004, January 2006,

August 2010, March 2014

FOREWORD BY AAUS

Since 1951 the scientific diving community has endeavored to promote safe, effective diving through self-imposed diver training and education programs. Over the years, manuals for diving safety have been circulated between organizations, revised and modified for local implementation, and have resulted in an enviable safety record.

This document represents the minimal safety standards for scientific diving at the present day. As diving science progresses so shall this standard, and it is the responsibility of every member of the Academy to see that it always reflects state of the art, safe diving practice.

American Academy of Underwater Sciences

ACKNOWLEDGEMENTS

The Academy thanks the numerous dedicated individual and organizational members for their contributions and editorial comments in the production of these standards.

AAUS Revision History

April, 1987

October, 1990

May, 1994

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March 1999

Added Sec 7.6.1 Nitrox Diving Guidelines.
Revised Appendix 7 and 11.

January 2001

Revised Section 1.23.1 DSO Qualifications.
Revised Section 5.31.4 Emergency Care Training.
Revised Section 6 Medical Standards.
Made Sec 7.6.1 Nitrox Diving Guidelines into Section 7.
Added Section 8.0 Scientific Aquarium Diving.

April 2002

Moved Section 7.0 to Section 9.0 Other Diving Technologies.
Removed Appendix 7 AAUS Checkout Dive and Training Evaluation.
Revised Section 5.33.3.
Revised Section 4.23.2.

August 2003

Section 1.27.3 Delete reference to Appendix 9 (checkout dive).
Section 1.4 Remove word "waiver".
Section 2.21 Change "supervisor" to "lead diver".
Section 2.72.2.1 Remove reference to Appendix 13, and remove Appendix 13. Replace with "at www.aaus.org" after Incident Report.
Section 3.28.3 Remove Appendix 10 (dive computers).
Section 5.32 Training and 100-hour requirement, eliminate "beyond the DIT level".
Section 5.32.1 Eliminate paragraph "Suggested topics include" and replace it with a list of topics for inclusion in the 100 hours. Some of these topics would be designated "R" (required).
Section 4.0 Remove lead sentence "This section describes for diving". Alter the lead sentence read as follows: "This section describes training for the non-diver applicant, previously not certified for diving, and equivalency for the certified diver."
Section 4.3 Delete this section.

Section 9 Update Required Decompression (9.10) and Mixed Gas Diving (9.60) to individual sections.
 Appendices 9, 10, 11, and 12 Remove these and make available online as historic documents in the Virtual Office.
 Formatted document for consistency.
 Separated manual into two volumes. Volume 1 and the appendices are required for all manual and Volume 2 sections only apply when the referenced diving activity is being conducted.
 Volume 2 is where organizational specific information is contained.

October 2005
 Section 11.70 Deleted section for rebreathers.
 Section 12.00 Added new section for rebreathers.

March 2006
 Section 13.00 Added new section for cave and cavern diving.
 Section 11.5 and 11.6, revised definitions for Hookah and surfaced supplied diving.

April 2006
 Section 5.30 Deleted emergency care training prerequisite.
 Section 5.50 Added emergency care training requirements to Continuation of Certificate.

November 2006
 Section 2.60 flying after diving rules updated to meet current DAN standards.
 Section 3.20 dive computers reference changed to “appendix 8”.
 Section 3.60 air quality guidelines updated to meet current CGA standards.
 Section 5.30 – added words “Transect Sampling” to item #9.
 Appendix 1 – Updated one medical web link.
 Appendix 2 - Added the abbreviation “DO” to the MD signature line.
 Appendix 6 – new LOR template.
 Updated and added Appendix 8 dive computer recommendations
 Added Appendix 9 (criteria for entering diving statistics).

December 2009
 Appendix 2 – Revised

December 2011
 Section 6 – Revised after Medical Review Panel review
 Appendix 1 - Revised

May 2013
 Section 3.10- added “and serviced according to manufacturers’ recommendations”
 Section 9.1(c) (1)- added “omitted decompression”
 Section 9.1(c) (7)- added “qualified” to DSO’s designee
 Section 9.30 (k)- replaced “mixed gas” with “decompression”
 Section 4.0- removed specific requirements for Entry-Level Training. Adopted WRSTC/ISO standards by reference.
 Section 5.0- merged requirements for Entry-Level Diver Training with Scientific Diver Training
 Formatted document for consistency

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Volume 1

Sections 1.00 through 6.00

SECTION 1.00 GENERAL POLICY

1.10 Scientific Diving Standards

Historical Perspective

The purpose of these Scientific Diving Standards is to ensure that all scientific diving is conducted in a manner that will maximize protection of scientific divers from accidental injury and/or illness, and to set forth standards for training and certification that will allow a working reciprocity between organizational members. Fulfillment of the purposes shall be consistent with the furtherance of research and safety.

This manual sets minimal standards for the establishment of the American Academy of Underwater Sciences (AAUS) recognized scientific diving programs, the organization for the conduct of these programs, and the basic regulations and procedures for safety in scientific diving operations. It also establishes a framework for reciprocity between AAUS organizational members that adhere to these minimum standards.

This standard was developed and written by AAUS by compiling the policies set forth in the diving manuals of several university, private, and governmental scientific diving programs. These programs share a common heritage with the scientific diving program at the Scripps Institution of Oceanography (SIO). Adherence to the SIO standards has proven both feasible and effective in protecting the health and safety of scientific divers since 1954.

In 1982, OSHA exempted scientific diving from commercial diving regulations (29CFR1910, Subpart T) under certain conditions that are outlined below. The final guidelines for the exemption became effective in 1985 (Federal Register, Vol. 50, No.6, p.1046). OSHA has recognized AAUS as the scientific diving standard setting organization. Organizational members are encouraged to adopt additional standards that extend this document according to local procedure.

Scientific Diving Definition

Scientific diving is defined (29CFR1910.402) 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.

Scientific Diving Exemption

OSHA has granted an exemption for scientific diving from commercial diving regulations under the following guidelines (Appendix B to 29CFR1910 Subpart T):

- a) 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.
- b) The purpose of the project using scientific diving is the advancement of science; therefore, information and data resulting from the project are non-proprietary.
- c) 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.
- d) 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.

In addition, the scientific diving program shall contain at least the following elements (29CFR1910.401):

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

Review of Standards

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

1.20 Operational Control

Organizational Member Auspices Defined

For the purposes of these standards the auspices of the University of New Hampshire (UNH) includes any scientific diving operation in which UNH 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 the UNH or employees of auxiliary organizations, where such employees are acting within the scope of their employment, and the operations of other persons who are engaged in scientific diving of the UNH or are diving as members of an organization recognized by the UNH.

It is the UNH's responsibility to adhere to the UNH and AAUS Standards for Scientific Diving Certification and Operation of Scientific Diving Programs. The administration of the local diving program will reside with the University of New Hampshire Dive Program (UNHDP) and Diving Control Board (DCB).

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

The University of New Hampshire's Scientific Diving Standards and Safety Manual

UNH's scientific diving safety manual has been designed to provide for the development and implementation of policies and procedures that will enable UNH to meet requirements of local environments and conditions as well as to comply with the AAUS scientific diving standards.

“This manual cannot cover every nuance that might occur in all diving situations. Remember none of the regulations in this manual should ever be a substitute for sound judgment, common sense, and situational awareness that constantly leads to a concern for safety.”

Diving Safety Officer

At UNH the Diving Program Officer (DSO) serves as a member of the Diving Control Board (DCB). This person shall have broad technical and scientific expertise in research related diving.

Qualifications:

- Shall be appointed by the Director of the School of Marine Science and Ocean Engineering , with the advice and counsel of the UNH Diving Control Board.
- Shall be trained and have experience as a scientific diver and supervisor for a minimum of 5 years.
- Shall be a full member as defined by AAUS.
- Shall be a current and active underwater instructor from an internationally recognized certifying agency.
- Shall possess diving experience in a variety of conditions including cold water, current, low visibility, and from large and small vessels.
- Shall have experience in supervising divers in a variety of environmental conditions

Duties and Responsibilities

- Shall be responsible, through the DCB, to the SMSOE Director or designee, for the conduct of the UNH's scientific diving program. 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 standard and all relevant regulations of the UNH, rests with the Diving Program Officer.
- 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.
- 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.
- Shall suspend diving operations considered to be unsafe or unwise.

Diving Control Board

- The UNH Diving Control Board (DCB) shall consist of a majority of active scientific divers. Voting members shall include the Diving Safety Officer. At least 1 representative from each of UNH's dive projects will hold a seat on the DCB. Graduate students may be invited to sit on the board if their research involves diving. A chairperson will be chosen from the membership of the board. The DCB Chair will be a rotating position.
- Has autonomous and absolute authority over UNH's scientific diving program's operation.
- Shall approve and monitor diving projects.
- Shall review and revise the diving safety manual.

- Shall assure compliance with the diving safety manual.
- Shall certify the depths to which a diver has been trained.
- Shall take disciplinary action for unsafe practices.
- Shall assure adherence to the buddy system for scuba diving.
- Shall act as the official representative of the UNH in matters concerning the scientific diving program.
- Shall act as a board of appeal to consider diver-related problems.
- Shall recommend the issue, reissue, or the revocation of UNH scientific diver certifications.
- Shall recommend changes in policy and amendments to AAUS and the UNH's diving safety manual as the need arises.
- Shall establish and/or approve training programs through which the applicants for certification can satisfy the requirements of the UNH's diving safety manual.
- Shall suspend diving programs that are considered to be unsafe or unwise.
- Shall establish criteria for equipment selection and use.
- Shall recommend new equipment or techniques.
- Shall establish and/or approve facilities for the inspection and maintenance of diving and associated equipment.
- Shall ensure that the UNHDP's air stations meet air quality standards as described in Section 3.60.
- Shall periodically review the Diving Program Officer's performance and program.
- Shall sit as a board of investigation to inquire into the nature and cause of diving accidents or violations of the UNH's diving safety manual.

