An underwater photograph showing a large, dark-colored fish with a yellow stripe near its eye swimming towards a vertical structure covered in colorful coral and other marine life. The background is a deep blue ocean.

# ARTIFICIAL REEF PROGRAM

TEXAS  
PARKS &  
WILDLIFE

## SCIENTIFIC DIVING STANDARDS AND SAFETY MANUAL

January 2007

# **ARTIFICIAL REEF PROGRAM**

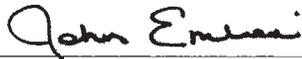
## **SCIENTIFIC DIVING STANDARDS AND SAFETY MANUAL**



**January 2007**

**TEXAS PARKS AND WILDLIFE DEPARTMENT  
ARTIFICIAL REEF PROGRAM  
DIVING STANDARDS AND OPERATIONS**

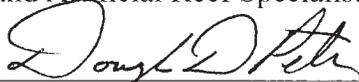
Submitted By:



John Embesi, Diving Safety Officer  
and Artificial Reef Specialist

8/15/06

Date

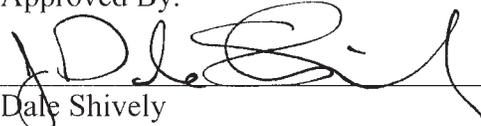


Douglas B. Peter, Scientific Diver  
and Artificial Reef Biologist

8/15/06

Date

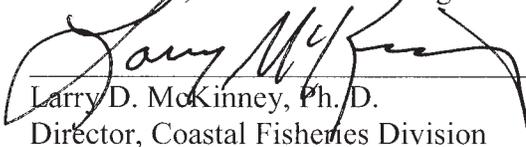
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Dale Shively  
Coordinator, Artificial Reef Program

18 AUG 2006

Date



Larry D. McKinney, Ph. D.  
Director, Coastal Fisheries Division

18 Aug 2006

Date

**TEXAS PARKS AND WILDLIFE DEPARTMENT  
ARTIFICIAL REEF PROGRAM  
DIVING CONTROL BOARD**

Membership for the Texas Parks and Wildlife Department (TPWD) Artificial Reef Program Diving Control Board includes TPWD staff and volunteer members as appointed by the TPWD Coastal Fisheries Division Director. Current Members as of August, 2006 include:

**TPWD State Board Members**

**Larry McKinney, Ph.D.**

Director, Coastal Fisheries Division, TPWD

**Dale Shively**

Coordinator, Artificial Reef Program, TPWD

**John Embesi**

Diving Safety Officer

Artificial Reef Specialist, Artificial Reef Program, TPWD

**Douglas Peter**

Artificial Reef Biologist, Artificial Reef Program, TPWD

**Volunteer Board Members**

**Caroline Fife, M.D.**

Director of Hyperbaric Medicine, Memorial Hermann Hospital, Houston

Associate Professor, Department of Anesthesiology, University of Texas

Health Science Center, Houston

Divers Alert Network Advisory Board

**Larry Martin**

Diving Safety Officer, LGL Ecological Research Associates, Inc.

PADI Master SCUBA Instructor

PSI Cylinder Inspector

NOAA Aquanaut (Inactive)

**Chris May**

PADI Master SCUBA Instructor

Divers Alert Network O<sub>2</sub> Provider Instructor

Medic First Aid International Instructor Trainer

Emergency Medical Technician, Texas Department of Health

Diver Medic Technician, National Board of Diving and Hyperbaric

Medical Technology (Inactive)

## PREFACE

The Texas Parks and Wildlife Department Artificial Reef Program Scientific Diving Standards and Safety Manual, 2007 revision, is based on the American Academy of Underwater Sciences *Standards for Scientific Diving*, 2003 revision. This 2007 revision replaces the TPWD Artificial Reef Program Scientific Diving Standards and Safety Manual, April 1998 edition, and retains the standard format and information of the current AAUS manual. Appropriate changes in Volume 1 and supplementary sections in Volume 2 of the AAUS manual were added to address the unique diving conditions of the Artificial Reef Program. This manual represents the current minimum diving safety standards for the Artificial Reef Program and will be updated as diving science and technology advances. All updates will be approved through the TPWD Artificial Reef Program Diving Control Board.

The following manual governs the scientific diving operations for the Artificial Reef Program and should not be considered the standard for other agency operations. The TPWD Artificial Reef Program has been an AAUS organizational member since 1998 and is listed as AAUS organizational member #131.

## ACKNOWLEDGEMENTS

The Diving Control Board of the TPWD Artificial Reef Program acknowledges AAUS and the authors of the *Standards for Scientific Diving*.

## REVISION HISTORY

- |             |  |
|-------------|--|
| April, 1998 | Texas Parks and Wildlife Department Artificial Reef Program Scientific Diving Standards  |
| July, 2006  | Texas Parks and Wildlife Department Artificial Reef Program Scientific Diving Standards and Safety Manual. The manual was separated into two volumes to comply with current AAUS manual standards. |

## COMMONLY USED ACRONYMS

- |                 |   |
|-----------------|---|
| <b>AAUS</b>     | - American Academy of Underwater Sciences                     |
| <b>DCB</b>      | - Diving Control Board  |
| <b>DOT</b>      | - U.S. Department of Transportation                           |
| <b>DSO</b>      | - Diving Safety Officer                                       |
| <b>NOAA</b>     | - National Oceanic and Atmospheric Administration             |
| <b>OSHA</b>     | - Occupational Safety and Health Administration               |
| <b>TPWD</b>     | - Texas Parks and Wildlife Department                         |
| <b>TPWD-ARP</b> | - Texas Parks and Wildlife Department Artificial Reef Program |

(Note: Please refer to Appendix 5, pg. 71, for other acronyms and definitions of terminology.)

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# **Volume 1**

**Sections 1.00 through 6.00**

**Required For All AAUS Organizational Members**

## SECTION 1.00 GENERAL POLICY

### 1.10 Scientific Diving Standards

#### 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 AAUS organizational members. Fulfillment of the purposes shall be consistent with the furtherance of research and safety.

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

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

In 1982, the Occupational Safety and Health Administration (OSHA) exempted scientific diving from commercial diving regulations (29CFR1910, Subpart T) under certain conditions that are outlined below. The final guidelines for the exemption became effective in 1985 (Federal Register, Vol. 50, No. 6, p. 1046). AAUS is recognized by OSHA as the scientific diving standard-setting organization.

Additional standards that extend this document may be adopted by each organizational member, according to local procedure.

Texas Parks and Wildlife Department Artificial Reef Program (TPWD-ARP) became an organizational member of AAUS in 1998. The TPWD-ARP conducts scientific diving operations in compliance with the Texas Artificial Reef Plan (approved by the Texas Legislature in 1990) to verify the placement, monitor progress and conduct scientific research on artificial reefs in the offshore waters adjacent to Texas.

#### Scientific Diving Definition

Scientific diving is defined (29CFR1910.402) as diving performed solely as a necessary part of a scientific, research or educational activity by employees whose sole purpose for diving is to perform scientific research tasks.

#### Scientific Diving Exemption

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

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

- b) The purpose of the project using scientific diving is the advancement of science; therefore, information and data resulting from the project are non-proprietary.
- c) The tasks of a scientific diver are those of an observer and data gatherer. Construction and trouble-shooting tasks traditionally associated with commercial diving are not included within scientific diving.
- d) Scientific divers, based on the nature of their activities, must use scientific expertise in studying the underwater environment and therefore, are scientists or scientists-in-training.
- e) In addition, the scientific diving program shall contain at least the following elements (29CFR1910.401):
  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.
  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.

#### Review of Standards

As part of each TPWD-ARP annual report, any recommendations for modifications of these standards shall be submitted to the AAUS for consideration.

### **1.20 Operational Control**

#### Organizational Member Auspices Defined

For the purposes of these standards the auspices of the TPWD-ARP includes any scientific diving operation in which TPWD-ARP 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 TPWD-ARP or employees of auxiliary organizations, where such employees are acting within the scope of TPWD-ARP, and the operations of other persons who are engaged in scientific diving of TPWD-ARP or are diving as members of an organization recognized by the AAUS organizational member.

It is TPWD-ARP's responsibility to adhere to the AAUS Standards for Scientific Diving Certification and Operation of Scientific Diving Programs. The administration of the local diving program will reside with the TPWD-ARP Diving Control Board (DCB).

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

## TPWD-ARP's Scientific Diving Standards and Safety Manual

TPWD-ARP shall develop and maintain a scientific diving safety manual that provides for the development and implementation of policies and procedures that will enable it to meet requirements of local environments and conditions as well as to comply with the AAUS scientific diving standards. TPWD-ARP's scientific diving manual shall include, but not be limited to:

- a) AAUS standards may be used as a set of minimal guidelines for the development of an organizational member's scientific diving safety manual. Volume 1, Sections 1.00 through 6.00 and the Appendices are required for all manuals. Volume 2, Sections 7.00 through 9.00 are required only when TPWD-ARP conducts that diving activity, and those specific sections are placed in Volume 2.
- b) Emergency evacuation and medical treatment procedures.
- c) Criteria for diver training and certification.
- d) Standards written or adopted by reference for each diving mode utilized which include the following:
  1. Safety procedures for the diving operation.
  2. Responsibilities of the dive team members.
  3. Equipment use and maintenance procedures.
  4. Emergency procedures.

