THE FLORIDA STATE UNIVERSITY

COASTAL AND MARINE LABORATORY

STANDARDS FOR SCIENTIFIC DIVING

AND OPERATION OF THE SCIENTIFIC DIVING PROGRAM

Revised August 2006

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FOREWORD

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 among 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 manual, and it is the responsibility of every member of the FSU Coastal and Marine Laboratory's Academic Diving Program to see that it always reflects state of the art, safe diving practice.

The Florida State University Diving Control Board

ACKNOWLEDGEMENTS

The FSU Diving Control Board thanks the numerous dedicated individuals for their contributions and editorial comments in the production of these standards.

Revision History

Major Revisions

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SECTION 1.00: GENERAL POLICY

The Academic Diving Program (ADP) is an administrative unit of the Edward Ball Marine Laboratory at The Florida State University that supervises all compressed gas diving on campus. Recreational diving operates under the Recreation Council and adheres to separate standards and procedures.

1.10 THE SCIENTIFIC DIVING STANDARDS

1.11 Purpose

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 document sets minimal standards for the establishment of the Florida State University scientific diving program. These standards meet or exceed the standards established by the American Academy of Underwater Sciences (AAUS) for recognized scientific diving programs. These standards also describe the organizational structure and standards 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 FSU, other AAUS organizational members, and other entities sanctioning scientific diving (e.g., NOAA, EPA), which adhere to these minimum standards.

This manual was originally developed and written by the 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. The standards have been adapted as necessary by the staff of the Florida State University Academic Diving Program.

In 1982, OSHA exempted scientific diving from commercial diving regulations (29 CFR Part 1910, 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 recognizes the AAUS as the scientific diving standard setting organization.

1.12 Scientific Diving Definition

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

1.13 Scientific Diving Exemption

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

1.13.1 The Diving Control Board consists of a majority of active scientific divers and has

autonomous and absolute authority over the scientific diving program's operation.

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

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

1.13.4 Scientific divers, based on the nature of their activities, must use scientific expertise in studying the underwater environment and therefore, are scientists or scientists-in-training.

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

1.13.5.1 Diving safety manual which includes at a minimum: Procedures covering all diving operations specific to the program; including procedures for emergency care, recompression and evacuation; and the criteria for diver training and certification.

1.13.5.2 Diving control (safety) board, with the majority of its members being active scientific divers, which shall at a minimum have the authority to: approve and monitor diving projects, review and revise the diving safety manual, assure compliance with the manual, certify the depths to which a diver has been trained, take disciplinary action for unsafe practices, and assure adherence to the buddy system (a diver is accompanied by and is in continuous contact with another diver in the water) for scuba diving.

1.14 Review of Standards

As part of the FSU ADP annual report, any recommendations for modifications of these standards shall be submitted to the FSU DCB for consideration.

1.20 OPERATIONAL CONTROL

1.21 The Florida State University Auspices Defined

For the purposes of these standards the auspices of The Florida State University includes any scientific diving operation in which the University is connected because of ownership of any equipment used, locations selected, or relationship with the individual(s) concerned. This includes all cases involving the operations of employees of The Florida State University 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 as associates or students of The Florida State University.

It is the responsibility of The Florida State University to adhere to these standards for Scientific Diving Certification and Operation of the Scientific Diving Program. The administration of the scientific diving program will reside with the Florida State University Diving Control Board (DCB).

The regulations herein shall be observed at all locations where scientific diving is conducted unless altered by terms of reciprocity with a qualifying organization.

1.22 The Florida State University Scientific Diving Standards and Safety Manual

The Florida State University is required by OSHA and AAUS to develop and maintain a scientific diving safety manual which provides for the development and implementation of policies and procedures that will enable the Florida State University scientific diving program to meet the requirements of local environments and conditions as well as to comply with the AAUS scientific diving standards. The standards of the Florida State University Academic Diving Program shall include, but not be limited to:

1.22.1 A set of minimal guidelines for the conductance of scientific diving under the auspices of The Florida State University.
1.22.2 Emergency evacuation and medical treatment procedures.
1.22.3 The criteria for diver training and certification.
1.22.4 Standards written or adopted by reference for each diving mode utilized which include the following:
1.22.4.1 Safety procedures for the diving operation.
1.22.4.2 Responsibilities of the dive team members.
1.22.4.3 Equipment use and maintenance procedures.
1.22.4.4 Emergency procedures.

1.23 The University Diving Officer

The University Diving Officer (UDO) (also known at the Diving Safety Officer [UDO]) serves as a member of the Diving Control Board. This person should have broad technical and scientific expertise in research related diving.

1.23.1 Qualifications

1.23.1.1 Shall be appointed by the responsible administrative officer of The Florida State University or his/her designee, with the advice and counsel of the diving control board.

1.23.1.2 Shall be trained as a scientific diver.

1.23.1.3 Shall be a member as defined by the AAUS.

1.23.1.4 Shall be certified as a scuba diving instructor with a national or international certifying agency (e.g., NAUI, YMCA, and PADI).

1.23.2 Duties and Responsibilities

1.23.2.1 Shall be responsible, through the DCB, to the responsible administrative officer or his/her designee, for the conduct of the scientific diving program of The Florida State University. The routine operational authority for this program, including the conduct of training and certification, approval of dive plans, maintenance of diving records, and ensuring compliance with this manual and all relevant regulations of the membership organization, rests with the University Diving Officer.

1.23.2.2 May permit portions of this program to be carried out by a qualified delegate, although the University Diving Officer may not delegate responsibility for the safe conduct of the local diving program.

1.23.2.3 Shall be guided in the performance of the required duties by the advice of the DCB, but operational responsibility for the conduct of the local diving program will be retained by the University Diving Officer.

1.23.2.4 Shall suspend diving operations which he/she considers to be unsafe or unwise.

1.24 The Diving Control Board

124.1 The Diving Control Board (DCB) shall consist of a majority of active scientific divers. Voting members shall include the University Diving Officer, and a representative (preferably a diving scientist) from each University department whose faculty or students engage in underwater research using diving. Members shall be nominated by their respective departmental Chair and appointed by the Vice President for Research. The voting members of the DCB shall choose a Chair, and the Chair shall designate a person to record minutes.

1.24.2 Non-voting members shall include the Director of the Department of Environmental Health and Safety or their designee, the General Counsel of the University or their designee.

1.24.3The Diving Control Board shall meet at least annually and as required by circumstances.

1.24.4 The Diving Control Board has autonomous and absolute authority over the Florida State University scientific diving program's operation.

The Diving Control Board is responsible for setting policy and:

1.24.5 Shall approve and monitor diving projects.

1.24.6 Shall review and revise the diving safety manual.

1.24.7 Shall assure compliance with the manual.

1.24.8 Shall certify the depths to which a diver has been trained.

1.24.9 Shall take disciplinary action for unsafe practices.

1.24.10 shall assure adherence to the buddy system for scuba diving.

1.24.11 shall act as the official representative of The Florida State University in matters concerning the scientific diving program.

1.24.12 Shall act as a board of appeal to consider diver-related problems.

1.24.13 Shall recommend the issue, reissue, or the revocation of diving certifications.

1.24.14 Shall recommend changes in policy and amendments to both the AAUS scientific diving manual and the Florida State University scientific diving manual as the need arises.

1.24.15 Shall establish and/or approve training programs through which the applicants for certification can satisfy the requirements of the Florida State University diving safety manual.

1.24.16 Shall suspend diving programs which it considers to be unsafe or unwise.

1.24.17 Shall establish criteria for equipment selection and use.

1.24.18 Shall recommend new equipment or techniques.

1.24.19 Shall establish and/or approve facilities for the inspection and maintenance of diving and associated equipment.

1.24.20 Shall ensure that the Florida State University air station(s) meet air quality standards as described in Sec. 3.60 of this manual.

1.24.21 Shall periodically review the University Diving Officer's performance and program and provide advice & counsel to the responsible administrative officer on hiring, performance and retention of the University Diving Officer.

1.24.22 Shall sit as a board of investigation to inquire into the nature and cause of diving accidents or violations of the Florida State University diving manual.

1.25 Instructional Personnel

1.25.1 Qualifications

All personnel involved in diving instruction under the auspices of The Florida State University shall be qualified for the type of instruction being given.