Instructional Personnel

- All personnel involved in diving instruction under the auspices of the University of New Hampshire shall be qualified for the type of instruction being given.
- The Diving Program Officer, or designee, will select Instructional personnel with the guidance and advice of the UNH.

UNH Diving Supervisor

- Responsibilities
- Act as the on-site representative of the Diving Safety Officer for scientific diving projects and diver training activities.
- Maintain presence on all dives from vessels and, all other dives, which may present unusual or difficult circumstances.
- In water supervision for individuals who hold a Diver-In-Training Permit.

- Coordination with other known activities in the vicinity that is likely to interfere with diving operations.
- Ensuring all dive team members possess current certification and are qualified for the type of diving operation.
- Planning dives in accordance with Section 2.20
- Ensuring safety and emergency equipment is in working order and at the dive site.
- Briefing dive team members on:
 - a) Dive objectives.
 - b) Unusual hazards or environmental conditions likely to affect the safety of the diving operation.
 - c) Modifications to diving or emergency procedures necessitated by the specific diving operation.
- Suspending diving operations if in their opinion conditions are not safe.
- Reporting to the DSO and DCB any physical problems or adverse physiological effects including symptoms of pressure-related injuries.

Qualifications:

- Meet all the qualification criteria for Scientific Diver as outlined in Section 5.00
- A minimum of 100 hours of documented dive time (underwater).
- Successful completion of an approved Diver Rescue Course
- Diving experience in a variety of conditions including cold water, current, low visibility, and from large and small vessels.
- Experience supervising divers in various conditions.
- Written recommendations from two UNH Supervisors.

Lead Diver

The diving Program Officer or Project Dive Supervisor will appoint one member of each dive team as the Lead Diver. The Lead Diver shall hold a Scientific Diver certification and be experienced with the site, mode, and dive objectives.

- This individual shall be responsible for the in-water coordination of the scientific effort and the safety of the team while underwater.
- When diving operations are conducted in protected or shallow areas (less than 60 fsw), with currents less than .5 knots, and at the discretion of the DSO, the Lead Diver may assume the on-site responsibilities of the Diving Supervisor.

Waiver of Requirements

The UNH Diving Control Board may grant a waiver for specific requirements of training, examinations, depth certification, and minimum activity to maintain certification. This should be documented in the scientific diver's file.

Reciprocity and Visiting Scientific Diver

Two or more AAUS Organizational Members engaged jointly in diving activities, or engaged jointly in the use of diving resources, shall designate one of the participating Diving Control Boards to govern the joint dive project.

A Scientific Diver from one Organizational Member shall apply for permission to dive under the auspices of another Organizational Member by submitting to the Diving Safety Officer of the host Organizational Member a document containing all the information described in Appendix 6, signed by the Diving Safety Officer or Chairperson of the home Diving Control Board.

A visiting Scientific Diver may be asked to demonstrate their knowledge and skills for the planned dive to the receiving DSO or designee.

If a host OM denies a visiting Scientific Diver permission to dive, the host Diving Control Board shall notify the visiting Scientific Diver and their Diving Control Board with an explanation of all reasons for the denial.

1.30 Consequence of Violation of Regulations by Scientific Divers

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

1.40 Consequences of Violation of Regulations by Organizational Members

Failure to comply with the regulations of this standard may be cause for the revocation or restriction of the University of New Hampshire's Dive Program recognition by AAUS.

1.50 Record Maintenance

The Diving Program Officer or designee shall maintain permanent records for each Scientific Diver certified. The file shall include evidence of certification level, log sheets, results of current physical examination, reports of disciplinary actions by the UNH Diving Control Board, and other pertinent information deemed necessary.

Availability of Records:

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

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

2.10 Introduction

No person shall engage in scientific diving operations under the auspices of the University of New Hampshire scientific diving program unless they hold a current certification issued pursuant to the provisions of this manual.

2.20 Pre-Dive Procedures

Dive Plans

Dives should be planned around the competency of the least experienced diver. Before conducting any diving operations under the auspices of the organizational member, the lead diver for a proposed operation must formulate a dive plan that should include the following:

- Divers' qualifications, and the type of certificate or certification held by each diver.
- Emergency plan (Appendix 7) with the following information:
 1. Name, telephone number, and relationship of person to be contacted for each diver in the event of an emergency.
 2. Nearest operational decompression chamber via contacting Divers Alert Network.
 3. Nearest accessible hospital.
 4. Available means of transport.
- Approximate number of proposed dives.
- Location(s) of proposed dives.
- Estimated depth(s) and bottom time(s) anticipated.
- Decompression status and repetitive dive plans, if required.
- Proposed work, equipment, and boats to be employed.
- Any hazardous conditions anticipated.

Pre-dive Safety Checks

Diver and Buddy evaluations-

- Prior to commencing the dive the team must be sure every team member is healthy, fit, and trained for the type of dive being attempted.

Equipment Evaluations-

- Scientific divers shall conduct a functional check of their diving equipment in the presence of the diving buddy or tender. And ensure the equipment is suitable for the type of diving operation.
- Each diver shall have the capability of achieving and maintaining neutral buoyancy underwater and positive buoyancy on the surface.

Site Evaluation-

- Environmental conditions at the site will be evaluated.

2.30 Diving Procedures

Solo Diving Prohibition

All UNH diving activities shall assure adherence to the buddy system for scuba diving. The buddy system is two comparably equipped divers in the water in constant communication. This buddy system is based upon mutual assistance, especially in the case of an emergency. An exception to this rule is during tethered diving described in sec 8. If dive team members become separated they shall search in the area for no longer than one minute before surfacing to relocate the other team members and resume the dive if possible.

Refusal to Dive and Diver's responsibility

- The decision to dive is that of the diver. A diver may refuse to dive, without fear of penalty, whenever they feel it is unsafe for them to make the dive.
- The ultimate responsibility for safety rests with the individual diver. It is the diver's responsibility and duty to refuse to dive if, in their judgment, conditions are unsafe or unfavorable, or if they would be violating the precepts of their training or the regulations in this manual.
- No dive team member shall be required to be exposed to hyperbaric conditions against their will, except when necessary to prevent or treat a pressure-related injury.
- 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.

Termination of the Dive

- It is the responsibility of the diver to terminate the dive, without fear of penalty, whenever they feel it is unsafe to continue the dive, unless it compromises the safety of another diver already in the water.
- 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.

Emergencies and Deviations from Regulations

Any diver may deviate from the requirements of this standard to the extent necessary to prevent or minimize a situation that 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.

Diving From Vessels

All diving from University of New Hampshire owned or controlled vessels shall be limited to the following individuals:

- Those persons certified as UNH divers or guest divers engaged in recognized University research diving projects.
- Those persons certified as UNH divers engaged in training or certification activities as authorized by the Diving Program Officer.
- Students enrolled in a recognized UNH Diver Certification Course.
- Those persons who are paid by the UNH for diving services.

Vessel Diving Personal requirements

- When diving from UNH vessels the minimum crew shall consist of a boat operator and the dive team members. The boat operator shall be a certified UNH diver or have experience operating a vessel with divers, on at least 3 occasions under the supervision of a UNH qualified boat operator, or UNH certified diver. In Addition if the boat operator is not a UNH Diver they shall be certified in CPR/First Aid and Oxygen Administration for diving accidents.
- When diving from the RV Gulf Challenger or other large vessels operating under the auspices of the University of New Hampshire, the ‘Zodiac’ or other support vessels may be deployed when the vessel is at anchor. The decision to deploy the support vessel will be discussed by the Captain and the Diving Supervisor prior to the start of diving operations.
- All UNH diving activities conducted from vessels shall be under the direction of a Diving Supervisor. The Supervisor will be responsible for all diving activities and will cooperate with the vessel captain to ensure the safety of all aboard.
- When diving operations take place in protected waters near shore (0.25nm), at depths less than 60fsw with currents less than 0.5knots, and at the discretion of the DSO a designated Lead diver may substitute for the Diving Supervisor.
- Due to special conditions that might include but is not limited to; winter weather, remote dive sites, depth of dives, and diving mode the DSO may at anytime require additional qualified personnel aboard the diving platform or vessel.

Safety Stop

- The inclusion of a safety stop performed during the ascent phase of the dive is strongly recommended to minimize the formation of inert gas bubbles. Stops at 15 or 20 FSW (depending upon surface swell heights) for at least 3 minutes should be part of the dive plan and air consumption calculations.
- Weighted lines to accommodate safety stops may be suspended from the stern of a vessel or be part of the anchor cable. Buoyed descent / ascent lines may be used provided there is enough scope to allow the buoy to move up and down with the swell. NOTE: Surfacing, then going back down for a safety stop negates any beneficial effect of the stop. Once on the surface the diver must remain there.

2.40 Post-Dive Procedures

Post-Dive Safety Checks

After the completion of a dive, each diver shall report any physical problems, symptoms of decompression sickness, or equipment malfunctions, as soon as they are noted.

When diving outside the no-decompression limits, the divers should remain awake for at least 1 hour after diving, and in the company of a dive team member who is prepared to transport them to a decompression chamber if necessary.

2.50 Emergency Action Procedures

The UNHDP has developed emergency procedures which follow the standards of care of the community and includes procedures for emergency care, recompression and evacuation for each type of diving (Appendix 7-general EAP). Detailed procedures will be displayed on the project dive plan submitted to the UNH DCB.

2.60 Flying After Diving or Ascending to Altitude (Over 1000 feet)

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

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

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

Before ascending to Altitude above (1000 feet) by Land Transport: Divers should follow the appropriate guideline for preflight surface intervals unless the decompression procedure used has accounted for the increase in elevation.