### Diving Safety Officer

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

- a) Qualifications
  1. Shall be appointed by the responsible administrative officer or designee, with the advice and counsel of the Diving Control Board.
  2. Shall be trained as a scientific diver.
  3. Shall be a full member as defined by AAUS.
  4. Shall be an active underwater instructor from an internationally recognized certifying agency.
- b) Duties and Responsibilities
  1. Shall be responsible, through the DCB, for the conduct of the scientific diving program of the TPWD-ARP. The routine operational authority for this program, including the conduct of training and certification, approval of dive plans,

maintenance of diving records and ensuring compliance with this standard and all relevant regulations of the TPWD-ARP, rests with the Diving Safety Officer.

2. May permit portions of this program to be carried out by a qualified delegate, although the Diving Safety Officer may not delegate responsibility for the safe conduct of the local diving program.
3. Shall be guided in the performance of the required duties by the advice of the DCB, but operational responsibility for the conduct of the local diving program will be retained by the Diving Safety Officer.
4. Shall suspend diving operations considered to be unsafe or unwise.

#### Diving Control Board

The TPWD Coastal Fisheries Division Director shall appoint the TPWD-ARP Diving Control Board (DCB). The DCB shall consist of a majority of active scientific divers. Voting members shall include the Diving Safety Officer, the responsible administrative officer, or designee, and should include other representatives of the diving program such as qualified divers and members selected by procedures established by DCB. A chairperson and a secretary may be chosen from the membership of the board according to local procedure. Each DCB member will serve a renewable three year term. The DCB shall meet at least once a year. DCB members must have the capability for electronic correspondence. The DCB:

- a) Has autonomous and absolute authority over the scientific diving program's operation.
- b) Shall approve and monitor diving projects.
- c) Shall review and revise the diving safety manual.
- d) Shall assure compliance with the diving safety manual.
- e) Shall certify the depths to which a diver has been trained.
- f) Shall take disciplinary action for unsafe practices.
- g) Shall assure adherence to the buddy system for scuba diving.
- h) Shall act as the official representative of the membership organization in matters concerning the scientific diving program.
- i) Shall act as a board of appeal to consider diver-related problems.
- j) Shall recommend the issue, reissue or the revocation of diving certifications.
- k) Shall recommend changes in policy and amendments to AAUS and the TPWD-ARP diving safety manuals as the need arises.
- l) Shall establish and/or approve training programs through which the applicants for certification can satisfy the requirements of the TPWD-ARP diving safety manual.
- m) Shall suspend diving programs that are considered to be unsafe or unwise.

- n) Shall establish criteria for equipment selection and use.
- o) Shall recommend new equipment or techniques.
- p) Shall establish and/or approve facilities for the inspection and maintenance of diving and associated equipment.
- q) Shall ensure that the TPWD-ARP air station(s) meet air quality standards as described in Section 3.60.
- r) Shall periodically review the Diving Safety Officer's performance and program.
- s) Shall sit as a board of investigation to inquire into the nature and cause of diving accidents or violations of the TPWD-ARP diving safety manual.

#### Instructional Personnel

- a) Qualifications - All personnel involved in diving instruction under the auspices of the TPWD-ARP shall be qualified for the type of instruction being given.
- b) Selection - Instructional personnel will be selected by the responsible administrative officer, or designee, who will solicit the advice of the DCB in conducting preliminary screening of applicants for instructional positions.

#### Lead Diver

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

- a) Coordination with other known activities in the vicinity that are likely to interfere with diving operations.
- b) Ensuring all dive team members possess current certification and are qualified for the type of diving operation.
- c) Planning dives in accordance with Section 2.20
- d) Ensuring safety and emergency equipment is in working order and at the dive site.
- e) Briefing dive team members on:
  1. Dive objectives.
  2. Unusual hazards or environmental conditions likely to affect the safety of the diving operation.
  3. Modifications to diving or emergency procedures necessitated by the specific diving operation.
- f) Suspending diving operations if, in their opinion, conditions are not safe.

- g) Reporting to the DSO and DCB any physical problems or adverse physiological effects including symptoms of pressure-related injuries.
- h) Recording dive logs, trip reports and data. Lead diver shall authorize individuals to record logs and designate a single timepiece and specific location for recording dives and other information. All reports and logs should be delivered to the DSO within 5 days after the diving operation.
- i) Identifying themselves to the vessel master as the person in charge of diving operations.

#### Reciprocity and Visiting Scientific Diver

- a) If TPWD-ARP is engaged in joint diving activities or use of diving resources with another organization, a governing DCB shall be designated by mutual agreement.
- b) A Scientific Diver from one AAUS Organizational Member shall apply for permission to dive under the auspices of TPWD-ARP by submitting to the TPWD-ARP Diving Safety Officer a document containing all the information described in Appendix 6, signed by the Diving Safety Officer or Chairperson of the home Diving Control Board.
- c) A visiting Scientific Diver may be asked to demonstrate their knowledge and skills for the planned dive.
- d) If TPWD-ARP denies a visiting Scientific Diver permission to dive, the TPWD-ARP Diving Control Board shall notify the visiting Scientific Diver and their Diving Control Board with an explanation of all reasons for the denial.

#### Waiver of Requirements

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

### **1.30 Consequence of Violation of Regulations by Scientific Divers**

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

### **1.40 Consequences of Violation of Regulations by AAUS Organizational Members**

Failure to comply with the regulations of this standard may be cause for the revocation or restriction of TPWD-ARP's recognition by AAUS.

### **1.50 Record Maintenance**

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

Availability of Records:

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

## **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 TPWD-ARP scientific diving program unless they hold a current certification issued pursuant to the provisions of this standard.

### **2.20 Pre-Dive Procedures**

#### Dive Plans

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

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

#### Pre-dive Safety Checks

- a) Diver's Responsibility:
  - 1. Scientific divers shall conduct a functional check of their diving equipment in the presence of the diving buddy or tender.

2. It is the diver's responsibility and duty to refuse to dive if, in their judgment, conditions are unfavorable, or if they would be violating the precepts of their training, this standard, or the TPWD-ARP diving safety manual.
3. No dive team member shall be required to be exposed to hyperbaric conditions against their will, except when necessary to prevent or treat a pressure-related injury, at the discretion of the lead diver.
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.

b) Equipment Evaluations

1. Divers shall ensure that their equipment is in proper working order and that the equipment is suitable for the type of diving operation.
2. Each diver shall have the capability of achieving and maintaining positive buoyancy.

c) Site Evaluation - Environmental conditions at the site will be evaluated.

## **2.30 Diving Procedures**

### Solo Diving Prohibition

All diving activities shall assure adherence to the buddy system for scuba diving. This buddy system is based upon mutual assistance, especially in the case of an emergency.

### Refusal to Dive

- a) The decision to dive is that of the diver. A diver may refuse to dive, without fear of penalty, whenever they feel it is unsafe for them to make the dive.
- b) 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 their judgment, conditions are unsafe or unfavorable, or if they would be violating the precepts of their training or the regulations in this standard.

### Termination of the Dive

- a) It is the responsibility of the diver to terminate the dive, without fear of penalty, whenever they feel it is unsafe to continue the dive, unless it compromises the safety of another diver already in the water.
- b) The dive shall be terminated while there is still sufficient cylinder pressure to permit the diver to safely reach the surface or an additional air source. Considerations should include any of the following that apply: half stops, safety stops, decompression time or required decompression stops.

## Emergencies and Deviations from Regulations

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

### **2.40 Post-Dive Procedures**

#### Post-Dive Safety Checks

- a) After the completion of a dive, each diver shall report any physical problems, symptoms of decompression sickness or equipment malfunctions to the Lead Diver.
- b) 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 them to a decompression chamber if necessary.

### **2.50 Emergency Procedures**

TPWD-ARP will develop emergency procedures which follow the standards of care of the community and must include procedures for emergency care, recompression and evacuation for each dive location. (Appendix 7)

### **2.60 Flying After Diving**

Divers should have a minimum surface interval of 24 hours before ascending to altitude.

### **2.70 Record Keeping Requirements**

#### Personal Diving Log

Each certified scientific diver shall log every dive made under the auspices of the TPWD-ARP and is encouraged to log all other dives. Standard forms will be provided. Log sheets shall be submitted to the Diving Safety Officer to be placed in the diver's permanent file. Details of the submission procedures are left to the discretion of the Diving Safety Officer. The diving log shall be in a form specified by the organization and shall include at least the following:

- a) Name of diver, buddy and Lead Diver.
- b) Date, time and location.
- c) Diving modes used.
- d) General nature of diving activities.
- e) Approximate surface and underwater conditions.

- f) Maximum depths, bottom time and surface interval time.
- g) Diving tables or computers used.
- h) Detailed report of any near or actual incidents.

### Required Incident Reporting

All diving incidents requiring recompression treatment, or resulting in moderate or serious injury, or death shall be reported to the TPWD-ARP Diving Control Board and to AAUS. The TPWD-ARP regular procedures for incident reporting, including those required by AAUS, shall be followed. The report will specify the circumstances of the incident and the extent of any injuries or illnesses.

Additional information must meet the following reporting requirements:

- a) TPWD-ARP shall record and report occupational injuries and illnesses in accordance with requirements of Texas Labor Code and TPWD form PWD-009.
- b) If pressure-related injuries are suspected, or if symptoms are evident, the following additional information shall be recorded and retained by TPWD-ARP, with the record of the dive, for a period of 5 years:
  - 1. Complete AAUS Incident Report at: <http://www.aaus.org>
  - 2. Written descriptive report to include:
    - Name, address, phone numbers of the principal parties involved.
    - Summary of experience of divers involved.
    - Location, description of dive site and conditions prior to incident.
    - Description of symptoms, including depth and time of onset.
    - Description and results of treatment.
    - Disposition of case.
    - Recommendations to avoid repetition of incident.
- c) TPWD-ARP shall investigate and document any incident of pressure-related injury and prepare a report that is to be forwarded to AAUS during the annual reporting cycle. This report must first be reviewed and released by the TPWD-ARP Diving Control Board.