1.25.2 Selection

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

1.26 Lead Diver

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

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

1.26.2 Ensuring all dive team members possess current certification and are qualified for the type of diving operation.

1.26.3 Planning dives in accordance with Section 2.21

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

1.26.5 Briefing the dive team members on:

1.26.5.1 Dive objectives.

1.26.5.2 Unusual hazards or environmental conditions likely to affect the safety of the diving operation.

1.26.5.3 Modifications to diving or emergency procedures necessitated by the specific diving operation.

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

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

1.27 Reciprocity And Visiting Scientific Diver

1.27.1 When the Florida State University Academic Diving Program conducts a joint diving operation with another organization, or engages jointly in the use of diving resources, both parties shall mutually designate one of the participating Diving Control Boards to govern the dive project.

1.27.2 A scientific diver from one organization shall apply for permission to dive under the auspices of another organization by submitting to the University Diving Officer of the host organization Member a document containing all the information described in the letter of reciprocity signed by the University Diving Officer or Chairperson of the home Diving Control Board.

1.27.3 A visiting scientific diver may be asked to demonstrate his/her knowledge and skills for the planned diving.

1.27.4 If a host organization denies a visiting scientific diver permission to dive, the host Diving Control Board shall notify the visiting scientific diver and his/her Diving Control Board with an explanation of all reasons for the denial.

1.28 Waiver of Requirements

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

1.29 Consequence of Violation of Regulations by Scientific Divers

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

1.30 CONSEQUENCES OF VIOLATION OF REGULATIONS BY ORGANIZATIONAL MEMBERS

Failure to comply with the regulations of these standards may be cause for the revocation or restriction of The Florida State University's organizational member's recognition by the AAUS.

1.40 RECORD MAINTENANCE

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

1.40.1 Availability of Records:

1.40.1.1 The Florida State University Academic Diving Program does not maintain diver medical records. Information on the location of medical records is included on all active dive plans for use by the attending physician of a diver when needed.

1.40.1.2 Records and documents required by these standards shall be retained by the FSU ADP for the following period:

1.40.1.2.1 Physician's written reports of medical examinations for dive team members - 5 years.

1.40.1.2.2 Manual for diving safety - current document only.

1.40.1.2.3 Records of dive - 1 year, except 5 years where there has been an incident of pressure-related injury.

1.40.1.2.4 Pressure-related injury assessment - 5 years.

1.40.1.2.5 Equipment inspection and testing records – From first inspection or testing 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 Florida State University Academic Diving Program unless he/she holds a current certification issued pursuant to the provisions of this manual.

2.20 PRE-DIVE PROCEDURES

2.21 Dive Plans

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

2.21.1 Divers qualifications and the type of certificate or certification held by each diver.

2.21.2 Emergency plan with the following information:

2.21.2.1 Name, telephone number, and relationship of person to be contacted for each diver in the event of an emergency.

2.21.2.2 nearest operational recompression chamber
2.21.2.3 nearest accessible hospital
2.21.2.4 available means of transport

2.21.3 Approximate number of proposed dives.

2.21.4 Location(s) of proposed dives.

2.21.5 Estimated depth(s) and bottom time(s) anticipated.

2.21.6 Decompression status and repetitive dive plans, if required.

2.21.7 Proposed work, equipment, and boats to be employed.

2.21.8 Any hazardous conditions anticipated.

The University Diving Officer must approve the dive plan prior to the commencement of a diving operation. It is strongly encouraged that diving operations be discussed while in the planning stage. Diving Supervisors should allow sufficient time for dive plan review prior to the diving operation.

Copies of approved dive plans must be filed with the UDO and also be available on the dive site

2.22 Pre-dive Safety Checks

2.22.1 Diver’s Responsibility:

2.22.1.1 Each scientific diver shall conduct a functional check of his/her diving equipment in the presence of the diving buddy or tender.

2.22.1.2 It is the diver's responsibility and duty to refuse to dive if, in his/her judgment, conditions are unfavorable, or if he/she would be violating the precepts of his/her training, of the AAUS standards, or the Florida State University diving manual.

2.22.1.3 No dive team member shall be required to be exposed to hyperbaric conditions against his/her will, except when necessary to prevent or treat a pressure-related injury.

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

2.22.2 Equipment Evaluations

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

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

2.22.3 Site Evaluation

The environmental conditions at the site will be evaluated.

2.30 DIVING PROCEDURES

2.31 Solo Diving Prohibition

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

2.32 Refusal to Dive

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

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

2.33 Termination of the Dive

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

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

2.34 Emergencies and Deviations from Regulations

Any diver may deviate from the requirements of this manual 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.

2.35 Diving Operations

2.35.1 Dive Team Organization

The dive team must be composed of no fewer than three (3) persons: A Diving Supervisor and two divers. One team member must remain on the surface during diving operations; functions such as timekeeping and dive site management shall be the responsibility of the surface team member. The Lead Diver (as defined in Sec. 1.26) may also serve as the Diving Supervisor and may not be the Principal Investigator without permission of the UDO or designee. One team member of the team must be appropriately qualified as a boat operator if a boat is involved.

2.36 Diver Deployment From and Recovery to Vessels

Divers shall not enter the water from a vessel unless the propeller has stopped; the engine may be in neutral or stopped. Divers shall not be recovered or picked up unless the vessel propeller has stopped. During liveboating operations (divers in the water while the vessel is underway), vessel operators will ensure that the propeller is stopped when a diver is within a vessel's length of the vessel. Surface supplied liveboating operations will follow the recommendations of the Association of Diving Contractors consensus standards.

2.40 POST-DIVE PROCEDURES

2.41 Post-Dive Safety Checks

2.41.1 After the completion of a dive, each diver shall report any physical problems, symptoms of decompression sickness, or equipment malfunctions.

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

2.50 EMERGENCY PROCEDURES

The Florida State University has developed emergency procedures that follow the standards of care of the community, including procedures for emergency care, recompression and evacuation for each dive location (See Appendix).

2.60 FLYING AFTER DIVING

Divers who have completed dives while following the U.S. Navy diving tables (or a more conservative set of tables) should have a minimum surface interval, at sea level, of 12 hours before ascending to altitudes over 1000 feet or flying in an airplane. Divers who have completed decompression dives should have a minimum surface interval, at sea level, of 24 hours before ascending to altitudes above 1000 feet or flying in an airplane, which can be pressurized to a maximum altitude of 8,000 feet (7.35 psi).

2.70 RECORDKEEPING AND REQUIREMENTS

2.71 Personal Diving Log

Each certified scientific diver shall log every dive made under the auspices of the Florida State University scientific diving program, and is encouraged to log all other dives. Standard forms will be provided by the Academic Diving Program and are available in a downloadable format on the ADP website. Log sheets shall be submitted monthly to the University Diving Officer to be placed in the diver's permanent file. The diving log shall include at least the following:

2.71.1 Name of diver, partner, and Lead Diver.

2.71.2 Date, time, and location.

2.71.3 Diving modes used.

2.71.4 General nature of diving activities.

2.71.5 Approximate surface and underwater conditions.

2.71.6 Maximum depths, bottom time and surface interval time.

2.71.7 Diving tables or computers used.

2.71.8 Detailed report of any incidents or problems.

2.72 Required Incident Reporting

All diving incidents requiring recompression treatment, or resulting in moderate or serious injury, or death shall be reported to the Florida State University Diving Control Board and the AAUS using the appropriate form. Incidents shall also be reported to the Director of the Florida State University Department of Environmental Health and Safety. The report will specify the circumstances of the incident and the extent of any injuries or illnesses. Additional information must meet the following reporting requirements:

2.72.1 Occupational injuries and illnesses shall be recorded and reported in accordance with requirements of the appropriate Labor Code section.

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

2.72.2.1 Complete AAUS Incident Report Form at www.aaus.org.

2.72.2.2 Written descriptive report to include:

2.72.2.2.1 Name, address, phone numbers of the principal parties involved.

2.72.2.2.2 Summary of experience of divers involved.

2.72.2.2.3 Location, description of dive site and description of conditions that led up to incident.

2.72.2.2.4 Description of symptoms, including depth and time of onset.

2.72.2.2.5 Description and results of treatment.

2.72.2.2.6 Disposition of case.

2.72.2.2.7 Recommendations to avoid repetition of incident.

2.72.3 The Florida State University DCB shall investigate and document any incident of pressure-related injury and prepare a report which is to be forwarded to the 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

3.10.1 All equipment shall meet standards as determined by the University Diving Officer and the Diving Control Board. Equipment that is subjected to extreme usage under adverse conditions should require more frequent testing and maintenance.