2.70 Record Keeping Requirements

UNH Diving Log

Each certified scientific diver shall log every dive made under the auspices of the University of New Hampshire's dive program, and is encouraged to log all other dives. Excel Log sheets may be submitted to the Diving Program Officer. Unh also encourages divers to use the UNH/AAUS web-logging site to record their dives.

The diving log shall include at least the following:

- Name of diver, buddy.
- Date, time, and location.
- Diving modes used.
- Type of breathing gas used
- General nature of diving activities.
- Approximate surface and underwater conditions.
- Maximum depths, bottom time, and surface interval time.
- Diving tables or computers used.
- Detailed report of any near or actual incidents.

Required Incident Reporting

Incident: "An occurrence that interrupts normal procedures, or brings about a crisis."

All diving incidents requiring recompression treatment, or resulting in moderate or serious injury, or death shall be reported to the University of New Hampshire's Diving Control Board and the AAUS. The University requires the divers involved to write up their version of the incident, this will be reviewed by the DSO and DCB and then a final report will be turned over to AAUS. 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:

- The UNH DCB shall record and report occupational injuries and illnesses in accordance with requirements of the appropriate Labor Code section.
- If pressure-related injuries are suspected, or if symptoms are evident, the following additional information shall be recorded and retained by the UNH, with the record of the dive, for a period of 5 years:

Complete AAUS Incident Report at <http://www.aaus.org>.

Written descriptive report to include:

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

UNH DP shall investigate and document any incident of pressure-related injury and prepare a report that is to be forwarded to AAUS during the annual reporting cycle. This report must first be reviewed and released by the Diving Control Board.

SECTION 3.00 DIVING EQUIPMENT

3.10 General Policy

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

3.20 Equipment

Regulators

- Only those makes and models specifically approved by the Diving Program Officer and the Diving Control Board shall be used.
- Scuba regulators and gauges shall be inspected and tested prior to each use and serviced every 12 months thereafter or according to manufacturer recommendations.
- Regulators will consist of a primary second stage and an alternate air source (such as an octopus second stage or redundant air supply), and a submersible pressure gauge.

Scuba Cylinders

- Scuba cylinders shall be designed, constructed, and maintained in accordance with the applicable provisions of the Unfired Pressure Vessel Safety Orders.
- Scuba cylinders must be hydrostatically tested in accordance with DOT standards.
- Scuba cylinders must have an internal and external inspection at intervals not to exceed 12 months.
- Scuba cylinder valves shall be functionally tested at intervals not to exceed 12 months.

Buoyancy Compensator Devices

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

Dive Tables, depth gauges, timers, Dive Computers-Determination of Decompression Status

- Each members of the diving team must have an underwater timing device, an approved depth indicator, or dive computer.
- UNH allows for the use of the NAUI dive tables (based on the USN tables). If tables are being used they must be available at the dive site. Exceptions for the use of dive planning software must be approved by the DSO/DCB prior to diving.
- Dive computers may be utilized in place of diving tables, and must be approved by the DSO/DCB. AAUS recommendations on dive computers are located in Appendix 9.

3.30 Auxiliary Equipment

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

First aid supplies

- A first aid kit and emergency oxygen unit shall be available.

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.

Compressor Systems - UNH Controlled

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

- 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.
- Compressed air systems over 500 psig shall have slow-opening shut-off valves.
- All air compressor intakes shall be located away from areas containing exhaust or other contaminants.

3.50 Equipment Maintenance

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:

- Regulators and Submersible pressure gauges
- Depth gauges and dive computers
- Scuba cylinders
- Cylinder valves
- Diving helmets and Submersible breathing masks
- Compressors and Air filtration systems
- Gas control panels
- Air storage cylinders
- Analytical instruments
- Buoyancy control devices
- Dry suits

Compressor Operation and Air Test Records

Gas analyses and air tests shall be performed on each UNH-controlled breathing air compressor at regular intervals of no more than 100 hours of operation or 6 months, whichever occurs first. The results of these tests shall be entered in a formal log and be maintained. If a compressor system is used less than 6 months per year and less than 100 hours, 1 air test shall be deemed appropriate for that unit.

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).

CGA Grade E	
Component	Maximum
Oxygen	20 - 22%/v
Carbon Monoxide	10 PPM/v
Carbon Dioxide	1000 PPM/v
Condensed Hydrocarbons	5 mg/m ³
Total Hydrocarbons as Methane	25 PPM/v
Water Vapor ppm	(2)
Objectionable Odors	None

For breathing air used in conjunction with self-contained breathing apparatus in extreme cold where moisture can condense and freeze, causing the breathing apparatus to malfunction, a dew point not to exceed -65°F (24 ppm v/v) or 10 degrees F lower than the coldest temperature expected in the area is required.

SECTION 4.00 ENTRY-LEVEL TRAINING REQUIREMENTS

4.10 General Policy

Training and certification as an entry-level diver is a prerequisite to UNH/AAUS Scientific Diver Training. In lieu of writing/promulgating AAUS specific standards for entry-level divers, AAUS references here, the standards for entry-level diver training as defined by the WRSTC and/or ISO.

AAUS programs that wish to train entry-level divers may do so using one of the following options:

- a) Under the auspices and standards of an internationally recognized diver training agency.
- b) Under the auspices of AAUS using the minimum guidelines presented by the most current version of the RSTC/WRSTC and/or ISO entry-level diver standards.

The University of New Hampshire supports an open-water dive training program, which follows the international standards promulgated by the National Association of Underwater Instructors (NAUI). These standards meet or exceed the WRSTC/ISO standards.

4.20 References

“Minimum Course Content for Open Water Diver Certification”-World Recreational Scuba Training Council (WRSTC), www.wrstc.com.

“Safety related minimum requirements for the training of recreational scuba divers -- Part 2: Level 2 -- Autonomous diver”. ISO 24801-2:2007- International Organization for Standardization (ISO)-
www.iso.org.

“NAUI Standards and Procedures Manual-section 2-policies applying to all courses, entry level course-scuba diver. Appendix-details of skills”. www.NAUI.org

SECTION 5.00 SCIENTIFIC DIVER CERTIFICATION

This section describes the training and performance standards for UNH Scientific Divers. An individual who is authorized to dive under the auspices of the University of New Hampshire must be able to safely operate in an environment, which may include below freezing air temperatures, near freezing water temperatures, high currents, low to zero visibility, and rough seas. The transition for a diver with an open-water SCUBA certification to one certified to dive at UNH requires a specific training program to enable an individual to safely perform research activities within this challenging environment.

5.10 Prerequisites

Administrative

The applicant/candidate must complete all administrative and legal documentation required by UNH.

Diver Certification

The applicant/candidate must, at minimum, show documented proof of open water diver certification from an internationally recognized training agency. This certification must include a minimum of at least four open water Scuba dives.

Medical Examination

The applicant/candidate must be medically qualified for diving as described in Section 6.0 and Appendices 1-4.

Swimming/Waterman-ship Evaluation

The applicant/candidate must demonstrate the following in the presence of the Diving Safety Officer, instructor, or other approved examiner. All tests are to be performed without swim aids, however, where exposure protection is needed, the applicant must be appropriately weighted to provide for neutral buoyancy.

- a) Swim underwater for a distance of 25 yards/meters without surfacing.
- b) Swim 400 yards/meters in less than 12 minutes without swim aids.
- c) Tread water for 10 minutes, or 2 minutes without the use of hands.
- d) Transport a passive person of equal size a distance of 25 yards/meters in the water.

5.20 Training

The diver must complete theoretical aspects and practical training for a minimum cumulative time of 100 hours. Theoretical aspects shall include principles and activities appropriate to the intended area of scientific study.

Theoretical Training/ Knowledge Development

Required Topics:

1. Diving Emergency Care Training
 - Cardiopulmonary Resuscitation (CPR)
 - Standard or Basic First Aid

- Recognition of DCS and AGE
 - Accident Management
 - Field Neurological Exam
 - Oxygen Administration
2. Dive Rescue
 3. Dive Physics
 4. Dive Physiology
 5. Dive Environments
 6. Decompression Theory and its Application
 7. AAUS Scientific Diving Regulations and History
 - Scientific Dive Planning
 - Coordination with other Agencies
 - Appropriate Governmental Regulations
 8. Scientific Method
 9. Data Gathering Techniques (Only Items specific to area of study required)
 - Transect Sampling (Quadrating)
 - Transecting
 - Mapping
 - Coring
 - Photography
 - Tagging
 - Collecting
 - Animal Handling
 - Archaeology
 - Common Biota
 - Organism Identification
 - Behavior
 - Ecology
 - Site Selection, Location, and Re-location
 - Specialized Equipment for data gathering
 - HazMat Training
 - HP Cylinders
 - Chemical Hygiene, Laboratory Safety (Use Of Chemicals)

Suggested Topics:

10. Specific Dive Modes (methods of gas delivery)
 - Open Circuit
 - Hooka
 - Surface Supplied diving
11. Small Boat Operation
12. Rebreathers
 - Closed
 - Semi-closed
13. Specialized Breathing Gas
 - Nitrox
 - Mixed Gas
14. Specialized Environments and Conditions

- Blue Water Diving,
 - Ice and Polar Diving (Cold Water Diving)
 - Zero Visibility Diving
 - Polluted Water Diving
 - Saturation Diving
 - Decompression Diving
 - Overhead Environments
 - Aquarium Diving
 - Night Diving
 - Kelp Diving
 - Strong Current Diving (Live-boating)
 - Potential Entanglement
15. Specialized Diving Equipment
- Full face mask
 - Dry Suit
 - Communications

Practical Training/ Skill Development

Confined Water Evaluation

At the beginning of training, the trainee must satisfy the Diving Program Officer of their ability to perform the following, as a minimum, in a pool or in sheltered water:

- Enter water with full equipment.
- Clear facemask.
- Demonstrate air sharing, including both buddy breathing and the use of alternate air source, as both donor and recipient, with and without a facemask.
- Demonstrate understanding of underwater signs and signals.
- Demonstrate ability to remove and replace equipment while submerged.
- Demonstrate waterman-ship ability, which is acceptable to the instructor.