## SECTION 3.00 DIVING EQUIPMENT

### 3.10 General Policy

All equipment shall meet standards as determined by the DSO and the DCB. Equipment that is subjected to extreme usage under adverse conditions should require more frequent testing and maintenance. All equipment shall be regularly examined by the person using them.

TPWD-ARP owned dive equipment may be utilized by TPWD-ARP scientific divers, at the discretion of the DSO, to conduct additional dives outside of official TPWD-ARP operations. These dives shall not conflict with other TPWD regulations. All equipment must be returned in the same condition as it was issued. Any malfunctions or repairs shall be reported to the DSO.

### 3.20 Equipment

#### Regulators

- a) Only those makes and models specifically approved by the Diving Safety Officer and the Diving Control Board shall be used.
- b) Scuba regulators shall be inspected and tested prior to first use and every 12 months thereafter.
- c) Regulators will consist of a primary second stage and an alternate air source (such as an octopus second stage or redundant air supply).

#### Breathing Masks and Helmets

Breathing masks and helmets shall have:

- a) A non-return valve at the attachment point between helmet or mask and hose, which shall close readily and positively.
- b) An exhaust valve.
- c) A minimum ventilation rate capable of maintaining the diver at the depth to which they are diving.

#### Scuba Cylinders

- a) Scuba cylinders shall be designed, constructed and maintained in accordance with the applicable provisions of the Unfired Pressure Vessel Safety Orders.
- b) Scuba cylinders must be hydrostatically tested in accordance with U.S. Department of Transportation (DOT) standards.
- c) Scuba cylinders must have an internal and external inspection at intervals not to exceed 12 months by a qualified cylinder inspector.
- d) Scuba cylinder valves shall be functionally tested at intervals not to exceed 12 months.

### 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.

### Gauges

Gauges shall be inspected and tested before first use and every 12 months thereafter.

### Flotation Devices

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

### Timing Devices, Depth and Pressure Gauges

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

### Determination of Decompression Status: Dive Tables, Dive Computers

- a) A set of NOAA Diving and NOAA Nitrox Tables must be available at the dive location.
- b) Dive computers may be utilized in place of diving tables and must be approved by the Diving Control Board. A backup dive computer must be worn throughout any dive operation that dive computers are used. AAUS recommendations on dive computers are available at <http://www.aaus.org>

## **3.30 Auxiliary Equipment**

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

## **3.40 Support Equipment**

### First aid supplies

A first aid kit and emergency oxygen shall be available.

### Diver's Flag

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

### Compressor Systems - TPWD-ARP Controlled

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

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

## **3.50 Equipment Maintenance**

### Record Keeping

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

- a) Regulators
- b) Submersible pressure gauges
- c) Depth gauges
- d) Scuba cylinders
- e) Cylinder valves
- f) Diving helmets
- g) Submersible breathing masks
- h) Compressors
- i) Gas control panels
- j) Air storage cylinders
- k) Air filtration systems
- l) Analytical instruments
- m) Buoyancy control devices
- n) Dry suits

### Compressor Operation and Air Test Records

- a) Gas analyses and air tests shall be performed on each TPWD-ARP controlled breathing air compressor at regular intervals of no more than 100 hours of operation or six months, whichever occurs first. The results of these tests shall be entered in a formal log and be maintained.
- b) 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).

<b>CGA Grade E</b>	
<b>Component</b>	<b>Maximum</b>
Oxygen	20 - 22%/v
Carbon Monoxide	10 PPM/v
Carbon Dioxide	1000 PPM/v
Condensed Hydrocarbons	5 mg/m <sup>3</sup>
Water Vapor	NS
Objectionable Odors	None

## **SECTION 4.00 ENTRY-LEVEL TRAINING REQUIREMENTS**

Each diver participating in scientific diving under the auspices of TPWD-ARP must be certified through a nationally recognized certifying agency prior to completing an application to become a scientific diver.

This section describes training for equivalency of the certified diver.

### **4.10 Evaluation**

#### **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 Section 4.20 (Section 6.00 and Appendices 1 through 4).

#### **Swimming Evaluation**

Applicant shall successfully perform the following tests, or equivalent, in the presence of the Diving Safety Officer, or an examiner approved by the Diving Safety Officer.

- a) Swim underwater without swim aids for a distance of 25 yards without surfacing.
- b) Swim 400 yards in less than 12 minutes without swim aids.
- c) Tread water for 10 minutes, or two minutes without the use of hands, without swim aids.
- d) Without the use of swim aids, transport another person of equal size a distance of 25 yards in the water.

### **4.20 Scuba Training**

#### **Practical Training**

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

- a) Enter water with full equipment.
- b) Clear face mask.
- c) 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.
- d) Demonstrate ability to alternate between snorkel and scuba while kicking.
- e) Demonstrate understanding of underwater signs and signals.
- f) Demonstrate simulated in-water mouth-to-mouth resuscitation.

- g) Rescue and transport, as a diver, a passive simulated victim of an accident.
- h) Demonstrate ability to remove and replace equipment while submerged.
- i) Demonstrate watermanship ability, which is acceptable to the instructor.

### Written Examination

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

- a) Function, care, use and maintenance of diving equipment.
- b) Physics and physiology of diving.
- c) Diving regulations and precautions.
- d) Near-shore currents and waves.
- e) Dangerous marine animals.
- f) Emergency procedures, including buoyant ascent and ascent by air sharing.
- g) Currently accepted decompression procedures.
- h) Demonstrate the proper use of dive tables.
- i) Underwater communications.
- j) Aspects of freshwater, saltwater and/or altitude diving.
- k) Hazards of breath-hold diving and ascents.
- l) Planning and supervision of diving operations.
- m) Diving hazards.
- n) 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.

### Open Water Evaluation

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

- a) Surface dive to a depth of 10 feet in open water without scuba.
- b) Demonstrate proficiency in air sharing as both donor and receiver.

- c) Enter and leave open water or surf, or leave and board a diving vessel, while wearing scuba gear.
- d) Kick on the surface 400 yards while wearing scuba gear, but not breathing from the scuba unit.
- e) Demonstrate judgment adequate for safe diving.
- f) Demonstrate, where appropriate, the ability to maneuver efficiently in the environment, at and below the surface.
- g) Complete a simulated emergency swimming ascent.
- h) Demonstrate clearing of mask and regulator while submerged.
- i) Demonstrate ability to achieve and maintain neutral buoyancy while submerged.
- j) Demonstrate techniques of self-rescue and buddy rescue.
- k) Navigate underwater.
- l) Plan and execute a dive.
- m) Successfully complete five open water dives for a minimum total time of three hours, of which 1-1/2 hours cumulative bottom time must be on scuba. No more than three training dives shall be made in any one day.

## **SECTION 5.00 SCIENTIFIC DIVER CERTIFICATION**

### **5.10 Certification Types**

#### Scientific Diver Certification

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

#### Temporary Diver Permit

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

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

### **5.20 General Policy**

AAUS requires that no person shall engage in scientific diving unless that person is authorized by an organizational member pursuant to the provisions of this standard. Only a person diving under the auspices of TPWD-ARP is eligible for an AAUS sanctioned scientific diver certification for TPWD-ARP.

### **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 Diving Safety Officer and members of the DCB that they are sufficiently skilled and proficient to be certified. This skill will be acknowledged by the signature of the Diving Safety Officer. Any applicant who does not possess the necessary judgment, under diving conditions, for the safety of the diver and their partner, may be denied TPWD-ARP scientific diving privileges. Minimum documentation and examinations required are as follows:

#### Prerequisites

- a) Application - Application for certification shall be made to the Diving Safety Officer on the form prescribed by the TPWD-ARP.
- b) Medical approval - 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 (Section 6.00 and Appendices 1 through 4).

- c) Scientific Diver-In-Training Permit - This permit signifies that a diver has completed and been certified as at least an open water diver through an internationally recognized certifying agency or scientific diving program and has the knowledge skills and experience to that gained by successful completion of training as specified in Section 4.00.
- d) Emergency Care Training - The trainee must provide proof of training in the following:
  - Adult CPR (must be current)
  - Emergency oxygen administration (must be current)
  - First aid for diving accidents (must be current)

### Theoretical and Practical Training

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

- a) Required Topics (include, but not limited to):
  1. Diving Emergency Care Training
    - Cardiopulmonary Resuscitation (CPR)
    - Standard or Basic First Aid
    - Recognition of Decompression Sickness (DCS) and Arterial Gas Embolism (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 and TPWD Scientific Diving Regulations and History
    - Scientific Dive Planning
    - Coordination with other Agencies
    - Appropriate Governmental Regulations
  8. Scientific Method
  9. Data Gathering Techniques (Only Items specific to area of study are required)
    - Quadrating
    - Transecting
    - Mapping
    - Coring
    - Photography
    - Tagging
    - Collecting
    - Animal Handling

- Archaeology
- Common Biota
  - Organism Identification
  - Behavior
  - Ecology
- Site Selection, Location and Re-location
- Specialized Equipment for data gathering

10. HazMat Training

- HP Cylinders
- 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
- Hooka
- Surface Supplied diving

2. Small Boat Operation

3. Rebreathers

- Closed
- Semi-closed

4. Specialized Breathing Gas

- Nitrox
- Mixed Gas

5. Specialized Environments and Conditions

- Blue Water Diving
- Boat 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 4.20 (Open Water Evaluation), with the DSO 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 DSO.

d) Examinations

1. Written examination.
  - General exam required for scientific diver certification.
  - Examination covering the suggested topics at the DSO's discretion.
2. Examination of equipment.
  - Personal diving equipment.
  - Task specific equipment.