3.10.2 All equipment shall be regularly examined by the person using them.

3.20 EQUIPMENT

3.21 Regulators

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

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

3.21.3 Regulators will consist of a primary second stage and an alternate air source (such as an octopus second stage or redundant air supply).

3.22 Breathing Masks and Helmets

Breathing masks and helmets shall have:

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

3.22.2 An exhaust valve.

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

3.23 Scuba Cylinders

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

3.23.2 Scuba cylinders must be hydrostatically tested in accordance with DOT standards.

3.23.3 Scuba cylinders must be externally inspected prior to each filling and an internally inspected at intervals not to exceed twelve months.

3.23.4 Scuba cylinder valves shall be functionally tested at intervals not to exceed twelve months.

3.24 Backpacks

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

3.25 Gauges

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

3.26 Flotation Devices

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

3.26.2 Personal flotation systems, buoyancy compensators, dry suits, or other variable volume buoyancy compensation devices shall be equipped with an exhaust valve.

3.26.3 Exhaust valves and inflator systems shall be functionally inspected and tested at intervals not to exceed twelve months.

3.27 Timing Devices, Depth and Pressure Gauges

Both members of the diving pair must have an underwater timing device, an approved depth indicator, and a submersible pressure gauge.

3.28 Determination of Decompression Status: Dive Tables, Dive Computers

3.28.1 A set of diving tables at least as conservative as the US Navy Diving Tables must be available at the dive location.

3.28.2 Dive computers may be utilized, but only to back up diving tables, and must be approved by the Diving Control Board.

3.30 AUXILIARY EQUIPMENT

3.31 Hand held underwater power tools.

The use of power tools is outside of the purview of the exemption granted to scientific divers by OSHA. The Florida State University diving programs using power tools (hydraulic drills, suction dredges, water jets) underwater, lifting heavy objects underwater, or engaging in such activities such as underwater cutting or welding must follow the OSHA commercial diving standards. Please refer to the Consensus Standards of the Association of Diving Contractors for guidance. All such projects must be approved in the conceptual phase by the Florida State University Diving Control Board and managed by the ADP.

3.40 SUPPORT EQUIPMENT

3.41 First aid supplies.

A first aid kit and emergency oxygen shall be available on the dive site.

3.42 Diver’s Flag

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

3.43 Compressor Systems - Organizational Member Controlled

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

3.43.1 Low pressure compressors used to supply air to the diver if equipped with a volume tank shall have a check valve on the inlet side, a relief valve, and a drain valve.

3.43.2 Compressed air systems over 500 psig shall have slow-opening shut-off valves.

3.43.3 All air compressor intakes shall be located away from areas containing exhaust or other contaminants

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3.44 Oxygen System

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

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

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

3.50 EQUIPMENT MAINTENANCE

3.51 Record Keeping

Each equipment modification, repair, test, calibration, or maintenance service shall be logged, including the date and nature of work performed, serial number of the item, and the name of the person performing the work for the following equipment:

3.51.1. Regulators

3.51.2 Submersible pressure gauges

3.51.3 Depth gauges

3.51.4 Scuba cylinders

3.51.5 Cylinder valves

3.51.6 Diving helmets

3.51.7 Submersible breathing masks

3.51.8 Compressors

3.51.9 Gas control panels

3.51.10 Air storage cylinders

3.51.11 Air filtration systems

3.51.12 Analytical instruments

3.51.13 Buoyancy control devices

3.51.14 Dry suits

3.52 Compressor Operation and Air Test Records

3.52.1 Gas analyses and air tests shall be performed on each all The Florida State University breathing air compressors at regular intervals of no more than 100 hours of operation or six months, whichever occurs first. The results of these tests shall be entered in a formal log and be maintained.

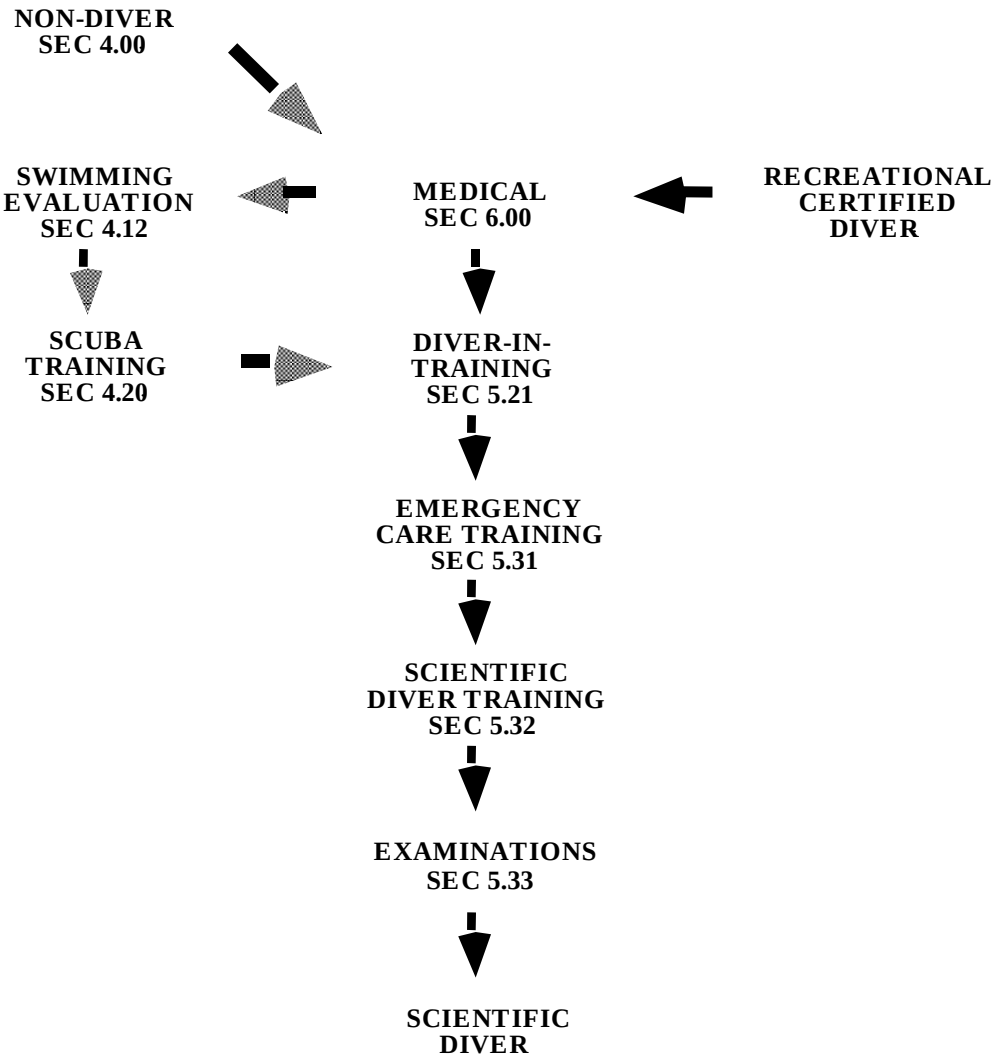
3.52.2 A log shall be maintained showing operation, repair, overhaul, filter maintenance, and temperature adjustment for each compressor.

3.60 AIR QUALITY STANDARDS

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

	CGA Grade E
Component	**Maximum**
Oxygen	20 - 22%/v
Carbon Monoxide	10 ppm/v
Carbon Dioxide	500 ppm/v
Condensed Hydrocarbons	5 mg/m3
Water Vapor	NS
Objectionable Odors	None

FSU SCIENTIFIC DIVER TRAINING FLOW CHART



SECTION 4.00: ENTRY-LEVEL TRAINING REQUIREMENTS

This section describes training for the non-diver applicant, previously not certified for diving, and equivalency for the certified diver.

4.10 EVALUATION

4.11 Medical Examination

The applicant for training shall be certified by a licensed physician to be medically qualified for diving before proceeding with the training as designated in Sec. 4.20 (see Sec. 6.00 and Appendices 1 through 4).

4.12 Swimming Evaluation

The applicant for training shall successfully perform the following tests, or their equivalent, in the presence of the University Diving Officer, or an examiner approved by the University Diving Officer.