Open Water Evaluation

The trainee must satisfy the Diving Program Officer, or designee of their ability to perform at least the following in open water:

- Surface dive to a depth of 10 feet in open water without scuba.
- Demonstrate proficiency in air sharing as both donor and receiver.
- Enter and leave open water or surf, or leave and board a diving vessel, while wearing scuba gear.
- Kick on the surface 400 yards while wearing scuba gear, but not breathing from the scuba unit.
- Demonstrate, where appropriate, the ability to maneuver efficiently in the environment, at and below the surface.

- Complete a simulated emergency swimming ascent.
- Demonstrate clearing of mask and regulator while submerged.
- Demonstrate ability to achieve and maintain neutral buoyancy while submerged.
- Demonstrate techniques of self-rescue and buddy rescue.
- Demonstrate simulated in-water mouth-to-mouth resuscitation.
- Rescue and transport, as a diver, a passive simulated victim of an accident.
- Navigate underwater.
- Plan and execute a dive.
- Demonstrate judgment adequate for safe diving.

Checkout Dive and Additional Experience

Practical training must include an Open Water checkout dive(s), with evaluation of the skills listed in Open Water Evaluation, with the DSO or qualified delegate. The checkout shall be followed by at least 12 ocean or open water dives in a variety of dive sites and diving conditions, for a cumulative bottom time of at least 6 hours. Dives following the checkout dive must be under the supervision of the DSO.

5.30 Examinations

Written Exams

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

1. Function, care, use, and maintenance of diving equipment.
2. Physics and physiology of diving.
3. Diving regulations, precautions, and diving hazards.
4. Near-shore currents, waves, and aspects of the local diving environment.
5. Dangerous marine animals.
6. Emergency procedures, including buoyant ascent and ascent by air sharing.
7. Currently accepted decompression procedures.
8. Demonstrate the proper use of dive tables.
9. Underwater communications.
10. Hazards of breath-hold diving and ascents.
11. Planning and supervision of diving operations.
12. Cause, symptoms, treatment, and prevention of the following: near drowning, air embolism, carbon dioxide excess, squeezes, oxygen poisoning, nitrogen narcosis, exhaustion and panic, respiratory fatigue, motion sickness, decompression sickness, hypothermia, and hypoxia/anoxia.
13. Suggested topics (from Sec. 5.20) at the DSO's discretion.

Equipment

The trainee will be subject to examination/review of:

1. Personal diving equipment
2. Task specific equipment

5.40 Diver Permits-Certification Types

The University of New Hampshire requires that no person shall engage in scientific diving unless that person is authorized by UNH pursuant to the provisions of this manual. Only a person diving under the auspices of the UNHDP that subscribes to the practices of UNH is eligible for a scientific diver certification.

Scientific Diver Certification

This permit signifies a diver has completed all requirements in Section 5.0 and is authorized by the UNHDP to engage in scientific diving without supervision, as approved by the DSO. Submission of documents and participation in aptitude examinations does not automatically result in certification. The applicant must convince the Diving Program Officer and members of the DCB that they are sufficiently skilled and proficient to be certified. The signature of the Diving Program Officer will acknowledge this certification. Any applicant who does not possess the necessary judgment, under diving conditions, for the safety of the diver and their partner, may be denied UNH scientific diving privileges.

Scientific Diver-In-Training Permit

This is a permit to dive, usable only while it is current and for the purpose intended. This permit signifies that a diver has completed and been certified as at least an open-water diver through an internationally recognized certifying agency or scientific diving program, and has the knowledge skills and experience necessary to continue training as a scientific diver under supervision, as approved by the DSO. This permit is for training and not data collection.

UNH Guest diver permit

A Guest diver permit may be given to a visiting scientist, student or researcher from a non-AAUS institution. A guest permit may also constitute a waiver of the requirements of Section 5.0 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 Program Officer. This permit is not to be construed as a mechanism to circumvent existing standards set forth in this manual.

The Diving Program Officer may waive requirements of Section 5.0 if the person in question has demonstrated proficiency in diving and can contribute measurably to a planned dive. A statement of the Guest diver's qualifications shall be submitted to the Diving Safety Officer as a part of the dive plan. Guest permits shall be restricted to the planned diving operation and shall comply with all other policies, regulations, and standards of this standard, including medical requirements. In addition the guest diver must complete the proper waiver and release forms, carry current DAN insurance, and may only act as an observer on existing UNH diving projects.

5.50 Depth Certifications

Depth Certifications and Progression to Next Depth Level

A certified diver diving under the auspices of the UNHDP may progress to the next depth level after successfully completing the required dives for the next level. Under these circumstances the diver may exceed their depth limit: Dives shall be planned and executed under close supervision of a diver certified to the deeper depth, with the knowledge and permission of the DSO.

* Certification to 60-Foot Depth

Due to extreme tidal ranges in the Gulf of Maine, at UNH 60 fsw is the initial permit level, approved upon successful completion of the training requirements listed in Sec 5.0. An additional 12 dives must be completed in the 31 to 60 fsw certification range before a diver may move beyond the 60 fsw level, or be considered a lead diver. These 12 dives must be with a lead diver, or diving supervisor. The minimum accumulated time for these dives should be 4 hours. At this point the total dives logged in the scientific program will be at least 24. If a diver applies for reciprocity before the 24 dives are completed they will be considered a 30 fsw diver.

* Certification to 100 and 130 fsw Depths

A diver holding a 60-fsw certificate may be certified to depths of 100 and 130 feet respectively, by logging six dives near the maximum 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 gas management and decompression Tools.

* Certification to Depths Over 130 fsw

A diver may be certified to depths of 150 and 190 feet after the completion of six dives near each depth. Dives shall be planned and executed under close supervision of a lead diver certified to this depth. The diver must also demonstrate knowledge of the special problems of deep diving, and of special safety requirements.

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

5.60 Continuation of Certificate

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.

Re-qualification of Depth Certificate

Once the initial certification requirements of Section 5.00 are met, divers whose depth certification has lapsed due to lack of activity may be re-qualified by procedures adopted by the UNH's DCB.

Medical Examination

All certified scientific divers shall pass a medical examination at the intervals specified in Section 6.0. After each major illness or injury, as described in Section 6.0, a certified scientific diver shall receive clearance to return to diving from a physician before resuming diving activities. Each UNH diver shall complete a medical history up-date to be filled out and turned in to the DSO in June.

Emergency Care Training

The scientific diver must provide proof of training in the following:

- Adult CPR – Divers shall complete a refresher course every 12 months.
- Emergency oxygen administration must be current within 2 years
- First aid for diving accidents must be current within 2 years

5.70 Revocation of Certification

A diving certificate may be revoked or restricted for cause by the Diving Program Officer or the DCB. Violations of regulations set forth in this manual, or other governmental subdivisions not in conflict with this standard, may be considered cause. Diving Program Officer shall inform the diver in writing of the reason(s) for revocation. The diver will be given the opportunity to present their 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.

5.80 Recertification

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

SECTION 6.00 MEDICAL STANDARDS

6.10 Medical Requirements

General

- The University Diving Program Officer 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.
- 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.
- The diver should be free of any chronic disabling disease and any conditions contained in the list of conditions for which restrictions from diving are generally recommended. (Appendix 1)

6.20 Frequency of Medical Evaluations

Medical evaluation shall be completed:

- 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 UNHDP has obtained the results of that examination, and those results have been reviewed and found satisfactory.
- Thereafter, at 5 year intervals up to age 40, every 3 years after the age of 40, and every 2 years after the age of 60.
- Clearance to return to diving must be obtained from a physician following any major injury or illness, or any condition requiring hospital care or chronic medication. If the injury or illness is pressure related, then the clearance to return to diving must come from a physician trained in diving medicine.
- Scientific divers shall update the UNH Medical history form each year at the beginning of summer field season, these forms will be kept private in the diver's files.

6.30 Information Provided Examining Physician

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

6.40 Content of Medical Evaluations and Physician's Written Report

Medical examinations conducted initially and at the intervals specified in Section 6.10 shall consist of the following: Applicant agreement for release of medical information to the UNH, Medical history (Appendix 3), and a Diving physical examination (Required tests in Appendix 2).

After any medical examination relating to the individual's fitness to dive, UNH shall obtain a written report prepared by the examining physician that shall contain the examining physician's opinion of the individual's fitness to dive, including any recommended restrictions or limitations. This report will be reviewed by the DCB. UNH shall make a copy of the physician's written report available to the individual.

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**Sections 7.00 through 12.00
Detailed training standards for
UNH Specific Sections
And
Appendices 1-10**

SECTION 7.00 NITROX DIVING GUIDELINES

The following guidelines address the use of nitrox by scientific divers under the auspices of UNH. 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

Eligibility

Only a certified Scientific Diver or Scientific Diver In Training sec 5.0 diving under the auspices of UNH is eligible for authorization to use nitrox. After completion, review and acceptance of application materials, training and qualification, an applicant will be authorized to use nitrox within their depth authorization, as specified in Section 5.50.

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 they are 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:

1. Training

The diver must complete additional theoretical and practical training beyond the Scientific Diver In Training air certification level, to the satisfaction of the UNH DSO and DCB (Section 7.30).

2. Examinations

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

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

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

Classroom Instruction

Topics should include, but are not limited to: review of previous training; physical gas laws pertaining to nitrox; partial pressure calculations and limits; equivalent air depth (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. 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.

Practical Training

The practical training portion will consist of a review of skills as stated for scuba (Section 5.00), with additional training as follows:

- Oxygen analysis of nitrox mixtures.
- Determination of MOD, oxygen partial pressure exposure, and oxygen toxicity time limits, for various nitrox mixtures at various depths.
- 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.
- Nitrox dive computer use may be included, as approved by the DCB.

