ARIZONA STATE UNIVERSITY

STANDARDS FOR SCIENTIFIC DIVING MANUAL

Revised: March 2, 2020
Tempe AZ 85281

As per the standards created and revised March 2019 by the

American Academy of Underwater Sciences
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FOREWORD

Arizona State University supports safe diving practices particularly in the field of research, as demonstrated by the adoption of the AAUS Standards for Scientific Diving.

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

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

ACKNOWLEDGEMENTS

We acknowledge the American Academy of Underwater Sciences for the development of research diving and the foundation of this manual.

Revision History of AAUS Manual

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Revised 3/2020
Volume 1

Sections 1.00 through 5.00
Required For All Organizational Members
Section 1.00 GENERAL POLICY

1.10 Scientific Diving Standards

Purpose

The purpose of these Scientific Diving Standards is to ensure scientific diving is conducted in a manner that will maximize the 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 Arizona State University (ASU) and other Organizational Members (OMs or OM). Fulfillment of these purposes shall be consistent with the furtherance of research and safety, and facilitation of collaborative opportunities between ASU and AAUS OMs.

This Manual sets minimum standards for the establishment of ASU’s American Academy of Underwater Sciences (AAUS) recognized scientific diving program, the organization for the conduct of this program, and the basic regulations and procedures for safety in scientific diving operations. It also establishes a framework for reciprocity between ASU and AAUS OMs that adhere to these minimum standards.

Historical Perspective

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

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

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 does not include performing any tasks usually associated with commercial diving such as: Placing or removing heavy objects underwater; inspection of pipelines and similar objects; construction; demolition; cutting or welding; or the use of explosives.”

Scientific Diving Exemption

The two elements that a diving program must contain as defined by OSHA in 29 CFR 1910 Subpart T 1910.401(a)(2)(iv) are:

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

b) Diving control (safety) board, with the majority of its members being active divers, which must 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.

OSHA has granted an exemption for scientific diving from commercial diving regulations under the following guidelines (Appendix B to 29 CFR 1910 Subpart T):

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

**Recommendations for Changes to AAUS Manual**

As part of each ASU’s annual report, recommendations for modifications of this Manual must be submitted to AAUS for consideration.

**1.20 Operational Control**

**Arizona State University’s (ASU) Auspices and Responsibilities**

ASU auspices include any scientific diving operation in which ASU is connected because of ownership of life support equipment used, locations selected, or relationship with the individual(s) concerned. This includes all cases involving the operations of authorized individuals of ASU or auxiliary organizations, where such individuals are acting within the scope of their authorization.

It is ASU’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 ASU’s Diving Control Board (DCB).

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

**Arizona State University’s (ASU) Diving Safety Manual**

Meeting AAUS minimum standards is a requirement for organizational membership in the Academy. ASU must develop and maintain a diving safety manual that includes wording on how ASU defines specific policies and procedures required for the proper function of a scientific diving program. The ASU manual must address environmental and working conditions unique to the program’s operations. ASU’s diving manual must meet or exceed the AAUS standards.

AAUS standards must be the foundation for the development of ASU’s scientific diving safety manual. The order and formatting of ASU’s manual does not have to conform to the AAUS template. The information contained in Volume 1, Sections 1.00 through 5.00 and the Appendices are required for all manuals. Volume 2, Sections 6.00 through 12.00 are required only when the OM conducts the specifically referenced diving mode or activity. Deviations or significant changes to AAUS minimum standards may require justification before approval is granted by the AAUS Standards Committee.

**Diving Control Board**

- The Diving Control Board (DCB) must consist of a majority of active scientific divers. Voting members include the Diving Safety Officer (DSO), and other representatives of the diving program such as qualified divers and members selected by procedures established by ASU. A
chairperson and a secretary may be chosen from the membership of the board according to local
procedure.

- Has autonomous and absolute authority over the scientific diving program’s operation.
- The DCB must:
  - Establish additional standards, protocols, and operational procedures beyond the AAUS
    minimums to address ASU’s specific needs and concerns.
  - Approve and monitor diving projects.
  - Review and revise the diving safety manual.
  - Ensure compliance with the diving safety manual.
  - Approve the depth to which a diver has been authorized to dive.
  - Take disciplinary action for unsafe practices.
  - Ensure adherence to the buddy system for scientific diving.
  - Act as the official representative of ASU in matters concerning the scientific diving
    program.
  - Act as a board of appeal to consider diver-related problems.
  - Recommend the issue, reissue, or the revocation of diving authorizations.
  - Recommend changes in policy and amendments to AAUS and ASU’s diving safety
    manual as the need arises.
  - Establish and/or approve training protocols or standards through which the applicants for
    authorization can satisfy the requirements of ASU's diving safety manual.
  - Suspend diving operations considered to be unsafe or unwise.
  - Establish criteria for equipment selection and use.
  - Recommend new equipment or techniques.
  - Establish and/or approve facilities for the inspection and maintenance of diving and
    associated equipment.
  - Ensure that ASU's air station(s) meet air quality standards as described in Section 3.60.
  - Periodically review the DSO’s performance and program.
  - Investigate diving incidents within ASU's diving program or violations of ASU's diving
    safety manual.
- The DCB may delegate operational oversight for portions of the program to the DSO; however,
  the DCB may not abdicate responsibility for the safe conduct of the diving program.

Diving Safety Officer

The Diving Safety Officer (DSO) serves as a voting member of the DCB, and should be
designated one of ASU’s Representatives to AAUS. This person should have broad technical
expertise and experience in research related diving.