4.12.1 Swim underwater without swim aids for a distance of 25 yards without surfacing.

4.12.2 Swim 400 yards in less than 12 minutes without swim aids.

4.12.3 Tread water for 10 minutes, or 2 minutes without the use of hands, without swim aids.

4.12.4 Without the use of swim aids, transport another person of equal size a distance of 25 yards in the water.

4.20 SCUBA TRAINING

4.21 Practical Training

At the completion of training, the trainee must satisfy the University Diving Officer or the instructor of his/her ability to perform the following, as a minimum, in a pool or in sheltered water:

4.21.1 Enter water with full equipment.

4.21.2 Clear face mask.

4.21.3 Demonstrate air sharing, including both buddy breathing and the use of alternate air source, as both donor and recipient, with and without a face mask.

4.21.4 Demonstrate ability to alternate between snorkel and scuba while kicking.

4.21.5 Demonstrate understanding of underwater signs and signals.

4.21.6 Demonstrate simulated in-water mouth-to-mouth resuscitation.

4.21.7 Rescue and transport, as a diver, a passive simulated victim of an accident.

4.21.8 Demonstrate ability to remove and replace equipment while submerged.

4.21.9 Demonstrate watermanship ability which is acceptable to the instructor.

4.22 Written Examination

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

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

4.22.2 Physics and physiology of diving.

4.22.3 Diving regulations and precautions.

4.22.4 Near-shore currents and waves.

4.22.5 Dangerous marine animals.

4.22.6 Emergency procedures, including buoyant ascent and ascent by air sharing.

4.22.7 Currently accepted decompression procedures.

4.22.8 Demonstrate the proper use of dive tables.

4.22.9 Underwater communications.

4.22.10 Aspects of freshwater and altitude diving.

4.22.11 Hazards of breath-hold diving and ascents.

4.22.12 Planning and supervision of diving operations.

4.22.13 Diving hazards.

4.22.14 Cause, symptoms, treatment, and prevention of the following: near drowning, air embolism, carbon dioxide excess, squeezes, oxygen poisoning, nitrogen narcosis, exhaustion and panic, respiratory fatigue, motion sickness, decompression sickness, hypothermia, and hypoxia/anoxia.

4.23 Open Water Evaluation

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

4.23.1 Surface dive to a depth of 10 feet in open water without scuba.

4.23.2 Demonstrate proficiency in air sharing, including both buddy breathing and the use of alternate air source, as both donor and receiver.

4.23.3 Enter and leave open water or surf, or leave and board a diving vessel, while wearing scuba gear.

4.23.4 Kick on the surface 400 yards while wearing scuba gear, but not breathing from the scuba unit.

4.23.5 Demonstrate judgment adequate for safe diving.

4.23.6 Demonstrate, where appropriate, the ability to maneuver efficiently in the environment, at and below the surface.

4.23.7 Complete a simulated emergency swimming ascent.

4.23.8 Demonstrate clearing of mask and regulator while submerged.

4.23.9 Demonstrate ability to achieve and maintain neutral buoyancy while submerged.

4.23.10 Demonstrate techniques of self-rescue and buddy rescue.

4.23.11 Navigate underwater.

4.23.12 Plan and execute a dive.

4.23.13 Successfully complete 5 open water dives for a minimum total time of 3 hours, of which 1-1/2 hours cumulative bottom time must be on scuba. No more than 3 training dives shall be made in any one day.

SECTION 5.00: SCIENTIFIC DIVER CERTIFICATION

5.10 CERTIFICATION TYPES

5.10.1 Scientific Diver Certification.

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

5.10.2 Temporary Diver Permit.

This permit constitutes a waiver of the requirements of Sec. 5.00 and is issued only following a demonstration of the required proficiency in diving. It is valid only for a limited time, as determined by the University Diving Officer. This permit is not to be construed as a mechanism to circumvent existing standards set forth in this manual.

Requirements of Sec. 5.31 and 5.32 may be waived by the University Diving Officer if the person in question has demonstrated proficiency in diving and can contribute measurably to a planned dive. A statement of the temporary diver's qualifications shall be submitted to the University Diving Officer as a part of the dive plan. Temporary permits shall be restricted to the planned diving operation and shall comply with all other policies, regulations, and standards of this manual, including medical requirements.

5.10.3 Observer Diver Permit

This permit allows a diver holding a nationally recognized SCUBA certification to conduct dives under restricted circumstances to observe an underwater research project. The Observer Diver must be an employee or official volunteer of FSU, and must complete a medical questionnaire. The Observer Diver may not undertake any tasks while diving, including photography.

5.20 GENERAL POLICY

The Florida State University Diving Control Board requires that no person shall engage in scientific diving unless that person is authorized by the DCB pursuant to the provisions of this manual. The following are considered minimal standards for a scientific diver certification.

5.21 Prerequisites

Diver-In-Training Permit

This permit signifies that a diver has completed and been certified as at least an open water diver through a nationally or internationally recognized certifying agency, scientific diving program, or its equivalent (Section 4.00).

5.22 Eligibility

Only a person diving under the auspices of The Florida State University and who subscribes to the practices and standards of the FSU DCB and of the AAUS is eligible for a scientific diver certification.

5.23 Application

Application for certification shall be made to the University Diving Officer on the form prescribed by the FSU ADP.

5.24 Medical Examination

Each applicant for diver certification shall submit a statement from a licensed physician, based on an approved medical examination, attesting to the applicant's fitness for diving (see Sec. 6.00 and Appendices 1-6).

5.30 REQUIREMENTS FOR SCIENTIFIC DIVER CERTIFICATION

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

5.31 Documents

5.31.1 Application for certification.

5.31.2 Medical approval.

5.31.3 Proof of diver-in-training permit level or its equivalent.

5.31.4 Emergency Care Training
The trainee must provide proof of training in the following:

a. cardiopulmonary resuscitation (CPR) (must be current)

b. emergency oxygen administration (must be current)

c. first aid for diving accidents (must be current)

5.32 Training

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

a) Required Topics (include, but not limited to):

1. Diving Emergency Care Training
    - Cardiopulmonary Resuscitation (CPR)
    - 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 Diving Planning
    - Coordination with other agencies
    - Appropriate Governmental Regulations
8. Scientific Method
9. Data Gathering Techniques (Only items specific to area of study are required)
    - Use of quadrants
    - Use of transects
    - 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
10. HazMat Training
    - For HP Cylinder Handlers and or Fillers
    - Chemical Hygiene, Laboratory Safety (Use of Chemicals)

b) Suggested Topics (include, but not limited to):

1. Specific Dive Modes (methods of gas delivery)
    - Open Circuit
    - Hookah
    - Surface-Supplied Diving
2. Small Boat Operation
3. Rebreathers
    - Closed
    - Semi-closed
4. Specialized Breathing Gases

- Nitrox
- Other Mixed Gas

5. 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

6. Specialized Diving Equipment
    - Full face mask
    - Dry suit
    - Communications

c. Practical training must include a checkout dive with evaluation of the skills listed in Section 4.23 with the UDO or qualified delegate followed by at least 11 ocean or open water dives in a variety of dive sites and diving conditions, for a cumulative bottom time of 6 hours. Dives following the checkout dive must be supervised by a certified Scientific Diver with experience in the type of diving planned, with the knowledge and permission of the UDO.

d. Examinations

1. Written examination
    - General exam required for scientific diver certification
    - Examination covering the suggested topics at the UDO's discretion.

2. Examination of equipment
    - Personal diving equipment
    - Task specific equipment

5.40 DEPTH CERTIFICATIONS

Diving is not permitted beyond a depth of 150 feet.

5.41 Depth Certification Levels and Progression To Next Depth Level

A scientific diver diving under the auspices of The Florida State University may progress to the next depth level after successfully completing the required dives for the next level. A diver may exceed his/her depth limit by one depth level if dives are planned and executed under close

supervision of a diver who is currently certified by the ADP to dive to the greater depth, and with the knowledge and permission of the UDO.

5.41.1 Certification to 30 Foot Depth - A diver will be permitted to dive to 30 FSW upon the successful completion of the ADP scientific diver program entry requirements (see Sections 4.00 and 5.30). This diver will also enter the program as a Diver-in-Training (Sec. 4.30) pending completion of the requirements to progress to the Scientific Diver status.

5.41.2 Certification to 60 Foot Depth - A diver holding a 30-foot depth certificate may be permitted to dive to a depth of 60 feet after successfully completing, under supervision of the ADP, 12 logged training dives to depths between 31 and 60 feet for a minimum cumulative bottom time of 4 hours. The diver must show proficiency in the use of appropriate dive tables and other skills as requested by the UDO.