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:

- Function, care, use, and maintenance of equipment cleaned for nitrox use.
- Physical and physiological considerations of nitrox diving (ex.: O₂ and CO₂ toxicity).
- Diving regulations and procedures as related to nitrox diving, either scuba or surface-supplied (depending on intended mode).
- Given the proper information, calculation of:
 - Equivalent air depth (EAD) for a given fO_2 and actual depth;
 - pO_2 exposure for a given fO_2 and depth;
 - Optimal nitrox mixture for a given pO_2 exposure limit and planned depth;
 - Maximum operational depth (MOD) for a given mix and pO_2 exposure limit;
 - For nitrox production purposes, percentages/psi of oxygen present in a given mixture, and psi of each gas required to produce a fO_2 by partial pressure mixing.
- Dive table and dive computer selection and usage.
- Nitrox production methods and considerations.
- Oxygen analysis.
- Nitrox operational guidelines (Section 7.40), dive planning, and dive station components.

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.

Surface-Supplied Training

All training as applied to surface-supplied diving (practical, classroom, and open-water) will follow the member organization's surface-supplied diving standards, including additions listed in Section 8.0.

7.40 Scientific Nitrox Diving Regulations

Dive Personnel Requirements

- Nitrox Diver In Training - A Diver In Training, who has completed the requirements to be a scientific diver in training, may be authorized by the DSO to use nitrox under the direct supervision of the Diving Program Officer, or designee who also holds nitrox authorization. Dive depths should be restricted to those specified in the diver's authorization.
- Scientific Diver - A Scientific Diver who has completed the requirements of 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 5.50.
- Lead Diver - On any dive during which nitrox will be used by any team member, the Lead Diver should be authorized to use nitrox, and hold appropriate authorizations required for the dive, as specified in AAUS Standards. Lead Diver authorization for nitrox dives by the DSO and/or DCB should occur as part of the dive plan approval process.

In addition to responsibilities listed in Section 1.20, the Lead Diver should:

1. As part of the dive planning process, verify that all divers using nitrox on a dive are properly qualified and authorized;
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.
3. The Lead Diver should also reduce the maximum allowable pO₂ exposure limit for the dive team if on-site conditions so indicate (see Sec. 7.42).

Dive Parameters

Oxygen Exposure Limits

- 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".
- 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.

- 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.

Bottom Time Limits

- Maximum bottom time should be based on the depth of the dive and the nitrox mixture being used.
- 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.

Dive Tables and Gases

- A set of DCB approved nitrox dive tables should be available at the dive site.
- When using the equivalent air depth (EAD) method, dives should be conducted using air dive tables approved by the DCB.
- 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.
- 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 and oxygen partial pressure limits set forth in Section 7.40 Dive Parameters.

Nitrox Dive Computers

- Dive computers may be used to compute decompression status during nitrox dives. Manufacturers’ guidelines and operations instructions should be followed.
- Use of Nitrox dive computers should comply with dive computer guidelines included in the AAUS Standards.
- 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 designee.
- 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 shall not be exceeded.
- Dive computers capable of pO_2 limit and fO_2 adjustment should be checked by the diver prior to the start each dive to assure compatibility with the mix being used.

Repetitive Diving

- Repetitive dives using nitrox mixtures should be performed in compliance with procedures required of the specific dive tables used.
- 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.
- 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.

- 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.

Oxygen Parameters

- Authorized Mixtures - Mixtures meeting the criteria outlined in Section 7.40 may be used for nitrox diving operations, upon approval of the DCB.
- Purity - Oxygen used for mixing nitrox-breathing gas should meet the purity levels for “Medical Grade” (U.S.P.) or “Aviator Grade” standards.
- 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%.
 - 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

Gas Mixing and Analysis for the University of New Hampshire Dive Program

Personnel Requirements

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

Production Methods

The UNHDP has approved the use of partial pressure blending for mixing Nitrox.

Analysis Verification by User

- a) It is the responsibility of each diver to analyze prior to the dive the oxygen content of his/her scuba cylinder and acknowledge in writing the following information for each cylinder: fO₂, MOD, cylinder pressure, date of analysis, and user’s name.
- b) Individual dive log reporting forms should report fO₂ of nitrox used, if different than 21%.

7.50 Nitrox Diving Equipment

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

- Labeled SCUBA Cylinders
- Oxygen Analyzers

Oxygen Cleaning and Maintenance Requirements

Requirement for Oxygen Service

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

Scuba Cylinder Identification Marking

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

- a) Cylinders should be marked “NITROX”, or “EANx”, or “Enriched Air”.
- b) 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.
- c) The alternate marking of a yellow cylinder by painting the cylinder crown green and printing the word “NITROX” parallel to the length of the cylinder in green print is acceptable.
- d) Other markings, which identify the cylinder as containing gas mixes other than Air, may be used as the approval of the DCB.A contents label should be affixed, to include the current fO_2 , date of analysis, and MOD.
- e) The cylinder should be labeled to indicate whether the cylinder is prepared for oxygen or nitrox mixtures containing greater than 40% oxygen.

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.

Other Support Equipment

- a) 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.
- b) All diver and support equipment should be suitable for the fO_2 being used.

Compressor system

- a) Compressor/filtration system must produce oil-free air.
- b) An oil-lubricated compressor placed in service for a nitrox system should be checked for oil and hydrocarbon contamination at least quarterly.

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 SURFACE SUPPLIED DIVING

8.10 General Policy

Surface Supplied: Dives where the breathing gas is supplied from the surface by means of a pressurized umbilical hose. The umbilical generally consists of a gas supply hose, strength member, pneumofathometer hose, and communication line. The umbilical supplies a helmet or full-face mask. The diver may rely on the tender at the surface to keep up with the divers' depth, time and diving profile. 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.

8.20 Surface Supplied Equipment

All system components, including breathing gas source, umbilical hose, diver mask, and regulator system must be approved by the Diving Control Board before use.

Breathing Masks and Helmets

- A-Breathing masks and helmets shall have:
 - 1-A non-return valve at the attachment point between helmet or mask hose, which shall close readily and positively.
 - 2-An exhaust valve.
 - A minimum ventilation rate capable of maintaining the diver at the depth to which he/she is diving.
- The diver will wear an approved harness to which the umbilical hose will be secured. The attachment must be of sufficient strength so as to prevent any strain on the helmet hose connections.
- No surface supplied diving will be allowed without an emergency gas supply (bail-out bottle) be carried by the diver containing sufficient air to complete the ascent to the surface, including all required decompression and safety stops,
- All divers will carry at least 1 cutting tool.

8.30 Diving Gas Source

- If the source of breathing gas is to be high pressure bottles, air consumption rates must be calculated to ensure an adequate safety margin.
- An approved high to low pressure regulator must be employed to reduce the bottle pressure to that required by the diver (typically 100 psig plus 1/2 the depth in feet).
- If the breathing gas source is a low pressure engine driven compressor, care must be taken to prevent contamination by the engine exhaust. Air quality samples shall be taken from the diver's gas supply line before diving operations begin.

8.40 Surface Supplied Tending and Communication

- Tending and Communication. A surface tender will be designated to handle the umbilical hose and at no time will the hose be unattended while the diver is in the water.
- A series of appropriate pull signals (including for emergencies) will be arranged between the diver and the tender.
- All pull signals received shall be answered (except for emergency signals) to ensure understanding and agreement.
- NOTE: The presence of an electronic communication system does not alter this requirement.

MINIMUM PULL SIGNALS

<u>Pulls</u>	<u>Tender</u>	<u>Diver</u>
1	Are you OK?	I am OK
2	Descend	Give me more hose or I am descending
3	Ascend	Take up my hose or I am ascending
4	Emergency!, come up	Emergency, haul me up now!!!

- An electronic communication system is required for Surface supplied diving to depths greater than 100 FWS.
- If a failure of the electronic communication system occurs at a depth greater than 100 FSW, the working diver should be immediately notified by pull signal to terminate the dive and return to the surface.

8.50 Safety Standby Diver

- A fully dressed safety diver will stand by prepared for immediate entry into the water to aid the working diver if by signal or lack of signal it becomes apparent that the diver requires assistance.
- Under no circumstances shall the safety diver act as tender.

SECTION 9.00 STAGED DECOMPRESSION DIVING

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

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

9.10 Minimum Experience and Training Requirements

Prerequisites

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

Training

Training shall be appropriate for the conditions in which dive operations are to be conducted. Minimum Training shall include the following:

- 1) A minimum of 6 hours of classroom training to ensure theoretical knowledge to include: physics and physiology of decompression; decompression planning and procedures; gas management; equipment configurations; decompression method, emergency procedures, and omitted decompression.
- 2) It is recommended that at least one training session be conducted in a pool or sheltered water setting, to cover equipment handling and familiarization, swimming and buoyancy control, to estimate gas consumption rates, and to practice emergency procedures.
- 3) At least 6 open-water training dives simulating/requiring decompression shall be conducted, emphasizing planning and execution of required decompression dives, and including practice of emergency procedures.
- 4) Progression to greater depths shall be by dive increments at depth intervals as specified in Section 5.50.
- 5) No training dives requiring decompression shall be conducted until the diver has demonstrated acceptable skills under simulated conditions.

- 6) The following are the minimum skills the diver must demonstrate proficiently during dives simulating and requiring decompression:
 - Buoyancy control
 - Proper ascent rate
 - Proper depth control
 - Equipment manipulation
 - Stage/decompression bottle use as pertinent to planned diving operation
 - Buddy skills
 - Gas management
 - Time management
 - Task loading
 - Emergency skills
- 7) Divers shall demonstrate to the satisfaction of the DSO or the DSO's qualified designee proficiency in planning and executing required decompression dives appropriate to the conditions in which diving operations are to be conducted.
- 8) Upon completion of training, the diver shall be authorized to conduct required decompression dives with DSO approval.