## 5.40 Depth Certifications

### Depth Certifications and Progression to Next Depth Level

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

- a) Certification to 30 Foot Depth - Initial permit level, approved upon the successful completion of training listed in Section 4.00 and 5.30.
- b) Certification to 60 Foot Depth - A diver holding a 30 foot certificate may be certified to a depth of 60 feet after successfully completing, under supervision, 12 logged training dives to depths between 31 and 60 feet, for a minimum total time of four hours.
- c) Certification to 100 Foot Depth - A diver holding a 60 foot certificate may be certified 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.
- d) Certification to 130 Foot Depth - A diver holding a 100 foot certificate may be certified to a depth of 130 feet after successfully completing, four dives to depths between 100 and 130 feet. The diver shall also demonstrate proficiency in the use of the appropriate Dive Tables.
- e) Certification to 150 Foot Depth - A diver holding a 130 foot certificate may be certified to a depth of 150 feet after successfully completing, four dives to depths between 130 and 150 feet. The diver must also demonstrate knowledge of the special problems of deep diving and of special safety requirements.
- f) Certification to 190 Foot Depth - A diver holding a 150 foot certificate may be certified to a depth of 190 feet after successfully completing, four dives to depths between 150 and 190 feet. The diver must also demonstrate knowledge of the special problems of deep diving and of special safety requirements.

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

## **5.50 Continuation of Certificate**

### Minimum Activity to Maintain Certification

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

### Re-qualification of Depth Certificate

Once the initial certification requirements of Section 5.30 are met, divers whose depth certification has lapsed due to lack of activity may be re-qualified by procedures adopted by the TPWD-ARP DCB.

### Medical Examination

All certified scientific divers shall pass a medical examination at the intervals specified in Section 6.10. After each major illness or injury, as described in Section 6.10, a certified scientific diver shall receive clearance to return to diving from a physician before resuming diving activities.

## **5.60 Revocation of Certification**

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

## **5.70 Recertification**

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

## SECTION 6.00 MEDICAL STANDARDS

### 6.10 Medical Requirements

#### General

- a) TPWD-ARP DSO shall determine that divers have passed a current diving physical examination and have been declared by the examining physician to be fit to engage in diving activities as may be limited or restricted in the medical evaluation report.
- b) 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.
- c) 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 (Appendix 1).

#### Frequency of Medical Evaluations

Medical evaluation shall be completed:

- a) Before a diver may begin diving, unless an equivalent initial medical evaluation has been given within the preceding five years (three years if over the age of 40, two years if over the age of 60), TPWD-ARP DSO has obtained the results of that examination and those results have been reviewed and found satisfactory by the DCB.
- b) 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.
- c) Clearance to return to diving must be obtained from a physician following any major injury or illness, or any condition requiring hospital care. If the injury or illness is pressure related, then the clearance to return to diving must come from a physician trained in diving medicine.

#### Information Provided Examining Physician

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

#### Content of Medical Evaluations

Medical examinations conducted initially and at the intervals specified in Section 6.10 shall consist of the following:

- a) Applicant agreement for release of medical information to the Diving Safety Officer and the DCB (Appendix 2).
- b) Medical history (Appendix 3).

- c) Diving physical examination (Required tests listed below and in Appendix 2).

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

- a) Abnormalities of the tympanic membrane, such as perforation, presence of a monomeric membrane or inability to auto inflate the middle ears.
- b) Vertigo including Meniere's Disease.
- c) Stapedectomy or middle ear reconstructive surgery.
- d) Recent ocular surgery.
- e) Psychiatric disorders including claustrophobia, suicidal ideation, psychosis, anxiety states, untreated depression.
- f) Substance abuse, including alcohol.
- g) Episodic loss of consciousness.
- h) History of seizure.
- i) History of stroke or a fixed neurological deficit.
- j) Recurring neurologic disorders, including transient ischemic attacks.
- k) History of intracranial aneurysm, other vascular malformation or intracranial hemorrhage.
- l) History of neurological decompression illness with residual deficit.
- m) Head injury with sequelae.
- n) Hematologic disorders including coagulopathies.
- o) Evidence of coronary artery disease or high risk for coronary artery disease.
- p) Atrial septal defects.
- q) Significant valvular heart disease - isolated mitral valve prolapse is not disqualifying.
- r) Significant cardiac rhythm or conduction abnormalities.
- s) Implanted cardiac pacemakers and cardiac defibrillators (ICD).
- t) Inadequate exercise tolerance.
- u) Severe hypertension.
- v) History of spontaneous or traumatic pneumothorax.
- w) Asthma.

- x) Chronic pulmonary disease, including radiographic evidence of pulmonary blebs, bullae or cysts.
- y) Diabetes mellitus.
- z) Pregnancy.

Laboratory Requirements for Diving Medical Evaluation and Intervals.

- a) Initial examination under age 40:
  - Medical History
  - Complete Physical Exam, emphasis on neurological and otological components
  - Chest X-ray
  - Spirometry
  - Hematocrit or Hemoglobin
  - Urinalysis
  - Any further tests deemed necessary by the physician
- b) Periodic re-examination under age 40 (every five years):
  - Medical History
  - Complete Physical Exam, emphasis on neurological and otological components
  - Hematocrit or Hemoglobin
  - Urinalysis
  - Any further tests deemed necessary by the physician
- c) Initial exam over age 40:
  - Medical History
  - Complete Physical Exam, emphasis on neurological and otological components
  - Assessment of coronary artery disease using Multiple-Risk-Factor Assessment<sup>1</sup> (age, lipid profile, blood pressure, diabetic screening, smoker)
  - Resting EKG
  - Chest X-ray
  - Spirometry
  - Urinalysis
  - Hematocrit or Hemoglobin
  - Any further tests deemed necessary by the physician
  - Exercise stress testing may be indicated based on risk factor assessment<sup>2</sup>
- d) 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 using Multiple-Risk-Factor Assessment<sup>1</sup> (age, lipid profile, blood pressure, diabetic screening, smoker)
  - Resting EKG
  - Urinalysis

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

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

- Hematocrit or Hemoglobin
- Any further tests deemed necessary by the physician
- Exercise stress testing may be indicated based on risk factor assessment.

e) Physician's Written Report

1. After any medical examination relating to the individual's fitness to dive, the TPWD-ARP shall obtain a written report prepared by the examining physician, containing the examining physician's opinion of the individual's fitness to dive and including any recommended restrictions or limitations. The report will be reviewed by the DSO and the DCB if necessary.
2. The TPWD-ARP shall make a copy of the physician's written report available to the individual.

# **Volume 2**

**Sections 7.00 through 11.00**

**TPWD-ARP Specific Sections**

**Required Only When Conducting Described Diving Activities**

## SECTION 7.00 NITROX DIVING GUIDELINES

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

### 7.10 Prerequisites

#### Eligibility

Only a certified Scientific Diver or Scientific Diver-In-Training (Sections 4.00 and 5.00) diving under the auspices of the TPWD-ARP is eligible for authorization to use nitrox. After completion, review and acceptance of application materials, training and qualification, an applicant will be authorized to use nitrox within their depth authorization, as specified in Section 5.40.

#### Application and Documentation

Application and documentation for authorization to use nitrox should be made on forms specified by the TPWD-ARP Diving Control Board (Appendix 9).

### 7.20 Requirements for Authorization to Use Nitrox

Submission of documents and participation in aptitude examinations does not automatically result in authorization to use nitrox. The applicant must convince the DSO and members of the DCB that they are sufficiently skilled and proficient and provide proof of certification. The signature of the DSO on the authorization form (Appendix 9) will acknowledge authorization. After completion of training and evaluation, authorization to use nitrox may be denied to any diver who does not demonstrate to the satisfaction of the DSO or DCB the appropriate judgment or proficiency to ensure the safety of the diver and dive buddy. Nitrox divers-in-training will be permitted to use nitrox while completing their certification while under the supervision of a certified Nitrox Instructor.

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

#### Certification

The diver must be certified as a nitrox diver by a nationally recognized certification agency.

#### Training

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

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

#### Minimum Activity to Maintain Authorization

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

### **7.30 Nitrox Training Guidelines**

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).

#### Classroom Instruction

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

#### Practical Training

The practical training portion will consist of a review of skills as stated for scuba (Section 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, as approved by the DCB.
- d) Nitrox dive computer use may be included, as approved by the DCB.

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

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

- a) Function, care, use and maintenance of equipment cleaned for nitrox use.
- b) Physical and physiological considerations of nitrox diving (ex.: O<sub>2</sub> and CO<sub>2</sub> toxicity).
- 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<sub>2</sub> and actual depth;
  - 2. pO<sub>2</sub> exposure for a given fO<sub>2</sub> and depth;
  - 3. Optimal nitrox mixture for a given pO<sub>2</sub> exposure limit and planned depth;
  - 4. Maximum operational depth (MOD) for a given mix and pO<sub>2</sub> 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<sub>2</sub> 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.

### Open Water Dives

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

### Surface-Supplied Training

All training as applied to surface-supplied diving (practical, classroom and openwater) will follow the TPWD-ARP's surface-supplied diving standards, including additions listed in Section 11.60.