5.41.2.1 Divers diving between the depths of 50 and 130 FSW are encouraged to use enriched air gas mixtures (nitrox). ADP staff members and volunteers are required to use nitrox on all supervisory dives below 40 fee.

5.41.3 Certification to 100 Foot Depth - A diver holding a 60-foot depth certificate may be permitted to dive to a depth of 100 feet after successfully completing four dives to depths between 61 and 100 feet. The diver shall also demonstrate proficiency in the use of the appropriate dive tables and any other skills as requested by the UDO.

5.41.4 Certification to 130 Foot Depth - A diver holding a 100-foot depth certificate may be permitted to dive to a depth of 130 feet after successfully completing four dives to depths between 101 and 130 feet. The diver shall also demonstrate proficiency in the use of the appropriate dive tables and any other skills as requested by the UDO.

5.41.4.1 Divers diving below 130 FSW are encouraged to use gas mixtures other than air to conduct these dives. Diving below 150 feet is not permitted.

5.41.4.2 Certification to 150 Foot Depth - A diver holding a 130-foot depth certificate may be permitted to dive to a depth of 150 feet after successfully completing four dives to depths between 131 and 150 feet. Dives shall be planned and executed under close supervision of a diver authorized by the ADP and certified to this depth. The diver must also demonstrate knowledge of the special problems of deep diving, and of special safety requirements. Divers seeking permission to dive to 150 feet must demonstrate proficiency with the appropriate dive tables for these depth ranges and any other skills as requested by the UDO.

5.50 CONTINUATION OF CERTIFICATE

5.51 Minimum Activity to Maintain Certification

During any 12-month period, each certified scientific diver or diver-in-training must log a minimum of 12 dives. At least 6 of these dives must be scientific (i.e., experiment setup or data gathering) 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 dive deeper than 130 FSW may satisfy these requirements with dives to 130 feet or over. Divers who failure to meet these requirements may have

their The Florida State University diving status revoked or restricted. Divers who fail to submit dive logs to the ADP may result in the suspension of diving privileges.

5.52 Requalification of Depth Certificate

Once the initial certification requirements of Sec. 5.31 - 5.33 are met, divers whose depth certification has lapsed due to lack of activity may be requalified by conducting and logging dives as required by the UDO with the advice of the DCB.

5.53 Medical Examination

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

5.60 REVOCATION OF CERTIFICATION

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

5.70 RECERTIFICATION

If a diver's certificate expires or is revoked, he/she may be recertified after complying with such conditions as the University Diving Officer or the DCB may impose. The diver shall be given an opportunity to present his/her case to the DCB before conditions for recertification are stipulated. Recertification may require completion of all or a portion of the qualification procedures for divers entering the scientific diving program, proficiency testing, and refresher dives as requested by the UDO or the DCB.

SECTION 6.00: MEDICAL STANDARDS

6.10 MEDICAL REQUIREMENTS

6.11 General

6.11.1 The Florida State University Diving Control Board shall determine that divers have passed a current diving physical examination and have been declared by the examining physician to be fit to engage in diving activities as may be limited or restricted in the medical evaluation report.

6.11.2 All medical evaluations required by this standard shall be performed by, or under the direction of, a licensed physician of the applicant-diver's choice, preferably one trained in diving/undersea medicine.

6.11.3 The diver should be free of any chronic disabling disease and be free of any conditions contained in the list of conditions for which restrictions from diving are generally recommended. (see Appendix)

6.12 Frequency of Medical Evaluations

Medical evaluation shall be completed:

6.12.1 before a diver may begin diving under, unless the diver has been given an equivalent initial medical evaluation within the preceding 5 years (3 years if over the age of 40 and 2 years if over the age of 60), the Florida State University ADP has obtained the results of that examination, and those results have been reviewed and found satisfactory by the UDO or the Program Physician.

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

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

6.13. Information Provided Examining Physician

The Florida State University ADP shall provide a copy of the medical evaluation requirements of this standard to the examining physician. (see Appendices).

6.14 Content of Medical Evaluations

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

6.14.1 Applicant agreement for release of medical information to the University Diving Officer and the DCB (seeAppednix).

6.14.2 Diver's medical history (see Appendix)

6.14.3 Diving physical examination (Section 6.15 and Appendices).

6.15 Conditions which may disqualify candidates from diving (Adapted from Bove 1998) (See Appendices)

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

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

6.16 Laboratory Requirements for Diving Medical Examination and Intervals:

6.16.1 Initial examination under age 40:

Medical History
Complete physical exam, emphasis on neurological and otological components
Chest X-ray, PA and lateral views
Pulmonary function (spirometry)
Audiogram
Visual acuity
Hematocrit or hemoglobin
Urinalysis
Any further tests deemed necessary by the physician

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

Medical History
Complete physical exam, emphasis on neurological and otological components
Hematocrit or hemoglobin
Urinalysis
Any further tests deemed necessary by the physician

6.16.3 Initial exam over the age of 40:

Medical History
Complete physical exam, emphasis on neurological and otological components
Assessment of coronary artery disease using Multiple-Risk-Factor Assessment[1]
Resting EKG*
Chest X-ray, PA and lateral views
Pulmonary function (spirometry)
Audiogram
Visual acuity
Hematocrit or hemoglobin
Urinalysis
Any further tests deemed necessary by the physician*

* Exercise stress test may be indicated based on risk factor analysis

6.16.4 Periodic re-examination over age 40 (every 3 years); over age 60 (every 2 years):

Medical History
Complete physical exam, emphasis on neurological and otological components
Assessment of coronary artery disease risk factors including lipid profile and diabetic screening*
Resting EKG*
Hematocrit or hemoglobin
Urinalysis
Any further tests deemed necessary by the physician*

* Exercise stress test may be indicated based on risk factor analysis

6.17 Physician's Written Report.

6.17.1 After any medical examination relating to the individual's fitness to dive, the FSU ADP shall obtain a written report prepared by the examining physician, which shall contain the examining physician's opinion of the individual's fitness to dive, including any recommended restrictions or limitations. This will be reviewed by the UDO and, if necessary, the DCB.

6.17.2 The ADP shall make a copy of the physician's written report available to the individual and retain a copy in the diver's file for at least 5 years.

6.17.3The examining physician will retain a copy of the complete medical evaluation.

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

2 Gibbons, R.J., et. al. 1997. ACC/AHA Guidelines for Exercise Testing. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing). Journal of the American College of Cardiology. 30: 260-311.

SECTION 7.00: Nitrox Diving Guidelines

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

7.10 Prerequisites

7.11 Eligibility. --

Only a certified Scientific Diver or Scientific Diver-in-Training (see Sections 4.00 and 5.00) diving under the auspices of The Florida State University 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 his/her depth authorization, as specified in Sec 5.40.

7.12 Application and documentation

Application and documentation for authorization to use nitrox shall 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 UDO and members of the DCB that they are sufficiently skilled and proficient. The signature of the UDO 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 UDO or DCB the appropriate judgment or proficiency to ensure the safety of the diver and dive buddy.

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

7.21 Training

The diver must complete additional theoretical and practical training beyond the Scientific Diver-in-Training air certification level, to the satisfaction of the FSU UDO and DCB (see Section 7.30).

7.22 Examinations

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

a) Written examinations covering the information presented in the classroom training session(s) such as gas theory, oxygen toxicity, partial pressure determination, and decompression tables);
b) Practical examinations covering the information presented in the practical training session(s) (i.e., gas analysis, documentation procedures, etc.);

c) A minimum of two open water checkout dives, to depths appropriate for the use of nitrox, to demonstrate the application of theoretical and practical skills learned.

7.23 Minimum Activity to Maintain Authorization

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

7.30 Nitrox Training Guidelines

Training in these guidelines should be in addition to training for Diver-in-Training authorization (Section 4.00). It may be included as part of training to satisfy the Scientific Diver training requirements (Section 5.30).

7.31 Classroom Instruction

a) Topics should include, but are not limited to: review of physical gas laws, particularly pertaining to nitrox; calculations of gas partial pressures; partial pressure and its role in limiting divers; oxygen physiology and oxygen toxicity; calculation of oxygen exposure and maximum safe operating depth (MOD); review of decompression theory and tables; equivalent air depth (EAD) concept and calculations; 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.
b) The DCB may choose to limit standard nitrox diver training to procedures applicable to diving, and subsequently reserve training such as nitrox production methods, oxygen cleaning, and dive station topics to divers requiring specialized authorization in these areas.