9.20 Minimum Equipment Requirements

- a) Valve and regulator systems for primary (bottom) gas supplies shall be configured in a redundant manner that allows continuous breathing gas delivery in the event of failure of any one component of the regulator/valve system.
- b) Cylinders with volume and configuration adequate for planned diving operations
- c) One of the second stages on the primary gas supply shall be configured with a hose of adequate length to facilitate effective emergency gas sharing in the intended environment.
- d) Minimum dive equipment shall include:
 - 1) Snorkel is optional
 - 2) Diver location devices adequate for the planned diving operations and environment.
 - 3) Compass
- e) Redundancy in the following components is desirable or required at the discretion of the DCB or DSO:
 - 1) Decompression Schedules
 - 2) Dive Timing Devices
 - 3) Depth gauges
 - 4) Buoyancy Control Devices
 - 5) Cutting devices
 - 6) Lift bags and line reels

9.30 Minimum Operational Requirements

- Approval of dive plan applications to conduct required decompression dives shall be on a case-by-case basis.
- The maximum pO_2 to be used for planning required decompression dives is 1.6. It is recommended that a pO_2 of less than 1.6 be used during bottom exposure.
- Diver's gas supplies shall be adequate to meet planned operational requirements and foreseeable emergency situations.
- Decompression dives may be planned using dive tables, dive computers, and/or PC software approved by the DSO/DCB.
- Breathing gases used while performing in-water decompression shall contain the same or greater oxygen content as that used during the bottom phase of the dive.
- The dive team prior to each dive shall review emergency procedures appropriate for the planned dive.
- If breathing gas mixtures other than air are used for required decompression, their use shall be in accordance with those regulations set forth in the appropriate sections of this standard.
- The maximum depth for required decompression using air as the bottom gas shall be 190 feet.
- Use of additional nitrox and/or high-oxygen fraction decompression mixtures as travel and decompression gases to decrease decompression obligations is encouraged.
- Use of alternate inert gas mixtures to limit narcosis is encouraged for depths greater than 150 feet.
- If a period of more than 6 months has elapsed since the last decompression dive, a series of progressive workup dives to return the diver(s) to proficiency status prior to the start of project diving operations are recommended.
- Mission specific workup dives are recommended.

SECTION 10.00 MIXED GAS DIVING

Mixed gas diving is defined as dives done while breathing gas mixes containing proportions greater than 1% by volume of an inert gas other than nitrogen.

10.10 Minimum Experience and Training Requirements

Prerequisites

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

Classroom training including

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

Practical Training

- 1) Confined water session(s) in which divers demonstrate proficiency in required skills and techniques for proposed diving operations.
- 2) A minimum of 6 open water training dives.
- 3) At least one initial dive shall be in 130 feet or less to practice equipment handling and emergency procedures.
- 4) Subsequent dives will gradually increase in depth, with a majority of the training dives being conducted between 130 feet and the planned operational depth.
- 5) Planned operational depth for initial training dives shall not exceed 260 feet.
- 6) Diving operations beyond 260 feet requires additional training dives.

10.20 Equipment and Gas Quality Requirements

- a) Equipment requirements shall be developed and approved by the DCB, and met by divers, prior to engaging in mixed-gas diving. Equipment shall meet other pertinent requirements set forth elsewhere in this standard.
- b) The quality of inert gases used to produce breathing mixtures shall be of an acceptable grade for human consumption.

10.30 Minimum Operational Requirements

- a) Approval of dive plan applications to conduct mixed gas dives shall be on a case-by-case basis.
- b) All applicable operational requirements for nitrox and decompression diving shall be met.
- c) The maximum pO_2 to be used for planning required decompression dives is 1.6. It is recommended that a pO_2 of less than 1.6 be used during bottom exposure.
- d) Maximum planned Oxygen Toxicity Units (OTU) will be considered based on mission duration.
- e) Divers decompressing on high-oxygen concentration mixtures shall closely monitor one another for signs of acute oxygen toxicity.
- f) If a period of more than 6 months has elapsed since the last mixed gas dive, a series of progressive workup dives to return the diver(s) to proficiency status prior to the start of project diving operations are recommended.

SECTION 11.00 OTHER DIVING TECHNOLOGY

Certain types of diving, some of which are listed below, require equipment or procedures that require training. Supplementary guidelines for these technologies are in development by the AAUS. Organizational member's using these, must have guidelines established by their Diving Control Board. Divers shall comply with all scuba diving procedures in this standard unless specified.

11.10 Blue Water Diving

Blue water diving is defined as diving in open water where the bottom is generally greater than 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).

11.20 Ice And Polar Diving

Divers planning to dive under ice or in polar conditions should use the following: "Guidelines for Conduct of Research Diving", National Science Foundation, Division of Polar Programs, 2013.

11.30 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.

11.40 Saturation Diving

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

11.50 Hookah

While similar to Surface Supplied in that the breathing gas is supplied from the surface by means of a pressurized hose, the supply hose does not require a strength member, pneumofathometer hose, or communication line. Hookah equipment may be as simple as a long hose attached to a standard scuba cylinder supplying a standard scuba second stage. The diver is responsible for the monitoring his/her own depth, time, and diving profile.

SECTION 12.00 REBREATHERS

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

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

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

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

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

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

12.10 Definitions and General Information

Rebreathers are defined as any device that recycles some or all of the exhaled gas in the breathing loop and returns it to the diver. Rebreathers maintain levels of oxygen and carbon dioxide that support life by metered injection of oxygen and chemical removal of carbon dioxide. These characteristics fundamentally distinguish rebreathers from open-circuit life support systems, in that the breathing gas composition is dynamic rather than fixed. An increased level of discipline and attention to rebreather system status by the diver is required for safe operation, with a greater need for self-reliance. Rebreather system design and operation varies significantly between make and model. For these reasons when evaluating any dive plan incorporating rebreathers, risk-management emphasis should be placed on the individual qualifications of the diver on the specific rebreather make and model to be used, in addition to specific equipment requirements and associated operational protocols.

- Advantages of rebreathers may include increased gas utilization efficiencies that are often independent of depth, extended no-decompression bottom times and greater decompression efficiency, and reduction or elimination of exhaust bubbles that may disturb aquatic life or sensitive environments.
- Disadvantages of rebreathers include high cost and, in some cases, a high degree of system complexity and reliance on instrumentation for gas composition control and monitoring, which may fail. The diver is more likely to experience hazardous levels of hypoxia, hyperoxia, or hypercapnia, due to user error or equipment malfunction, conditions which may lead to underwater blackout and drowning. Inadvertent flooding of the breathing loop and wetting of the carbon dioxide absorbent may expose the diver to ingestion of an alkaline slurry ("caustic cocktail").

Oxygen Rebreathers

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

Semi-Closed Circuit Rebreathers

Semi-closed circuit rebreathers (SCR) recycle the majority of exhaled breathing gas, venting a portion into the water and replenishing it with a constant or variable amount of a single oxygen-enriched gas mixture. Gas addition and venting is balanced against diver metabolism to maintain safe oxygen levels by means which differ between SCR models, but the mechanism usually provides a semi-constant fraction of oxygen (FO₂) in the breathing loop at all depths, similar to open-circuit SCUBA.

Closed-Circuit Mixed Gas Rebreathers

Closed-circuit mixed gas rebreathers (CCR) recycle all of the exhaled gas and replace metabolized oxygen via an electronically controlled valve, governed by electronic oxygen sensors. Manual oxygen addition is available as a diver override, in case of electronic system failure. A separate inert gas source (diluent), usually containing primarily air, heliox, or trimix, is used to maintain oxygen levels at safe levels when diving below 20fsw. CCR systems operate to maintain a constant oxygen partial pressure (PPO₂) during the dive, regardless of depth.

12.20 Prerequisites

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

Training Prerequisites

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

Training

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

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

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

1. In particular, causes, signs and symptoms, first aid, treatment and prevention of the following must be covered:
 - Hyperoxia (CNS and Pulmonary Oxygen Toxicity)
 - Middle Ear Oxygen Absorption Syndrome (oxygen ear)
 - Hyperoxia-induced myopia
 - Hypoxia
 - Hypercapnia
 - Inert gas narcosis
 - Decompression sickness

2. Rebreather-specific information required for the safe and effective operation of the system to be used, including:
 - System design and operation, including:
 - Counterlung(s)
 - CO₂ scrubber
 - CO₂ absorbent material types, activity characteristics, storage, handling and disposal
 - Oxygen control system design, automatic and manual
 - Diluent control system, automatic and manual (if any)
 - Pre-dive set-up and testing
 - Post-dive break-down and maintenance
 - Oxygen exposure management
 - Decompression management and applicable decompression tracking methods
 - Dive operations planning
 - Problem recognition and management, including system failures leading to hypoxia, hyperoxia, hypercapnia, flooded loop, and caustic cocktail
 - Emergency protocols and bailout procedures

Practical training with model of rebreather being used

- A minimum number of hours of underwater time.

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

* Dives should not exceed 20 fsw.

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

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

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

Practical Evaluations

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

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

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

Written Evaluation

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

Supervised Rebreather Dives

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

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

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

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

Extended Range, Required Decompression and Helium-Based Inert Gas

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

- As a prerequisite for training in staged decompression using rebreathers, the diver shall have logged a minimum of 25 hours of underwater time on the rebreather system to be used, with at least 10 rebreather dives in the 100 fsw to 130 fsw range.

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

Training shall be in accordance with standards for required-decompression and mixed gas diving, as applicable to rebreather systems, starting at the 130 fsw level.