## 7.40 Scientific Nitrox Diving Regulations

### Dive Personnel Requirements

- a) Nitrox Diver In Training - A Scientific Diver-In-Training, who has completed the requirements of Section 4.00 and the training, certification and authorization sections of these guidelines, may be authorized by the DSO to use nitrox under the supervision of a certified Nitrox Instructor and the direct supervision of a Scientific Diver who also holds nitrox authorization. Dive depths should be restricted to those specified in the diver's authorization.
- 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 DSO to use nitrox. Depth authorization to use nitrox should be the same as those specified in the diver's depth certifications, 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 and certified to use nitrox and hold appropriate authorizations required for the dive, as specified in AAUS Standards. Lead Diver authorization for nitrox dives by the DSO and/or DCB should occur as part of the dive plan approval process.

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

1. As part of the dive planning process, verify that all divers using nitrox on a dive are properly qualified, certified 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<sub>2</sub> exposure limit for the dive team if on-site conditions so indicate (see Sec. 7.42.).

### Dive Parameters

- a) Oxygen Exposure Limits
  1. The inspired oxygen partial pressure experienced at depth should not exceed 1.4 ATA. All dives performed using nitrox breathing mixtures should be within 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, which proposes to use nitrox. The Lead Diver should also review on-site conditions and reduce the allowable pO<sub>2</sub> 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 NOAA Nitrox tables should be available at the dive site.
2. When using the equivalent air depth (EAD) method, dives should be conducted using NOAA dive tables.
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 oxygen partial pressure limits set forth in Section 7.40 Dive Parameters.

d) Nitrox Dive Computers

1. Dive computers may be used to compute decompression status during nitrox dives. Manufacturers' guidelines and operations instructions should be followed.
2. Use of Nitrox dive computers should comply with dive computer guidelines included in the AAUS Standards.
3. Nitrox dive computer users should demonstrate a clear understanding of the display, operations and manipulation of the unit being used for nitrox diving prior to using the computer, to the satisfaction of the DSO or designee.
4. If nitrox is used to increase the safety margin of an air-based dive computer, the MOD and oxygen exposure and time limits for the nitrox mixture being dived should not be exceeded.
5. Dive computers capable of pO<sub>2</sub> limit and fO<sub>2</sub> adjustment should be checked and reset by the diver prior to the start of each dive to assure compatibility with the mix 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 Section 7.40 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 the AAUS Air Purity Guidelines (Section 3.60), the following standard should be met for breathing air that is either:

- a. Placed in contact with oxygen concentrations greater than 40%.
- b. Used in nitrox production by the partial pressure mixing method with gas mixtures containing greater than 40% oxygen as the enriching agent.

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

g) Gas Mixing and Analysis for Organizational Members

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 DSO and/or DCB 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<sub>2</sub>, 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 AAUS Standards should apply to nitrox scuba operations. Additional minimal equipment necessary for nitrox diving operations includes:

- Labeled SCUBA Cylinders
- Oxygen Analyzers

### Oxygen Cleaning and Maintenance Requirements

#### 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 plumbing.

#### 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 four-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 one-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 upon the approval of the DCB.
5. A contents label should be affixed, to include the current  $fO_2$ , 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 due 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 fO<sub>2</sub> being used.
- e) Compressor system
  - 1. 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 perform a direct return to the surface without performing a mandatory decompression stop to allow the release of inert gas from the diver's body.

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

### **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 AAUS Section 7.00 recommended.

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

c) Minimum Training shall include the following:

1. A minimum of six hours of classroom training to ensure theoretical knowledge to include: physics and physiology of decompression, decompression planning and procedures, gas management, equipment configurations, decompression method and emergency procedures.
2. It is recommended that at least one training session be conducted in a pool or sheltered water setting, to cover equipment handling and familiarization, swimming and buoyancy control, to estimate gas consumption rates and to practice emergency procedures.
3. At least six open-water training dives simulating/requiring decompression shall be conducted, emphasizing planning and execution of required decompression dives and including practice of emergency procedures.
4. Progression to greater depths shall be by four-dive increments at depth intervals as specified in Section 5.40.
5. No training dives requiring decompression shall be conducted until the diver has demonstrated acceptable skills under simulated conditions.
6. The following are the minimum skills the diver must demonstrate proficiently during dives simulating and requiring decompression:
  - Buoyancy control
  - Proper ascent rate
  - Proper depth control

- Equipment manipulation
  - Stage/decompression bottle use as pertinent to planned diving operation
  - Buddy skills
  - Gas management
  - Time management
  - Task loading
  - Emergency skills
7. Divers shall demonstrate to the satisfaction of the DSO or the DSO's designee proficiency in planning and executing required decompression dives appropriate to the conditions in which diving operations are to be conducted.
  8. Upon completion of training, the diver shall be authorized to conduct required decompression dives with DSO approval.

### **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 is optional at the DCB's discretion, as determined by the conditions and environment.
  2. Diver location devices adequate for the planned diving operations and environment.
  3. Compass
- e) Redundancy in the following components is desirable or required at the discretion of the DCB or DSO:
  1. Decompression Schedules
  2. Dive Timing Devices
  3. Depth gauges
  4. Buoyancy Control Devices
  5. Cutting devices
  6. Lift bags and line reels

### 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 1.4. It is recommended that a  $pO_2$  of 1.4 or less be used during bottom exposure. A  $pO_2$  of 1.6 or less should be used for decompression stops. A  $pO_2$  of 1.6 may only be used while decompression is being conducted with a diver remaining at rest.
- c) Divers gas supplies shall be adequate to meet planned operational requirements and foreseeable emergency situations.
- d) Decompression dives may be planned using dive tables, dive computers and/or PC software approved by the DSO/DCB.
- e) Breathing gases used while performing in-water decompression shall contain the same or greater oxygen content as that used during the bottom phase of the dive.
- f) The dive team prior to each dive shall review emergency procedures appropriate for the planned dive.
- g) If breathing gas mixtures other than air are used for required decompression, their use shall be in accordance with those regulations set forth in the appropriate sections of this standard.
- h) The maximum depth for required decompression using air as the bottom gas shall be 190 feet.
- i) Use of additional nitrox and/or high-oxygen fraction decompression mixtures as travel and decompression gases to decrease decompression obligations is encouraged.
- j) Use of alternate inert gas mixtures to limit narcosis is encouraged for depths greater than 150 feet.
- k) If a period of more than six months has elapsed since the last mixed gas dive, a series of progressive workup dives to return the diver(s) to proficiency status prior to the start of project diving operations are recommended.
- l) Mission specific workup dives are recommended.

## SECTION 9.00 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.

### 9.10 Minimum Experience and Training Requirements

a) Prerequisites:

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

b) Classroom training including:

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

c) Practical Training:

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

### 9.20 Equipment and Gas Quality Requirements

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

### 9.30 Minimum Operational Requirements

- a) Approval of dive plan applications to conduct mixed gas dives shall be on a case-by-case basis.
- b) All applicable operational requirements for nitrox and decompression diving shall be met.
- c) The maximum  $pO_2$  to be used for planning required decompression dives is 1.6. It is recommended that a  $pO_2$  of less than 1.6 be used during bottom exposure.
- d) Maximum planned Oxygen Toxicity Units (OTU) will be considered based on mission duration.
- e) Divers decompressing on high-oxygen concentration mixtures shall closely monitor one another for signs of acute oxygen toxicity.

If a period of more than six 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 10.00 REBREATHER DIVING

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. The Diving Control Board reserves the authority to review each application of all specialized diving modes and include any further requirements deemed necessary beyond those listed here on a case-by-case basis. No diver shall conduct planned operations using rebreathers without prior review and approval of the DCB. In all cases, trainers shall be qualified for the type of instruction to be provided. Training shall be conducted by agencies or instructors approved by DSO and DCB.

### 10.10 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.
  1. 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.
  2. 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”).
  3. 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 risk-management, emphasis should be placed on the individual qualifications of the diver on the specific rebreather make and model to be used, in addition to specific equipment requirements and associated operational protocols.
- b) 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 20 fsw due to the risk of unsafe hyperoxic exposure.

- c) 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.
- d) 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 20 fsw. CCR systems operate to maintain a constant oxygen partial pressure ( $PPO_2$ ) during the dive, regardless of depth.

## 10.20 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

- a) Active scientific diver status, with depth qualification sufficient for the type, make and model of rebreather, and planned application.
- b) Completion of a minimum of 100 open-water dives on SCUBA.
- c) For SCR or CCR, a minimum 100-fsw-depth qualification is generally recommended, to ensure the diver is sufficiently conversant with the complications of deeper diving. If the sole expected application for use of rebreathers is shallower than this, a lesser depth qualification may be allowed with the approval of the DCB.
- d) Nitrox training - Training in use of nitrox mixtures containing 25% to 40% oxygen is required.
- e) Advanced Nitrox training - Training in use of mixtures containing 40% to 100% oxygen is also required, as needed for the planned application and rebreather system. Advanced Nitrox Training must meet the requirements of a nationally recognized certifying agency and must be completed prior to rebreather training.
- f) Decompression training - Training in basic stage decompression techniques through a nationally recognized certifying agency is required and must be completed prior to 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 130 fsw 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:
  1. 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.
  2. 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
  3. 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<sub>2</sub> scrubber
    - CO<sub>2</sub> 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)

- a) A minimum number of hours of underwater time.

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

\* Dives should not exceed 20 fsw.

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

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

- b) Amount of required in-water time should increase proportionally to the complexity of rebreather system used.
- c) 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 (pO<sub>2</sub> 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.

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

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

\* Dives should not exceed 20 fsw.