7.32 Practical Training

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

a) Oxygen analysis of nitrox mixtures.
b) Determination of MOD, oxygen partial pressure exposure, and oxygen toxicity time limits, for various nitrox mixtures at various depths.
c) Determination of nitrogen-based dive limits status by EAD method using air dive tables, and/or using nitrox dive tables at least as conservative as the NOAA nitrox tables.
d) Nitrox dive computer use may be included, as approved by the DCB but dives may not be planned using dive computers (Section 3.28.2).

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

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

a) Function, care, use, and maintenance of equipment cleaned for nitrox use.

b) Physical and physiological considerations of nitrox diving (e.g., O_2 toxicity and its relationship to CO_2).
c) Diving regulations and procedures as related to nitrox diving, either scuba or surface-supplied (depending on intended mode).
d) Given the proper information, calculation of:
    1. Equivalent air depth (EAD) for a given fO_2 and actual depth;
    2. pO_2 exposure for a given fO_2 and depth;
    3. Optimal nitrox mixture for a given pO_2 exposure limit and planned depth;
    4. Maximum operational depth (MOD) for a given mix and pO_2 exposure limit;
    5. 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.
e) Dive table and dive computer selection and usage;
f) Nitrox production methods and considerations;
g) Oxygen analysis;
h) Nitrox operational guidelines (Section 7.40), dive planning, and dive station components.

7.34 Open Water Dives

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

7.35 Surface-Supplied Training

All training as applied to surface-supplied diving (practical, classroom, and open water) will follow the Florida State University surface-supplied diving standards, including additions listed in Sec. 7.30. The Florida State University follows the consensus standards of the Association of Diving Contractors when conducting surface-supplied diver training or operations. Any variance from ADC standards must be authorized by the DCB.

7.40 Scientific Nitrox Diving Regulations

7.41 Dive Personnel Requirements

a) Nitrox Diver in Training - A Diver in Training, who has completed the requirements of Section 4.00 and the training and authorization sections of these guidelines, may be authorized by the UDO to use nitrox under the direct supervision a Scientific Diver who also holds nitrox authorization. Dive depths should be restricted to those specified in the diver's authorization.
b) 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 UDO to use nitrox. Depth authorization to use nitrox should be the same as those specified in the diver's authorization, as described in Section 5.40.

c) 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 the FSU Standards. Lead Diver authorization for nitrox dives by the UDO and/or DCB should occur as part of the dive plan approval process.

In addition to responsibilities listed in Section 1.26, 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 pO_2 exposure limit for the dive team if on-site conditions so indicate (see Sec. 7.42)

7.42 Dive Parameters

a) Oxygen Exposure Limits

1. The inspired oxygen partial pressure experienced at depth should not exceed 1.6 atm O_2. All dives performed using nitrox breathing mixtures should comply with the current *NOAA Diving Manual* "Oxygen Partial Pressure Limits for 'Normal' Exposures"
2. The maximum allowable exposure limit should be reduced in cases where cold or strenuous dive conditions, or extended exposure times are expected. The DCB should consider this in the review of any dive plan application that proposes to use nitrox. The Lead Diver should also review on-site conditions and reduce the allowable pO_2 exposure limits if conditions indicate.
3. If using the equivalent air depth (EAD) method the maximum depth of a dive should be based on the oxygen partial pressure for the specific nitrox breathing mix to be used.

b) Bottom Time Limits

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

c) Dive Tables and Gases

1. A set of nitrox dive tables at least as conservative as the NOAA nitrox tables should be available at the dive site.
2. When using the equivalent air depth (EAD) method, dives should be conducted using air dive tables approved by the DCB.
3. If nitrox is used to increase the safety margin of air-based dive tables, the MOD and oxygen exposure and time limits for the nitrox mixture being dived should not be exceeded

4. Breathing mixtures used while performing in-water decompression, or for bail-out purposes, should contain the same or greater oxygen content as that being used during the dive, within the confines of depth limitations and the oxygen partial pressure limits set forth in Section 7.42.

d) Nitrox Dive Computers

1. Dive computers may only be used to backup diving tables, not as the primary means of planning decompression obligation (see Section 3.28.2).
2. Divers may only use nitrox diving decompression computers approved by the DCB. Manufacturer's guidelines and operations instructions should be followed.
3. Use of Nitrox dive computers should comply with dive computer guidelines established by the AAUS Standards and the DCB.
4. 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 UDO or designee.
5. If nitrox is used to increase the safety margin of air based tables (backed up by an air-based dive computer), the MOD and oxygen exposure and time limits for the nitrox mixture being dived should not be exceeded.
6. Dive computers capable of pO_2 limit and fO_2 adjustment should be checked by the diver prior to the start of each dive to ensure compatibility with the mixture being used.

e) Repetitive Diving

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

f) Oxygen Parameters

1. Authorized Mixtures - Mixtures meeting the criteria outlined in Sec. 7.42 may be used for nitrox diving operations, upon approval of the DCB.
2. 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 AAUS and FSU 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.

CGA Modified Grade E standard (oxygen compatible)	
Component	**Maximum**
Oxygen	20-22%/v
Carbon Monoxide	2 ppm/v
Carbon Dioxide	1,000 ppm
Condensed Hydrocarbons	0.1 mg/m
Water Vapor	67 ppm (-50° F dewpoint)
Objectionable odors	None

g) Gas Mixing and Analysis

1. Personnel Requirements
   a. Individuals responsible for producing and/or analyzing nitrox mixtures should be knowledgeable and experienced in all aspects of the technique.
   b. Only those individuals approved by the UDO and/or DCB and the Diving Engineer should be responsible for mixing and/or analyzing nitrox mixtures.

2. Production Methods - It is the responsibility of the DCB to approve the specific nitrox production method used.

3. Analysis Verification by User
   a. It is the responsibility of each diver to analyze, prior to the dive, the oxygen content of his/her scuba cylinder and acknowledge in writing the following information for each cylinder: fO_2, MOD, cylinder pressure, date of analysis, and user's name.
   b. Individual dive log reporting forms should report fO_2 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 FSU Standards should apply to nitrox scuba operations. Additional minimal equipment necessary for nitrox diving operations includes:

- Labeled SCUBA cylinders
- Oxygen analyzers.

7.51 Oxygen Cleaning and Maintenance Requirements

a) Requirement for Oxygen Service

1. 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.
2. 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 piping.

b) Scuba Cylinder Identification Marking

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

1. Cylinders should be marked “NITROX”, or “EANx”, or “Enriched Air”
2. Nitrox identification color-coding should include a 4-inch wide green band around the cylinder, starting immediately below the shoulder curvature. If the cylinder is not yellow, the green band should be bordered above and below by a 1-inch yellow band.
3. The alternate marking of a yellow cylinder by painting the cylinder crown green and printing the word “NITROX” parallel to the length of the cylinder in green print is acceptable.
4. Other markings, which identify the cylinder as containing gas mixes other than air, may be used with the approval of the DCB.
5. A contents label should be affixed, to include the current f O_2, date of analysis, and MOD.
6. The cylinder should be labeled to indicate whether the cylinder is prepared for oxygen or nitrox mixtures containing greater than 40% oxygen.

c) 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.

d) Other Support Equipment

1. An oxygen analyzer is required which is capable of determining the oxygen content in the scuba cylinder. Two analyzers are recommended to reduce the likelihood of errors related to a faulty analyzer. The analyzer should be capable of reading a scale of 0 to 100% oxygen, within 1% accuracy.
2. All diver and support equipment should be suitable for the f O_2 being used.

e) Compressor system

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

f) 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: STAGED DECOMPRESSION DIVING

Decompression diving shall be defined as any diving during which the diver cannot directly return to the surface without performing a mandatory decompression stop to allow the release of inert gas from the diver's body. It is recommended that dives requiring decompression be conducted using the surface-supplied mode. **No diver shall plan or conduct staged decompression dives without prior approval of the Diving Control Board**.

8.10 Minimum Experience and Training Requirements

a) Prerequisites:

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

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

c) Minimum training shall include the following:

1. A minimum of 6 hours of classroom training to ensure theoretical knowledge of concepts including: physics and physiology of decompression; decompression planning and procedures; gas management; equipment configurations; decompression method; emergency procedures.