Maintenance of Proficiency

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

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

12.30 Equipment Requirements

General Requirements

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

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

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

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

These should include:

- Operational depth range
- Operational temperature range
- Breathing gas mixtures that may be used
- Maximum exercise level which can be supported as a function of breathing gas and depth
- Breathing gas supply durations as a function of exercise level and depth
- CO₂ absorbent durations, as a function of depth, exercise level, breathing gas, and water temperature
- Method, range and precision of inspired PPO₂ control, as a function of depth, exercise level, breathing gas, and temperature
- Likely failure modes and backup or redundant systems designed to protect the diver if such failures occur
- Accuracy and precision of all readouts and sensors
- Battery duration as a function of depth and temperature
- Mean time between failures of each subsystem and method of determination

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

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

Minimum Equipment

1. A surface/dive valve in the mouthpiece assembly, allowing sealing of the breathing loop from the external environment when not in use.
2. An automatic gas addition valve, so that manual volumetric compensation during descent is unnecessary.
3. Manual gas addition valves, so that manual volumetric compensation during descent and manual oxygen addition at all times during the dive are possible.
4. The diver shall carry alternate life support capability (open-circuit bail-out or redundant rebreather) sufficient to allow the solution of minor problems and allow reliable access to a pre-planned alternate life support system.

Oxygen Rebreathers

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

Semi-Closed Circuit Rebreathers.

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

Closed Circuit Mixed-gas Rebreathers.

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

12.40 Operational Requirements

General Requirements

- All dives involving rebreathers must comply with applicable operational requirements for open-circuit SCUBA dives to equivalent depths.
- No rebreather system should be used in situations beyond the manufacturer's stated design limits (dive depth, duration, water temperature, etc).

- Modifications to rebreather systems shall be in compliance with manufacturer's recommendations.
- Rebreather maintenance is to be in compliance with manufacturer's recommendations including sanitizing, replacement of consumables (sensors, CO₂ absorbent, gas, batteries, etc) and periodic maintenance.

Dive Plan

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

- Information about the specific rebreather model to be used
- Make, model, and type of rebreather system
- Type of CO₂ absorbent material
- Composition and volume(s) of supply gases
- Complete description of alternate bailout procedures to be employed, including manual rebreather operation and open-circuit procedures
- Other specific details as requested by DCB

Buddy Qualifications

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

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

Oxygen Exposures

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

Decompression Management

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

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

1. Oxygen rebreathers: Not applicable.
2. SCR (presumed constant FO₂):
 - Use of any method approved for open-circuit scuba diving breathing air, above the maximum operational depth of the supply gas.

- Use of open-circuit nitrox dive tables based upon expected inspired FO_2 . In this case, contingency air dive tables may be necessary for active-addition SCR's in the event that exertion level is higher than expected.
 - Equivalent air depth correction to open-circuit air dive tables, based upon expected inspired FO_2 for planned exertion level, gas supply rate, and gas composition. In this case, contingency air dive tables may be necessary for active-addition SCR's in the event that exertion level is higher than expected.
3. CCR (constant PPO_2):
- Integrated constant PPO_2 dive computer.
 - Non-integrated constant PPO_2 dive computer.
 - Constant PPO_2 dive tables.
 - Open-circuit (constant FO_2) nitrox dive computer, set to inspired FO_2 predicted using PPO_2 set point at the maximum planned dive depth.
 - Equivalent air depth (EAD) correction to standard open-circuit air dive tables, based on the inspired FO_2 predicted using the PPO_2 set point at the maximum planned dive depth.
 - Air dive computer, or air dive tables used above the maximum operating depth (MOD) of air for the PPO_2 setpoint selected.

Maintenance Logs, CO₂ Scrubber Logs, Pre and Post dive check lists

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

- Gas supply cylinders full
- Composition of all supply and bail-out gases analyzed and documented
- Oxygen sensors calibrated
- Carbon dioxide canister properly packed
- Remaining duration of canister life verified
- Breathing loop assembled
- Positive and negative pressure leak checks
- Automatic volume addition system working
- Automatic oxygen addition systems working
- Pre-breathe system for 3 minutes (5 minutes in cold water) to ensure proper oxygen addition and carbon dioxide removal (be alert for signs of hypoxia or hypercapnia)
- Other procedures specific to the model of rebreather used
- Documentation of ALL components assembled
- Complete pre-dive system check performed
- Final operational verification immediately before to entering the water:
 - PO_2 in the rebreather is not hypoxic
 - Oxygen addition system is functioning;
 - Volumetric addition is functioning
 - Bail-out life support is functioning

Alternate Life Support System

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

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

CO₂ Absorbent Material

- CO₂ absorption canister shall be filled in accordance with the manufacturer's specifications.
- CO₂ absorbent material shall be used in accordance with the manufacturer's specifications for expected duration.
- If CO₂ absorbent canister is not exhausted and storage between dives is planned, the canister should be removed from the unit and stored sealed and protected from ambient air, to ensure the absorbent retains its activity for subsequent dives.
- Long-term storage of carbon dioxide absorbents shall be in a cool, dry location in a sealed container. Field storage must be adequate to maintain viability of material until use.

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

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

Unit Disinfections

The entire breathing loop, including mouthpiece, hoses, counter lungs, and CO₂ canister, should be disinfected periodically according to manufacturer's specifications. The loop must be disinfected between each use of the same rebreather by different divers.

12.50 Oxygen Rebreathers

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

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

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

12.60 Semi-Closed Circuit Rebreathers

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

The gas addition rate of active addition SCR (e.g., Draeger Dolphin and similar units) shall be checked before every dive, to ensure it is balanced against expected workload and supply gas FO₂.

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

Maximum operating depth shall be based upon the FO_2 in the active supply cylinder.

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

12.70 Closed-Circuit Rebreathers

The FO_2 of each diluent gas supply used shall be chosen so that, if breathed directly while in the depth range for which its use is intended, it will produce an inspired PPO_2 greater than 0.20 ata but no greater than 1.4 ata.

Maximum operating depth shall be based on the FO_2 of the diluent in use during each phase of the dive, so as not to exceed a PO_2 limit of 1.4 ata.

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

The PPO_2 set point shall not be lower than 0.4 ata or higher than 1.4 ata.

Appendices

Appendix 1 through 10

APPENDIX 1

DIVING MEDICAL EXAM OVERVIEW FOR THE EXAMINING PHYSICIAN

TO THE EXAMINING PHYSICIAN:

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

Elizabeth Kintzing ek@unh.edu 603-834-1398 Diving Program Officer

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

CONDITIONS WHICH MAY DISQUALIFY CANDIDATES FROM DIVING

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

SELECTED REFERENCES IN DIVING MEDICINE

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

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

APPENDIX 2
UNH MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING REPORT

Name of Applicant (Print or Type)

Date of Medical Evaluation (Month/Day/Year)

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

TESTS: THE FOLLOWING TESTS ARE REQUIRED-Please initial that each required tests have been completed:

DURING ALL INITIAL EXAMS

- Medical history
- Complete physical exam, with emphasis on neurological and otological components
- Chest X-Ray-required only on initial exam
- Spirometry-required only on initial exam
- Hematocrit or Hemoglobin
- Urinalysis
- Any further tests deemed necessary by the physician
-

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

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

PHYSICIAN'S STATEMENT:

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

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

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

_____ MD or DO _____
Signature **Date**

Dr. Name (Print or Type)

Address

Telephone Number

E-Mail Address

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

My familiarity with diving medicine is: _____

APPLICANT'S RELEASE OF MEDICAL INFORMATION FORM

Name of Applicant (Print or Type)

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

Signature of Applicant _____

Date _____

REFERENCES

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

APPENDIX 3
DIVING MEDICAL HISTORY FORM
 (To Be Completed By Applicant-Diver)

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

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

TO THE APPLICANT:

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

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

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

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

59			Low blood pressure
60			Recurrent or persistent swelling of the legs
61			Pounding, rapid heartbeat or palpitations
62			Easily fatigued or short of breath
63			Abnormal EKG
64			Joint problems, dislocations or arthritis
65			Back trouble or back injuries
66			Ruptured or slipped disk
67			Limiting physical handicaps
68			Muscle cramps
69			Varicose veins
70			Amputations
71			Head injury causing unconsciousness
72			Paralysis
73			Have you ever had an adverse reaction to medication?
74			Do you smoke?
75			Have you ever had any other medical problems not listed? If so, please list or describe below;
76			Is there a family history of high cholesterol?
77			Is there a family history of heart disease or stroke?
78			Is there a family history of diabetes?
79			Is there a family history of asthma?
80			Date of last tetanus shot? Vaccination dates?

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

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

Signature

Date

APPENDIX 4
RECOMMENDED PHYSICIANS WITH EXPERTISE IN DIVING MEDICINE

Dr. Thomas Chayka (retired)	Old Post Road York Maine	207 363 5321
Dr. Craig Hersh	Pulmonary Medicine Mass General	617 726 1721
Dr. Marc Lombardo	Neurology Associate Concord NH	603-224-6691
Dr. Frank S. Shank	Boston MA	617-573-4411
Dr. Robert Hawkins	Orono, Maine	207-866-7235
Dr. Mary E. Hanley	Kent Hospital Wound Center RI	401-736-4646
Dr. Christopher Mozdzanowoski	Kent Hospital	401-736-4646
Dr. Geradine Ruffa	Groton CT	860-446-8265 x7091
Dr. David Charash	Danbury Hospital	203-788-7133

APPENDIX 5 DEFINITION OF TERMS

Air sharing - Sharing of an air supply between divers.

ATA(s) - “Atmospheres Absolute”, 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 - 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 - 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 internationally recognized certifying agency.

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

Cylinder - A pressure vessel for the storage of gases.

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

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 - Physical location of a diver during a dive.

Dive 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.

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

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

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

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

Diving Control Board (DCB) - Group of individuals who act as the official representative of the membership organization in matters concerning the scientific diving program (Section 1.24).