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

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

- a) As a prerequisite for training in staged decompression using rebreathers, the diver shall have logged a minimum of 25 hours of underwater time on the rebreather system to be used, with at least 10 rebreather dives in the 100 fsw to 130 fsw range.
- b) As a prerequisite for training for use of rebreathers with gas mixtures containing inert gas other than nitrogen, the diver shall have logged a minimum of 50 hours of underwater time on the rebreather system to be used and shall have completed training in stage decompression methods using rebreathers. The diver shall have completed at least 12 dives requiring staged decompression on the rebreather model to be used, with at least four dives near 130 fsw.

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

### Maintenance of Proficiency

- a) To maintain authorization to dive with rebreathers, an authorized diver shall make at least one dive using a rebreather every eight 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.
- b) 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.

## **10.30 Equipment Requirements**

### General Requirements

- a) Only those models of rebreathers specifically approved by DCB shall be used.
- b) Rebreathers should be manufactured according to acceptable Quality Control/Quality Assurance protocols, as evidenced by compliance with the essential elements of ISO 9004. Manufacturers should be able to provide to the DCB supporting documentation to this effect.
- c) Unit performance specifications should be within acceptable levels as defined by standards of a recognized authority (CE, U.S. Navy, Royal Navy, NOAA, etc.).
- d) Prior to approval, the manufacturer should supply the DCB with supporting documentation detailing the methods of specification determination by a recognized third-party testing agency, including unmanned and manned testing. Test data should be from a recognized, independent test facility.
- e) The following documentation for each rebreather model to be used should be available as a set of manufacturer's specifications. These should include:
  - Operational depth range
  - Operational temperature range
  - Breathing gas mixtures that may be used
  - Maximum exercise level which can be supported as a function of breathing gas and depth
  - Breathing gas supply durations as a function of exercise level and depth
  - CO<sub>2</sub> absorbent durations, as a function of depth, exercise level, breathing gas and water temperature
  - Method, range and precision of inspired PPO<sub>2</sub> control, as a function of depth, exercise level, breathing gas and temperature
  - Likely failure modes and backup or redundant systems designed to protect the diver if such failures occur
  - Accuracy and precision of all readouts and sensors
  - Battery duration as a function of depth and temperature
  - Mean time between failures of each subsystem and method of determination

- f) A complete instruction manual is required, fully describing the operation of all rebreather components and subsystems as well as maintenance procedures.
- g) A maintenance log is required. The unit maintenance shall be up-to-date based upon manufacturer's recommendations.

#### Minimum Equipment

- a) A surface/dive valve in the mouthpiece assembly, allowing sealing of the breathing loop from the external environment when not in use.
- b) An automatic gas addition valve, so that manual volumetric compensation during descent is unnecessary.
- c) Manual gas addition valves, so that manual volumetric compensation during descent and manual oxygen addition at all times during the dive are possible.
- d) 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

SCRs 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

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

## 10.40 Operational Requirements

### General Requirements

- a) All dives involving rebreathers must comply with applicable operational requirements for open-circuit SCUBA dives to equivalent depths.
- b) No rebreather system should be used in situations beyond the manufacturer's stated design limits (dive depth, duration, water temperature, etc).
- c) Modifications to rebreather systems shall be in compliance with manufacturer's recommendations.
- d) Rebreather maintenance is to be in compliance with manufacturer's recommendations including sanitizing, replacement of consumables (sensors, CO<sub>2</sub> absorbent, gas, batteries, etc.) and periodic maintenance.
- e) 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<sub>2</sub> absorbent material
  - Composition and volume(s) of supply gases
  - Complete description of alternate bailout procedures to be employed, including manual rebreather operation and open-circuit procedures
  - Other specific details as requested by DCB

### Buddy Qualifications

- a) A diver whose buddy is diving with a rebreather shall be trained in basic rebreather operation, hazard identification and assist/rescue procedures for a rebreather diver.
- b) If the buddy of a rebreather diver is using open-circuit scuba, the rebreather diver must be equipped with a means to provide the open-circuit scuba diver with a sufficient supply of open-circuit breathing gas to allow both divers to return safely to the surface.

### Oxygen Exposures

- a) Planned oxygen partial pressure in the breathing gas shall not exceed 1.4 atmospheres at depths greater than 30 feet.
- b) 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 current NOAA Oxygen Exposure Limits.
- c) Oxygen exposures should not exceed the NOAA oxygen single and daily exposure limits.

Both CNS and pulmonary (whole-body) oxygen exposure indices should be tracked for each diver.

## Decompression Management

- a) DCB shall review and approve the method of decompression management selected for a given diving application and project.
- b) Decompression management can be safely achieved by a variety of methods, depending on the type and model of rebreather to be used. Following is a general list of methods for different rebreather types:
  1. Oxygen rebreathers: Not applicable.
  2. SCR (presumed constant  $fO_2$ ):
    - 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 SCRs 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 SCRs in the event that exertion level is higher than expected.
  3. CCR (constant  $PPO_2$ ):
    - Integrated constant  $PPO_2$  dive computer.
    - Non-integrated constant  $PPO_2$  dive computer.
    - Constant  $PPO_2$  dive tables.
    - Open-circuit (constant  $fO_2$ ) nitrox dive computer, set to inspired  $fO_2$  predicted using  $PPO_2$  set point at the maximum planned dive depth.
    - Equivalent air depth (EAD) correction to standard open-circuit air dive tables, based on the inspired  $fO_2$  predicted using the  $PPO_2$  set point at the maximum planned dive depth.
    - Air dive computer, or air dive tables used above the maximum operating depth (MOD) of air for the  $PPO_2$  setpoint selected.

## Maintenance Logs, CO<sub>2</sub> 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 three minutes (five 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 prior to entering the water
- PO<sub>2</sub> in the rebreather is not hypoxic
- Oxygen addition system is functioning
- Volumetric addition is functioning
- Bail-out life support is functioning

#### 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:

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

#### CO<sub>2</sub> Absorbent Material

- a) CO<sub>2</sub> absorption canister shall be filled in accordance with the manufacturer's specifications.
- b) CO<sub>2</sub> absorbent material shall be used in accordance with the manufacturer's specifications for expected duration.
- c) If CO<sub>2</sub> absorbent canister is not exhausted and storage between dives is planned, the canister should be removed from the unit and stored sealed and protected from ambient air, to ensure the absorbent retains its activity for subsequent dives.
- d) 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 CO<sub>2</sub> canister, should be disinfected periodically according to manufacturer's specifications. The loop must be disinfected between each use of the same rebreather by different divers.

### **10.50 Oxygen Rebreathers**

- a) Oxygen rebreathers shall not be used at depths greater than 20 feet.
- b) Breathing loop and diver's lungs must be adequately flushed with pure oxygen prior to entering the water on each dive. Once done, the diver must breathe continuously and solely from the intact loop, or re-flushing is required.
- c) Breathing loop shall be flushed with fresh oxygen prior to ascending to avoid hypoxia due to inert gas in the loop.

### **10.60 Semi-Closed Circuit Rebreathers**

- a) The composition of the injection gas supply of a semi-closed rebreather shall be chosen such that the partial pressure of oxygen in the breathing loop will not drop below 0.2 atm, even at maximum exertion at the surface.
- b) The gas addition rate of active addition SCR (e.g., Draeger Dolphin and similar units) shall be checked before every dive to ensure it is balanced against expected workload and supply gas  $fO_2$ .
- c) The intermediate pressure of supply gas delivery in active-addition SCR shall be checked periodically, in compliance with manufacturer's recommendations.
- d) Maximum operating depth shall be based upon the  $fO_2$  in the active supply cylinder.
- e) Prior to ascent to the surface the diver shall flush the breathing loop with fresh gas or switch to an open-circuit system to avoid hypoxia. The flush should be at a depth of approximately 30 fsw during ascent on dives deeper than 30 fsw and at bottom depth on dives 30 fsw and shallower.

### **10.70 Closed-Circuit Rebreathers**

- a) 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.
- b) 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.
- c) Divers shall monitor both primary and secondary oxygen display systems at regular intervals throughout the dive to verify that readings are within limits, that redundant displays are providing similar values and whether readings are dynamic or static (as an indicator of sensor failure).
- d) The  $PPO_2$  set point shall not be lower than 0.4 atm or higher than 1.4 atm.

# Appendices

**Appendix 1 through 7**

**Required For All AAUS Organizational Members**

**Appendix 8 through 9**

**TPWD-ARP Use Only**

**APPENDIX 1**  
**DIVING MEDICAL EXAM OVERVIEW FOR THE EXAMINING PHYSICIAN**

TO THE EXAMINING PHYSICIAN:

This person, \_\_\_\_\_, requires a medical examination to assess their fitness for certification as a Scientific Diver for the \_\_\_\_\_. Their answers on the \_\_\_\_\_  
Organizational Member

Diving Medical History Form (attached) may indicate potential health or safety risks as noted. Your evaluation is requested on the attached scuba Diving Fitness Medical Evaluation Report. If you have questions about diving medicine, you may wish to consult one of the references on the attached list or contact one of the physicians with expertise in diving medicine whose names and phone numbers appear on an attached list. Please contact the undersigned Diving Safety Officer if you have any questions or concerns about diving medicine or the \_\_\_\_\_ standards.  
Organizational Member  
Thank you for your assistance.

_____ Diving Safety Officer	_____ Date
_____ Printed Name	_____ Phone Number

Scuba and other modes of compressed-gas diving can be strenuous and hazardous. A special risk is present if the middle ear, sinuses, or lung segments do not readily equalize air pressure changes. The most common cause of distress is eustachian insufficiency. Most fatalities involve deficiencies in prudence, judgment, emotional stability, or physical fitness. Please consult the following list of conditions that usually restrict candidates from diving.