2. It is recommended that at least one training session be conducted in a pool or sheltered water setting to cover: equipment handling and familiarization, swimming and buoyancy control, estimation of gas consumption rates, and to practice emergency procedures.
3. At least 6 open-water dives simulating/requiring decompression shall be conducted, emphasizing planning and execution of required decompression dives, and including practice of emergency procedures.

4. Progression to greater depths shall be by 4-dive increments at depth intervals as specified in Section 5.40.

5. No training dives requiring decompression shall be conducted until the diver has demonstrated acceptable skills under simulated conditions.

6. The following are the minimum skills the diver must demonstrate proficiently during dives simulating and requiring decompression:

   - Buoyancy control
   - Proper ascent rate
   - Proper depth control
   - Equipment manipulation
   - Stage/decompression cylinder use as pertinent to planned diving operations
   - Buddy skills
   - Gas management
   - Time management
   - Task loading
   - Emergency skills

7. Divers shall demonstrate, to the satisfaction of the UDO or 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 UDO approval.

8.20 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
2. Diver location devices adequate for the planned diving operations and environment. Decompression without benefit of a down line connected to either a moored surface float or a surface vessel requires approval of the DCB.
3. Compass

e) Redundancy in the following components is desirable or required at the discretion of the UDO:

1. Decompression schedules
2. Dive timing devices
3. Depth gauges
4. Buoyancy control devices
5. Cutting devices
6. Lift bags and line reels

8.30 Minimum Operational Requirements

a) Approval of dive plan applications to conduct required decompression dives shall be on a case-by-case basis
b) The maximum pO_2 to be used for planning required decompression dives is 1.6 ata. It is recommended that a pO_2 of less than 1.6 ata be used during bottom exposure.
c) Divers' gas supplies shall be adequate to meet planned operational requirements and foreseeable emergency situations.
d) Decompression dives must be planned using dive tables. Dive computers and dive planning software may only be used to back up dive tables.
e) Breathing gases used while performing in-water decompression shall contain the same or greater oxygen content as that used during the bottom phase of the dive.
f) Prior to each dive the dive team shall review emergency procedures appropriate for the planned dive.
g) If breathing gas mixtures other than air are used for required decompression, their use shall ne in accordance with those regulations set forth in the appropriate sections of these standards
h) The maximum depth for required decompression using air as the bottom gas shall be 150 feet, although for dives between the depths of 50 and 130 FSW, divers are encouraged to use enriched air gas mixtures (nitrox). Divers diving below 130 FSW are encouraged to use gas mixtures other than air to conduct these dives. Diving below 150 feet is not permitted
i) Use of additional nitrox and/or high-oxygen fraction decompression mixtures as travel and decompression gases to decrease decompression obligations is encouraged.
j) Use of alternate gas mixtures to limit narcosis is encouraged for dives to depths exceeding 130 feet, but these mixtures must be approved by the DCB.
l) Mission specific workup dives are recommended.

SECTION 9.00: SHALLOW-WATER SURFACE SUPPLIED (HOOKAH**)**

Diving operations requiring the use of hookah must be approved by the UDO

9.10 Minimum Requirements

9.11 In addition to all other requirements of these standards divers using the hookah mode shall be trained in the operation, care, maintenance of hookah equipment. Divers shall also be equipped with a diver-carried independent reserve breathing gas supply while diving on hookah.

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

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

9.14 Divers shall comply with the basic ADP SOP, including the use of a standby diver. Hookah divers do not require a buddy if line tended.

9.15 Only hookah units approved by the UDO or designee shall be used while diving under the auspices of FSU.

SECTION 10.00: SURFACE-SUPPLIED DIVING

Surface-supplied divers shall comply with all scuba diving procedures in this manual (except Sec. 2.31). Surface supplied diving shall not be conducted at depths greater than 150 fsw. Divers utilizing the surface-supplied mode shall be properly trained in the use, care, and maintenance of the equipment and in all aspects of surface-supplied diving operations. Unless specifically authorized by the DCB, all surface-supplied diving at FSU will comply with the consensus standards of the Association of Diving Contractors (ADC).

10.10 Minimum Requirements

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

10.12 Each surface-supplied diver shall be hose tended by a separate dive team member while in the water.

10.13 Divers using the surface-supplied mode shall maintain voice communication with the surface tender.

10.14 The surface-supplied breathing gas supply shall be sufficient to support all surface supplied divers in the water for the duration of the planned dive, including decompression.

10.15 During surface-supplied diving operations when only one diver is in the water, there must be a standby diver in attendance at the dive location.

10.16 During liveboating operations (divers in the water while the vessel is underway), vessel operators will ensure that the propeller is stopped when a diver is within a vessel's length of the vessel. Surface supplied liveboating operations will follow the recommendations of the Association of Diving Contractors consensus standards.

SECTION 11.00: OTHER DIVING TECHNOLOGY

Certain types of diving, some of which are listed below, require specialized equipment or require additional training. Supplementary guidelines for these technologies are in development by the AAUS. Researchers that have a need to use such technologies must follow guidelines established by the FSU Diving Control Board. Divers shall comply with all scuba diving procedures in this manual unless specified.

11.10 MIXED GAS DIVING

The use of mixed gas (gas mixtures other than air or nitrox) is not currently supported by the FSU DCB or ADP. Divers requiring the use of mixed gas must make application for approval and support to the DCB. Mixed gas diving standards are contained in Section 12.

11.20 SATURATION DIVING

Divers requiring the use of saturation diving on open circuit SCUBA shall comply with the guidelines established by the FSU DCB.

11.30 CLOSED AND SEMI-CLOSED CIRCUIT SCUBA (REBREATHERS)

Closed and semi-closed circuit scuba (rebreathers) are currently not supported by the FSU DCB or ADP. Divers requiring the use of rebreather technology must make application for approval and support to the DCB. Rebreather diving standards are contained in Section 13.

11.40 BLUE WATER DIVING

The Florida State University Diving Control Board does not currently support blue water diving, which is defined as diving in open water where the bottom is generally >200 feet deep. Blue-water diving 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). No blue-water diving activity shall take place without the prior approval of the DCB.

11.50 ICE AND POLAR DIVING

Divers anticipating the need to dive under ice or in polar conditions should seek the approval of the DCB. Divers planning such diving activity should consult the following: "Guidelines for Conduct of Research Diving", National Science Foundation, Division of Polar Programs, 1990. No ice or polar diving is permitted without the prior approval of the DCB.

11.60 OVERHEAD ENVIRONMENTS

Overhead environments include cavern, cave, and shipwreck penetration diving. In cavern or confined space situations, 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. Diving in caves and penetration diving in shipwrecks are currently not supported by the

FSU DCB or ADP. Divers with a demonstrated need to dive in overhead environments must make application for approval and support to the DCB.

11.70 DRY SUIT DIVING

Divers planning on conducting dives using dry suits shall be properly trained by the ADP staff or shall attend an equivalent training course. At a minimum, the diver should be familiar with the care and maintenance of the dry suit, proper fitting and dressing in the dry suit, thermal properties and buoyancy considerations of dry suits, diving techniques using dry suits, and repair of the dry suit. In addition, divers should be trained in emergency procedures for loss of or significant gain in buoyancy while wearing a drysuit. Divers should be initially exposed to the dry suit in a pool or confined water environment, and should also make at least 4 open water dives in the dry suit under the supervision of instructional personnel. No diver shall be permitted to check out a dry suit without the approval of the UDO or designee.

SECTION 12.00: 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.

12.10 Minimum Experience and Training Requirements

Prerequisites:

- Nitrox certification and authorization (Section 7.00)
- If the intended use entails required decompression stops, divers will be previously certified and authorized in decompression diving (Section 9.00).
- 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:
    - Review of topics and issues previously outlined in nitrox and required decompression diving training as pertinent to the planned operations.
    - The use of helium or other inert gases, and the use of multiple decompression gases.
    - Equipment configurations
    - Mixed gas decompression planning
    - Gas management planning
    - Thermal considerations

END determination

- Mission planning and logistics
- Emergency procedures
- Mixed gas production methods
- Methods of gas handling and cylinder filling
- Oxygen exposure management
- Gas analysis
- Mixed gas physics and physiology

Practical Training:

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

12.20 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.