Diving Safety Officer (DSO) - Individual responsible for the safe conduct of the scientific diving program of the membership organization (Section 1.20).

EAD - 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” (Section 7.00).

Equivalent Air Depth (EAD) - 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 or saltwater, will always be less than the actual depth for any enriched air mixture.

fN_2 - Fraction of nitrogen in a gas mixture, expressed as either a decimal or percentage, by volume.

fO_2 - Fraction of oxygen in a gas mixture, expressed as either a decimal or percentage, by volume.

FFW - Feet of freshwater, or equivalent static head.

FSW - Feet of seawater, or equivalent static head.

Hookah - While similar to Surface Supplied in that the breathing gas is supplied from the surface by means of a pressurized hose, the supply hose does not require a strength member, pneumofathometer hose, or communication line. Hookah equipment may be as simple as a long hose attached to a standard scuba cylinder supplying a standard scuba second stage. The diver is responsible for the monitoring his/her own depth, time, and diving profile.

Hyperbaric Chamber - See decompression chamber.

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

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

Maximum Working Pressure - 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 - MG

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 pO_2 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 EAN.

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 - 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 less.

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 Unit - OTU

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, or 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 - Unit of pressure, "pounds per square inch.

Psig - Unit of pressure, "pounds per square inch gauge.

Recompression Chamber - see decompression chamber.

Scientific Diving - Scientific diving is defined (29CFR1910.402) 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 - Surface Supplied: Dives where the breathing gas is supplied from the surface by means of a pressurized umbilical hose. The umbilical generally consists of a gas supply hose, strength member, pneumofathometer hose, and communication line. The umbilical supplies a helmet or full-face mask. The diver may rely on the tender at the surface to keep up with the divers' depth, time and diving profile.

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

Umbilical - 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 - Normal pressure at which the system is designed to operate.

APPENDIX 6



UNIVERSITY of NEW HAMPSHIRE

This Form is not valid unless issued by the Diving Program Officer

UNH/AAUS REQUEST FOR DIVING RECIPROCITY FORM

VERIFICATION OF DIVER TRAINING AND EXPERIENCE

Name of Diver _____

This letter serves to verify that the above listed person has met the training and pre-requisites as indicated below, and has completed all requirements necessary to be certified as a Scientific Diver_ as established by the University of New Hampshire Diving Safety Manual, and has demonstrated competency in the indicated areas. The University of New Hampshire is an AAUS OM and meets or exceeds all AAUS training requirements.

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

- _____ Original diving authorization
- _____ Written scientific diving examination
- _____ Last diving medical examination _____ Medical examination expiration
- _____ Most recent checkout dive
- _____ Scuba regulator/equipment service/test
- _____ CPR training expiration
- _____ Oxygen administration expiration
- _____ First aid for diving expiration
- _____ Date of last dive _____ Depth

Number of dives completed within previous 12 months? _____ Depth Certification _____ fsw

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

Please indicate any pertinent specialty certifications or training:

Emergency Contact Information-Person and relationship to diver:

Telephone:

This is to verify that the above individual is currently a certified scientific diver at the University of NH

Diving Safety Officer: signature _____ Date _____

Elizabeth Kintzing

603 834 1398

ek@unh.edu

APPENDIX 7

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 UNH dive project to develop procedures for diving emergencies including evacuation and medical treatment for each dive location and type of diving conducted.

General Procedures-followed at all dive incidents

Depending on and according to the nature of the diving accident:

1. Make appropriate contact with victim or rescue as required-bring them to shore or the vessel.
2. Establish (ABC's) Airway, Breathing and Circulation as required.
3. Stabilize the victim, treat for shock, and retrieve AED if needed.
3. Administer 100% oxygen, if appropriate (in cases of Decompression Illness, or Near Drowning).
4. Contact local Emergency Medical System (EMS) for transport to nearest medical treatment facility.
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.
5. Call Divers Alert Network for contact with diving physician and recompression chamber.
6. Notify DSO or designee according to the Emergency Action Plan.
7. Complete and submit Incident Report Form (www.aaus.org) to the DCB of the organization and the AAUS (Section 2.70 Required Incident Reporting).

Each Project shall have detailed procedures for:

- Emergency contact for care-mobile phones, marine radio, sat phone.
- Evacuation methods-vehicle, vessel, helicopter.
- Recompression chamber location if available.

Emergency Plan Content

- Name, telephone number, and relationship of person to be contacted for each diver in the event of an emergency.
- DAN or nearest operational decompression chamber.
- Nearest accessible hospital.
- Available means of transport

List of Emergency Contact Numbers Appropriate For Local Dive Locations

Diver's Alert Network (DAN)	800-446-2671
Concord Hospital Hyperbaric Center	ERD 603-225-7511 603-230-1970
Norman Knight Hyperbaric Medicine Center	617-573-4411
UNH Dive Safety Elizabeth Kintzing (Mobile)	603-834-1398
Portsmouth Regional Hospital	603-436-5110
York Hospital	207-363-4321
US Coast Guard (Portsmouth Harbor)	marine radio CH 16, or 603-436-4415

APPENDIX 8

OPERATIONAL PROCEDURES FOR DIVES BEYOND THE SCOPE OF SCIENTIFIC DIVING

1.0 DEFINITION

As defined in Part 1910 of the Occupational Safety and Health Standards, Subpart T - Commercial Diving Operations, Appendix B Guidelines for Scientific Diving #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 within the scope of scientific diving.

2.0 SCOPE

Any dive, which involves tasks that extend beyond the definition of scientific diving as, described in Section 1.0 shall be conducted under the applicable regulations of the Commercial Diving Standards. This includes, but is not limited to, activities such as: underwater structure construction or repair; mooring emplacement; underwater rigging for and about heavy objects; underwater cutting, burning, welding, cleaning or demolition; erection of underwater habitats for human occupancy; etc.

3.0 PROCEDURES

3.1 Project supervisors who anticipate that such non-scientific dives will be required must submit a request to the DCB for permission to conduct these diving operations. This request must contain a written SOP for the detailing the specific dive tasks, and procedures to minimize hazards.

3.2 The request must include the following:

- Overall project plan and objectives
- Date, location, and time of the dive (s)
- Dive profile and the tasks to be performed
- Equipment to be used
- Names and qualifications of the divers involved-All divers must be trained in the work they are tasked with completing
- Identification of support vessels including size, capabilities, and the name of Captain
- Emergency procedures, and evacuation plan

3.3 The DCB will review the SOP and dive plan with respect to the requirements of the Commercial Diving Operations Regulations particularly Sections 1910.423 (c) and 1910.424 (b-2) which require more divers, and equipment than scientific dives.

3.4 Personnel and equipment requirements for non-scientific exemption dives include:

- All divers must be trained and experienced in the type of diving, equipment used, and tasks to be performed on the working dives.
- A SOP manual for the tasks and equipment used for the dive must be at the dive work site.
- There must be a designated person in charge at the dive site (not diving).
- There must be a stand-by diver dressed and ready to enter the water to assist the diver.
- If the diver is on Scuba they must have a comparably equipped buddy, or be line tended.
- A backup source of breathing gas shall be available to the diver, the amount and type must be appropriate for the dive, and tasks undertaken.
- If dives take place deeper than 100fsw, are stage decompression dives or utilize mixed gas, a staffed, operational recompression chamber shall be within 5 minutes of the dive site.

3.5 Once the SOP/dive plan has been approved, the DSO or his / her designee will monitor the operation to ensure compliance.

4.0 EMERGENCY REPAIRS

4.1 If during scientific or training dive operations a situation occurs where underwater repairs to a vessel or structure are immediately required to maintain the safety of on-board personnel e.g. a fouled or bent propeller, leaking hull due to collision damage or penetrator failure etc, and the Diving Supervisor determines that these repairs are within the capability of the dive team (in terms of diver qualification, available air, and bottom time without decompression), then he/she is authorized to conduct dive operations to effect the necessary repairs.

4.2 A written report of the repair issues shall be forwarded to the DSO

APPENDIX 9

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 Program Officer, 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/her 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, following the particular dive computer recommendations.
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.
10. Whenever practical, divers using a dive computer should make a safety-stop as indicated by the dive computer.
11. Multiple deep dives require special consideration.

APPENDIX 10

University of New Hampshire Diving Operations Plan

This Plan must be submitted to the Diving Safety Officer for approval prior to implementation.

PROJECT TITLE

TIMELINE (From) (To)

PERSONNEL

Principal Investigator Phone

Diving Supervisor Phone

University Status Certification

Divers Name Sci diver/diver in training Depth certification

- 1.
- 2.
- 3.
- 4.

DIVE SITES (Use additional sheets as required)

Location (s)

Depth

Current

Hazards

(Pollution, Obstructions, Vessels, etc)

Comments

DIVING OPERATIONS

Vessel Required Yes, No, Vessel Name

Master Vessel Description

Diving Tasks, Science () Training () Work ()

Description (Use additional sheets as required)

Diving Mode and Equipment

() Scuba () Surface Supply () Mixed Gas () Rebreather () Other

Number of Gas Cylinders Available Refill Station

Wet Suit (# of Divers) Dry Suit (# of Divers)

Special Equipment Required

Number of Dives per Day Number of Divers per dive

Night Dives () Yes () No

Computer () Tables () Dive planning software ()

Decompression Required () Yes () No If Yes, provide details

Comments:

EMERGENCY MANAGEMENT PLAN FOR THIS PROJECT (See Appendix 7)

Equipment Checklist

Oxygen Kit () First Aid Kit () Communications Radio () Cell Phone ()

Nearest Hospital _____ Phone _____

Nearest Chamber _____ Phone _____

DAN Phone Number 919 684 8111

UNH DSO Number 603-834-1398

Transport Plan

APPROVED AS SUBMITTED

APPROVED WITH THE FOLLOWING CHANGES

Documents Attached

By _____ UNH DSO

Date _____