*(Adapted from Bove, 1998: bracketed numbers are pages in Bove)*

**CONDITIONS WHICH MAY DISQUALIFY CANDIDATES FROM DIVING**

1. Abnormalities of the tympanic membrane, such as perforation, presence of a monomeric membrane, or inability to autoinflate the middle ears. [5 ,7, 8, 9]
2. Vertigo including Meniere’s Disease. [13]
3. Stapedectomy or middle ear reconstructive surgery. [11]
4. Recent ocular surgery. [15, 18, 19]
5. Psychiatric disorders including claustrophobia, suicidal ideation, psychosis, anxiety states, untreated depression. [20 - 23]
6. Substance abuse, including alcohol. [24 - 25]
7. Episodic loss of consciousness. [1, 26, 27]
8. History of seizure. [27, 28]
9. History of stroke or a fixed neurological deficit. [29, 30]
10. Recurring neurologic disorders, including transient ischemic attacks. [29, 30]
11. History of intracranial aneurysm, other vascular malformation or intracranial hemorrhage. [31]
12. History of neurological decompression illness with residual deficit. [29, 30]
13. Head injury with sequelae. [26, 27]
14. Hematologic disorders including coagulopathies. [41, 42]
15. Evidence of coronary artery disease or high risk for coronary artery disease<sup>1</sup>. [33 - 35]

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

16. Atrial septal defects. [39]
17. Significant valvular heart disease - isolated mitral valve prolapse is not disqualifying. [38]
18. Significant cardiac rhythm or conduction abnormalities. [36 - 37]
19. Implanted cardiac pacemakers and cardiac defibrillators (ICD). [39, 40]
20. Inadequate exercise tolerance. [34]
21. Severe hypertension. [35]
22. History of spontaneous or traumatic pneumothorax. [45]
23. Asthma<sup>2</sup>. [42 - 44]
24. Chronic pulmonary disease, including radiographic evidence of pulmonary blebs, bullae, or cysts. [45,46]
25. Diabetes mellitus. [46 - 47]
26. Pregnancy. [56]

## SELECTED REFERENCES IN DIVING MEDICINE

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

- ACC/AHA Guidelines for Exercise Testing. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing). Gibbons RJ, et al. 1997. *Journal of the American College of Cardiology*. 30:260-311. <http://www.acc.org/clinical/guidelines/exercise/exercise.pdf>
- Alert Diver Magazine; Articles on diving medicine  
<http://www.diversalertnetwork.org/medical/articles/index.asp>
- "Are Asthmatics Fit to Dive?" Elliott DH, ed. 1996. Undersea and Hyperbaric Medical Society, Kensington, MD.
- "Assessment of Cardiovascular Risk by Use of Multiple-Risk-Factor Assessment Equations." Grundy et. al. 1999. AHA/ACC Scientific Statement.  
<http://www.acc.org/clinical/consensus/risk/risk1999.pdf>
- DIVING MEDICINE, Third Edition, 1997. A. Bove and J. Davis. W.B. Saunders Company, Philadelphia
- DIVING AND SUBAQUATIC MEDICINE, Third Edition, 1994. C. Edmonds, C. Lowery and J. Pennefather. Butterworth-Heinemann Ltd. Oxford
- MEDICAL EXAMINATION OF SPORT SCUBA DIVERS, 1998. Alfred Bove, M.D., Ph.D. (ed.). Medical Seminars, Inc. San Antonio, TX
- NOAA DIVING MANUAL, NOAA. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.
- U.S. NAVY DIVING MANUAL. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.

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2 "Are Asthmatics Fit to Dive?" Elliott DH, ed. 1996. Undersea and Hyperbaric Medical Society, Kensington, MD.

## APPENDIX 2

### MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING REPORT

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Name of Applicant (Print or Type)

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Date (Mo/Day/Year)

#### TO THE PHYSICIAN:

This person is an applicant for training or is presently certified to engage in diving with self-contained underwater breathing apparatus (scuba). This is an activity that puts unusual stress on the individual in several ways. Your opinion on the applicant's medical fitness is requested. Scuba diving requires heavy exertion. The diver must be free of cardiovascular and respiratory disease. An absolute requirement is the ability of the lungs, middle ear and sinuses to equalize pressure. Any condition that risks the loss of consciousness should disqualify the applicant.

**TESTS:** Please initial that the following tests were completed.

**Initial Examination**

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

**Additional testing for first over age 40**

- Resting EKG
- Assessment of coronary artery disease using Multiple-Risk-Factor Assessment<sup>3</sup> (age, lipid profile, blood pressure, diabetic screening, smoker) Note: Exercise stress testing may be indicated based on risk factor assessment<sup>4</sup>

**Re-examination**

(Every 5 years under age 40, first exam over age 40, every 3 years over age 40, every 2 years over age 60)

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

**Additional testing for first over age 40**

- Resting EKG
- Assessment of coronary artery disease using Multiple-Risk-Factor Assessment<sup>3</sup> (age, lipid profile, blood pressure, diabetic screening, smoker) Note: Exercise stress testing may be indicated based on risk factor assessment<sup>4</sup>

#### RECOMMENDATION:

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

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<sup>3</sup> "Assessment of Cardiovascular Risk by Use of Multiple-Risk-Factor Assessment Equations." Grundy et. al. 1999. AHA/ACC Scientific Statement. <http://www.acc.org/clinical/consensus/risk/risk1999.pdf>

<sup>4</sup> Gibbons RJ, et al. ACC/AHA Guidelines for Exercise Testing. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing). Journal of the American College of Cardiology. 30:260-311, 1997. <http://www.acc.org/clinical/guidelines/exercise/exercise.pdf>



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

Name \_\_\_\_\_ Sex \_\_\_\_ Age \_\_\_\_ Wt. \_\_\_\_ Ht. \_\_\_\_

Sponsor \_\_\_\_\_ Date \_\_\_\_/\_\_\_\_/\_\_\_\_  
 (Dept./Project/Program/School, etc.) (Mo/Day/Yr)

**TO THE APPLICANT:**

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

Your answers to the questions are as important, in determining your fitness as your physical examination. Obviously, you should give accurate information or the medical screening procedure becomes useless.

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

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

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

*continued*

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

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

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

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

**APPENDIX 4**  
**RECOMMENDED PHYSICIANS WITH EXPERTISE IN DIVING MEDICINE**

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

1. Name: Caroline Fife, M.D.  
Address: 6411 Fannin St 2 Robertson  
Houston, TX 77030  
Telephone: (713) 704-5793

2. Name: \_\_\_\_\_  
Address: \_\_\_\_\_  
Telephone: \_\_\_\_\_

3. Name: \_\_\_\_\_  
Address: \_\_\_\_\_  
Telephone: \_\_\_\_\_

4. Name: \_\_\_\_\_  
Address: \_\_\_\_\_  
Telephone: \_\_\_\_\_

5. Name: \_\_\_\_\_  
Address: \_\_\_\_\_  
Telephone: \_\_\_\_\_

## **APPENDIX 5 DEFINITION OF TERMS**

Air sharing – Sharing of an air supply between divers.

ATA(s) – “Atmospheres Absolute” Total pressure exerted on an object, by a gas or mixture of gases, at a specific depth or elevation, including normal atmospheric pressure.

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

Bottom Time – Time from initial descent to start of final ascent

Buddy Breathing – Sharing of a single air source between divers.

Buddy Diver – Second member of the dive team.

Buddy System – Two comparably equipped scuba divers in the water in constant communication.

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

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

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

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

Cylinder – A pressure vessel for the storage of gases.

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

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

Decompression Stop – On ascent from a dive, a specified time spent at a specific depth, for purposes of nitrogen off-gassing; when not mandatory to stay within No-Stop limits it is called a safety stop.

Depth – (for recording purposes) maximum depth reached during a dive

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

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

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

Dive Site – Physical location of a diver during a dive.

Dive Table – A profile or set of profiles of depth-time relationships for ascent rates and breathing mixtures to be followed after a specific depth-time exposure or exposures.

Dive Time – Time from initial descent to surfacing, equivalent to Total Dive Time.

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

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

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

Diving Mode – A type of diving required specific equipment, procedures and techniques (e.g., snorkel, scuba, surface-supplied air or mixed gas).

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

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

EAD – Equivalent Air Depth (see below)

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

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

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

fN<sub>2</sub> – Fraction of nitrogen in a gas mixture, expressed as either a decimal or percentage, by volume.

fO<sub>2</sub> – Fraction of oxygen in a gas mixture, expressed as either a decimal or percentage, by volume.

FFW – Feet of freshwater, or equivalent static head.

FSW – Feet of seawater, or equivalent static head.

Half Stop – A pause in ascent from a dive at half of the maximum depth of the dive.

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

Hyperbaric Chamber – See decompression chamber.

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

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

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

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

MG – Mixed Gas

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

MOD – Maximum Operating Depth, usually determined as the depth at which the pO<sub>2</sub> for a given gas mixture reaches a predetermined maximum.

MSW – Meters of seawater or equivalent static head.

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

NOAA Diving Manual – Refers to the *NOAA Diving Manual, Diving for Science and Technology*, 2001 edition or later. National Oceanic and Atmospheric Administration, Office of Undersea Research, U.S. Department of Commerce.

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

Normal Ascent – An ascent made with an adequate air supply at a rate of 60 feet per minute or less.

Oxygen Clean – All combustible contaminants have been removed.

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

Oxygen Service – Gas delivery system that is both oxygen clean and oxygen compatible.

OTU – Oxygen Toxicity Unit

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

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

Pressure Vessel – See Cylinder

pN<sub>2</sub> – Inspired partial pressure of nitrogen, usually expressed in units of atmospheres absolute.

pO<sub>2</sub> – Inspired partial pressure of oxygen, usually expressed in units of atmospheres absolute.