The quality of inert gases used to produce breathing mixtures shall be of an acceptable grade for human consumption.

12.30 Minimum Operational Requirements

a) Approval of dive plan applications to conduct mixed gas dives shall be on a case-by-case basis.

All applicable operational requirements for nitrox and decompression diving shall be met.

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.

Maximum planned Oxygen Toxicity Units (OTU) will be considered based on mission duration.

Divers decompressing on high-oxygen concentration mixtures shall closely monitor one another for signs of acute oxygen toxicity.

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 13.00: REBREATHERS[1]

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

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

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

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

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

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

13.10 Definitions and General Information

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

Advantages of rebreathers may include increased gas utilization efficiencies that are often independent of depth, extended no-decompression bottom times and greater decompression efficiency, and reduction or elimination of exhaust bubbles that may disturb aquatic life or sensitive environments.

Disadvantages of rebreathers include high cost and, in some cases, a high degree of system complexity and reliance on instrumentation for gas composition control and monitoring, which may fail. The diver is more likely to experience hazardous levels of hypoxia, hyperoxia, or hypercapnia, due to user error or equipment malfunction, conditions which may lead to underwater blackout and drowning. Inadvertent flooding of the breathing loop and wetting of the carbon dioxide absorbent may expose the diver to ingestion of an alkaline slurry ("caustic cocktail").

An increased level of discipline and attention to rebreather system status by the diver is required for safe operation, with a greater need for self-reliance. Rebreather system design and operation varies significantly between make and model. For these reasons when evaluating any dive plan incorporating rebreathers, risk-management emphasis should be placed on the individual qualifications of the diver on

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(Based on guidelines developed by the University of Hawaii, University of California-Davis, and Harbor Branch Oceanographic Institution. Incorporating reviewer comments and suggestions of Tom Mount, Joseph Dituri, Jeorg Hess, John Clarke, Richard Pyle, Gregg Stanton, Dudley Crosson, Steve Sellers, and Daniel Marelli)

the specific rebreather make and model to be used, in addition to specific equipment requirements and associated operational protocols.

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

Semi-Closed Circuit Rebreathers. Semi-closed circuit rebreathers (SCR) recycle the majority of exhaled breathing gas, venting a portion into the water and replenishing it with a constant or variable amount of a single oxygen-enriched gas mixture. Gas addition and venting is balanced against diver metabolism to maintain safe oxygen levels by means which differ between SCR models, but the mechanism usually provides a semi-constant fraction of oxygen (FO_2) in the breathing loop at all depths, similar to open-circuit SCUBA.

Closed-Circuit Mixed Gas Rebreathers. Closed-circuit mixed gas rebreathers (CCR) recycle all of the exhaled gas and replace metabolized oxygen via an electronically controlled valve, governed by electronic oxygen sensors. Manual oxygen addition is available as a diver override, in case of electronic system failure. A separate inert gas source (diluent), usually containing primarily air, heliox, or trimix, is used to maintain oxygen levels at safe levels when diving below 20fsw. CCR systems operate to maintain a constant oxygen partial pressure (PPO_2) during the dive, regardless of depth.

13.20 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

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

c) Completion of a minimum of 50 open-water dives on SCUBA.

d) 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.

e) 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.

a) 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.

b) Classroom training shall include:

A review of those topics of diving physics and physiology, decompression management, and dive planning included in prior scientific diver, nitrox, staged decompression and/or mixed gas training, as they pertain to the safe operation of the selected rebreather system and planned diving application. In particular, causes, signs and symptoms, first aid, treatment and prevention of the following must be covered:

Hyperoxia (CNS and Pulmonary Oxygen Toxicity)
Middle Ear Oxygen Absorption Syndrome (oxygen ear)
Hyperoxia-induced myopia
Hypoxia
Hypercapnia
Inert gas narcosis
Decompression sickness

Rebreather-specific information required for the safe and effective operation of the system to be used, including:

System design and operation, including:
Counterlung(s)
CO_2 scrubber
CO_2 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 to be used):

c) 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 greate depths, with at least one dive in the 80 to 100 fsw range.; *** Total underwater time (pool and open water) of approximately 5(First two open water dives should not exceed 60 fsw. Subsequent dives should be at progressively greater depths, with at least 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.

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

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

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

* Dives should not exceed 20 fsw.

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

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

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

Extended Range, Required Decompression and Helium-Based Inert Gas

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

e) 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 the130 fsw level.

Maintenance of Proficiency

f) 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.

13.30 Equipment Requirements

General Requirements

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

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

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

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

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

- Operational depth range
- Operational temperature range
- Breathing gas mixtures that may be used
- Maximum exercise level which can be supported as a function of breathing gas and depth
- Breathing gas supply durations as a function of exercise level and depth
- CO_2 absorbent durations, as a function of depth, exercise level, breathing gas, and water temperature
- Method, range and precision of inspired PPO_2 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

h) A surface/dive valve in the mouthpiece assembly, allowing sealing of the breathing loop from the external environment when not in use.

An automatic gas addition valve, so that manual volumetric compensation during descent is unnecessary.

Manual gas addition valves, so that manual volumetric compensation during descent and manual oxygen addition at all times during the dive are possible.

The diver shall carry alternate life support capability (open-circuit bail-out or redundant rebreather) sufficient to allow the solution of minor problems and allow reliable access to a pre-planned alternate life support system.

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.

i) 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.

13.40 Operational Requirements

General Requirements

j) All dives involving rebreathers must comply with applicable operational requirements for open-circuit SCUBA dives to equivalent depths.

No rebreather system should be used in situations beyond the manufacturer's stated design limits (dive depth, duration, water temperature, etc).

Modifications to rebreather systems shall be in compliance with manufacturer's recommendations.

Rebreather maintenance is to be in compliance with manufacturer's recommendations including sanitizing, replacement of consumables (sensors, CO_2 absorbent, gas, batteries, etc) and periodic maintenance.

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

Information about the specific rebreather model to be used
Make, model, and type of rebreather system
Type of CO_2 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.

k) 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

l) 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 atm. 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

m) 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:

Oxygen rebreathers: Not applicable.

SCR (presumed constant FO_2):

Use of any method approved for open-circuit scuba diving breathing air, above the maximum operational depth of the supply gas.

Use of open-circuit nitrox dive tables based upon expected inspired FO_2. In this case, contingency air dive tables may be necessary for active-addition SCR's in the event that exertion level is higher than expected.

Equivalent air depth correction to open-circuit air dive tables, based upon expected inspired FO_2 for planned exertion level, gas supply rate, and gas composition. In this case, contingency air dive tables may be necessary for active-addition SCR's in the event that exertion level is higher than expected.

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, Battery Logs, and Pre-And Post-Dive Checklists

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

Gas supply cylinders full
Composition of all supply and bail-out gases analyzed and documented
Oxygen sensors calibrated
Carbon dioxide canister properly packed
Remaining duration of canister life verified
Breathing loop assembled
Positive and negative pressure leak checks
Automatic volume addition system working
Automatic oxygen addition systems working
Pre-breathe system for 3 minutes (5 minutes in cold water) to ensure proper oxygen addition and carbon dioxide removal (be alert for signs of hypoxia or hypercapnia)
Other procedures specific to the model of rebreather used
Documentation of ALL components assembled
Complete pre-dive system check performed

- Final operational verification immediately before to entering the water:
  - PO_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:

s) 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

t) CO_2 absorption canister shall be filled in accordance with the manufacturer's specifications.

CO_2 absorbent material shall be used in accordance with the manufacturer's specifications for expected duration.

If CO_2 absorbent canister is not exhausted and storage between dives is planned, the canister should be removed from the unit and stored sealed and protected from ambient air, to ensure the absorbent retains its activity for subsequent dives.

Long-term storage of carbon dioxide absorbents shall be in a cool, dry location in a sealed container. Field storage must be adequate to maintain viability of material until use.

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

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

Unit Disinfections

The entire breathing loop, including mouthpiece, hoses, counterlungs, and 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.

13.50 Oxygen Rebreathers

n) 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.

13.60 Semi-Closed Circuit Rebreathers

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

The gas addition rate of active addition SCR (e.g., Draeger Dolphin and similar units) shall be checked before every dive, to ensure it is balanced against expected workload and supply gas FO_2.

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.

13.70 Closed-Circuit Rebreathers

p) 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 atm but no greater than 1.4 atm.

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 atm.

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 atm or higher than 1.4 atm.