PSI – Unit of pressure, “pounds per square inch.”

PSIG – Unit of pressure, “pounds per square inch gauge.”

Recompression Chamber – See Decompression Chamber

Safety Diver – see Standby Diver

Safety Stop – On ascent from a dive, a specified time spent at a specific depth, for purposes of nitrogen off-gassing. By definition a safety stop is not mandatory to stay within No-Stop limits.

Scientific Diving – Scientific diving is defined (29CFR1910.402) as diving performed solely as a necessary part of a scientific, research or educational activity by employees whose sole purpose for diving is to perform scientific research tasks.

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

Standby Diver - A diver at the dive location capable of rendering assistance to a diver in the water; also known as Safety Diver.

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

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

Total Dive Time - See Dive Time

TPWD - Texas Parks and Wildlife Department

TPWD-ARP - Texas Parks and Wildlife Department Artificial Reef Program

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

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

**APPENDIX 6**  
**AAUS REQUEST FOR DIVING RECIPROCITY FORM**  
**VERIFICATION OF DIVER TRAINING AND EXPERIENCE**

A scientific diver that is currently certified under the auspices of an organizational member institution of the American Academy of Underwater Sciences (AAUS) shall be recognized by any other organizational member of AAUS and may apply for reciprocity in order to dive with the host organization. Organizational members that are in good standing with AAUS operate, at a minimum, under the AAUS Standards for Scientific Diving Certification and Operation of Scientific Diving Programs (2003 edition). The visiting diver will comply with the diving regulations of the host organization's Diving Safety Manual unless previously arranged by both organization's Diving Control Boards.

The host organization has the right to approve or deny this request and may require, at a minimum, a checkout dive with the Diving Safety Officer (DSO) or designee of the host organization. If the request is denied, the host organization should notify to the DSO of the visiting diver the reason for the denial. The DSO for the visiting scientific diver has confirmed the following information:

(Date)

- \_\_\_\_\_ Written scientific diving examination
- \_\_\_\_\_ Last diving medical examination
- \_\_\_\_\_ Most recent checkout dive
- \_\_\_\_\_ Scuba regulator/equipment service/test
- \_\_\_\_\_ CPR training (Agency), Expires \_\_\_\_\_
- \_\_\_\_\_ Oxygen administration (Agency), Expires \_\_\_\_\_
- \_\_\_\_\_ First aid for diving (Agency), Expires \_\_\_\_\_
- \_\_\_\_\_ Date of last dive

Number of dives completed within previous 12 months? \_\_\_\_\_

Depth certification \_\_\_\_\_

Any restrictions? (Y/N) \_\_\_\_\_ if Yes, explain: \_\_\_\_\_

Please check any pertinent specialty certifications:

- |                      |                                |                  |
|----------------------|--------------------------------|------------------|
| _____ Dry Suit       | _____ Rescue                   | _____ Blue water |
| _____ Dive Computer  | _____ Divemaster               | _____ Altitude   |
| _____ Nitrox         | _____ Instructor               | _____ Ice/Polar  |
| _____ Mixed gas      | _____ EMT                      | _____ Cave       |
| _____ Closed Circuit | _____ Dive Accident Management | _____ Night      |
| _____ Saturation     | _____ Chamber Operator         | Other _____      |
| _____ Decompression  | _____ Lifesaving               | _____            |

Name of diver: \_\_\_\_\_

Emergency Information: (To notify in an emergency)

Name: \_\_\_\_\_ Relationship: \_\_\_\_\_

Telephone: (work) \_\_\_\_\_ (home) \_\_\_\_\_

Address: \_\_\_\_\_

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

\_\_\_\_\_ (Name of AAUS Organizational Member)

Diving Safety Officer: \_\_\_\_\_ (Signature) \_\_\_\_\_ (Date)

\_\_\_\_\_ (Print) \_\_\_\_\_ (Telephone, FAX, E-mail)



**APPENDIX 8  
TPWD-ARP DIVING PROGRAM APPLICATION**

**Personal Information**

Name \_\_\_\_\_ E-mail \_\_\_\_\_  
 Address \_\_\_\_\_ Telephone \_\_\_\_\_  
 City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_  
 Social Security # \_\_\_\_\_ Birth Date \_\_\_\_\_ Last Dive Physical \_\_\_\_\_  
 Status: TPWD Employee \_\_\_\_\_ Non-employee \_\_\_\_\_  
 Emergency Contact \_\_\_\_\_ Relationship \_\_\_\_\_  
 Address \_\_\_\_\_ Telephone \_\_\_\_\_  
 City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

**Reciprocity** (if applicable, attach current reciprocity form)

Agency or Institution \_\_\_\_\_ Location \_\_\_\_\_  
 Diving Safety Officer \_\_\_\_\_ Telephone \_\_\_\_\_

**Certification desired** (choose one)

Scientific Diver \_\_\_\_\_ Scientific Diver-in-Training \_\_\_\_\_ Temporary Scientific Diver \_\_\_\_\_

<b>Diving certifications</b>	Date	Agency	Certification #	Certifying Instructor
Basic Open Water	_____	_____	_____	_____
Advanced Open Water	_____	_____	_____	_____
Rescue Diver	_____	_____	_____	_____
Divemaster	_____	_____	_____	_____
Instructor	_____	_____	_____	_____
Nitrox Diver	_____	_____	_____	_____

<b>Ancillary training</b>	Date	Agency	Location	Instructor
CPR	_____	_____	_____	_____
First Aid	_____	_____	_____	_____
O <sub>2</sub> Administration	_____	_____	_____	_____

**Insurance**

DAN Insurance # \_\_\_\_\_ Plan \_\_\_\_\_ Expiration \_\_\_\_\_

**Dive activity**

Number of years \_\_\_\_\_ Total hours (estimate) \_\_\_\_\_ Greatest depth \_\_\_\_\_  
 Total number of dives \_\_\_\_\_ Total number of dives in last 12 months \_\_\_\_\_  
 Total dives to: 0-30' \_\_\_\_\_ 31-60' \_\_\_\_\_ 61-100' \_\_\_\_\_ 101-130' \_\_\_\_\_ > 130' \_\_\_\_\_  
 Dive locations \_\_\_\_\_

**Diving experience:** Check areas in which you have some diving experience and double check areas which you have much diving experience.

_____ Ocean	_____ Low visibility	_____ Research	_____ Dive computer
_____ Fresh	_____ Kelp/weeds	_____ Collecting	_____ Search/recovery
_____ Surf	_____ Cold water	_____ Photography	_____ Decompression
_____ Shore	_____ Tropical	_____ Spearfishing	_____ Strong currents
_____ Night	_____ Blue water	_____ Surface supply	_____ Dry suit
_____ Caves	_____ Under ice	_____ Mixed gas	_____ Saturation

A signature below verifies that the above information is true and that TPWD may verify the information provided by the applicant.

**Signature of applicant:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**APPENDIX 9**  
**TPWD-ARP RELEASE AND WAIVER FOR SCUBA DIVING**  
**AND RESEARCH ACTIVITIES**

I \_\_\_\_\_, the undersigned, declare and agree that this document is and shall act as a release of any liability to me or for my benefit, from TPWD-ARP with respect to any damage or injury arising out of SCUBA diving or research activities conducted under the auspices of, or sponsored by, TPWD-ARP. I recognize that by signing this release that I am agreeing to release and waive any claims or causes of action that I may have or may hereafter have, or that anyone acting for, by or through me may have or hereafter have, as a result of any claim or cause of action for injury, death, or damages arising out of SCUBA diving or research activities under the auspices of, or sponsored by, TPWD-ARP.

I understand that there are significant risks associated with SCUBA diving and offshore research and those risks will expose me to the threat and possibility of serious injury or death. It is also clearly understood that the permission and consent of the TPWD-ARP is required before I may participate in any SCUBA diving or research activity conducted under the auspices of, or sponsored by TPWD-ARP. Therefore, in consideration of the granting of permission by the TPWD-ARP for me to participate and engage in SCUBA diving or research activities conducted under the auspices of, or sponsored by, TPWD-ARP, I, on behalf of myself, my heirs, representatives, executors, administrators and assigns, do hereby release, hold harmless, and discharge TPWD-ARP, TPWD, the employees, agents or representatives, and their successors and assigns, from any and all claims and demands of any character whatsoever by reason of any accident, injury, illness, or death arising out of, or as a consequence of, directly or indirectly, my participating or engaging in any SCUBA diving or research activity conducted under the auspices of, or sponsored by, TPWD-ARP. I understand that this release and waiver shall not apply to injuries and claims caused as a direct result of gross negligence or willful misconduct of TPWD-ARP. I agree to abide by the policies, provisions and standards which govern training, diving or research operations in the TPWD-ARP diving program as set forth in the current *TPWD-ARP Scientific Diving Standards and Safety Manual*. I further agree to familiarize myself with the manual.

I am eighteen (18) years of age or older; my birthday is \_\_\_\_\_, 19\_\_\_\_; and I know of no reason which would disqualify me from being able, or qualified to grant this release and waiver and it is being given to me freely and voluntarily for the purpose of obtaining the requisite permission to participate or engage in SCUBA diving or research activities conducted under the auspices of, or sponsored by the TPWD-ARP.

\_\_\_\_\_  
**Signature of Applicant**                      \_\_\_\_\_  
**Date**    \_\_\_\_\_  
**Witness**    \_\_\_\_\_  
**Date**



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[www.tpwd.state.tx.us](http://www.tpwd.state.tx.us)

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