Qualifications:

1. Must be an active scuba instructor from an internationally recognized certifying
   agency.
2. Must be appointed by the responsible administrative officer or designee, with the
   advice and counsel of the DCB.
3. Must qualify as a Full Voting Member of AAUS as defined by AAUS Bylaws:
   “(a) Holds a diving certification from a recognized national certifying agency or
   equivalent, and
   (b) Has engaged in sustained or successive scientific diving activities during the
   past two years, or
   (c) Has completed a course in scientific diving that meets the requirements as
specified by the most current edition of the AAUS Standards for Scientific Diving.”

4. Must attend an AAUS DSO Orientation within one year of accepting a position at an AAUS approved OM, unless he/she has served as a DSO for another current AAUS OM within the last year.

Duties and Responsibilities

1. Answers, through the DCB, to the appropriate administrative officer or designee, for the conduct of the scientific diving program of ASU.

2. If delegated by the DCB, the routine operational authority for this program rests with the DSO. This oversight includes, but is not limited to: training, diver authorizations, approval of dive plans, maintenance of diving records, and ensuring compliance with this Manual.

3. May permit some duties and responsibilities to be carried out by a qualified delegate, with the approval of the DCB.

4. Must be guided in the performance of the required duties by the advice of the DCB, but operational responsibility for the conduct of the scientific diving program will be retained by the DSO.

5. Must suspend diving operations determined to be unsafe or unwise.

Instructional Personnel Qualifications

All personnel involved in diving instruction under the auspices of ASU must be reviewed and authorized by the DCB.

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:

- Ensuring dives are conducted in accordance with Section 2.0.
- Ensuring all dive team members possess current authorization and are qualified for the type of diving operation.
- Coordination with other known activities in the vicinity that are likely to interfere with diving operations.
- Ensuring safety and emergency equipment is in working order and at the dive site.
- Suspending diving operations if in their opinion conditions are not safe.
- Reporting to the DCB, through the DSO, any physical problems or adverse physiological effects including symptoms of pressure-related injuries.

Reciprocity and Visiting Scientific Diver

- Two or more AAUS OMs engaged jointly in diving activities, or engaged jointly in the use of diving resources, must designate one of the participating DCBs to govern the joint dive project. However, responsibility for individual divers ultimately resides with the home OM.
- A Scientific Diver from one OM must apply for permission to dive under the auspices of another OM by submitting to the DSO of the host OM a document containing all the information listed in Appendix 6, signed by the DSO or designee of the home DCB.
- A visiting Scientific Diver may be asked to demonstrate their knowledge and skills for the planned dive.
• If a host OM denies a visiting Scientific Diver permission to dive, the host DCB must notify the visiting Scientific Diver and their DCB with an explanation of all reasons for the denial.

**Waiver of Requirements**

ASU’s DCB may grant a waiver for specific requirements of training, examinations, depth authorizations, and minimum activity to maintain authorizations. AAUS medical standards may not be waived.

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

Failure to comply with the regulations of ASU’s diving safety manual may be cause for the restriction or revocation of the diver’s scientific diving authorization by action of ASU’s DCB.

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

Failure to comply with the regulations of this Manual may be cause for the restriction or revocation of ASU’s recognition by AAUS.

**1.50 Record Maintenance**

ASU and other OMs must maintain consistent records for their diving programs and for each participant. These records include but are not limited to: diving safety manual; equipment inspection, testing, and maintenance records; dive plans (project and/or individual); records of dive (project and/or individual); medical approval to dive; diver training records; diver authorization(s); individual dive log; dive incident reports; reports of disciplinary actions by the DCB; and other pertinent information deemed necessary by the OM.

**Availability of Records:**

• Medical records must be available to an attending physician of a diver or former diver when released in writing by the diver.

• Records and documents required by this Manual must be retained by ASU for the following period:

  1. Diving safety manual – Current document only.
  2. Equipment inspection, testing, and maintenance records – Minimum current entry or tag.
  3. Records of Dive – minimum of 1 year, except 5 years where there has been an incident of pressure-related injury.
  4. Medical approval to dive – Minimum of 1 year past the expiration of the current document except 5 years where there has been an incident of pressure-related injury.
  5. Diver training records – Minimum of 1 year beyond the life of the diver’s program participation.
  6. Diver authorization(s) – Minimum of 1 year beyond the life of the diver’s program participation.
  7. Pressure-related injury assessment - 5 years.
  8. Reports of disciplinary actions by the DCB – Minimum of 1 year beyond the life of the diver’s program participation.
SECTION 2.00 DIVING REGULATIONS

2.10 Introduction

No person shall engage in scientific diving operations under the auspices of ASU’s scientific diving program unless they are authorized pursuant to the provisions of this Manual.

2.20 Pre-Dive Procedures

Dive Plans

Before conducting any diving operations under the auspices of ASU, a dive plan for the proposed project or dive must be formulated and submitted for approval by the DCB or designee. Dives should be planned around the competency of the least experienced diver. The dive plan (project or individual) should include the following:

- Diving Mode(s) and Gas(es)
- Divers’ authorizations
- Approximate number of proposed dives
- Location(s) of proposed dives
- Estimated depth(s) and bottom time(s) anticipated
- Decompression status and repetitive dive plans, if required
- Proposed work, equipment, and boats to be employed
- Any hazardous conditions anticipated
- Emergency Action Plan (Appendix 7)
  - In water details of the dive plan should include:
    - Dive Buddy assignments and tasks
    - Goals and objectives
    - Maximum depth(s) and bottom time
    - Gas management plan
    - Entry, exit, descent and ascent procedures
    - Perceived environmental and operational hazards and mitigations
    - Emergency and diver recall procedures

Diver Responsibility and Refusal to Dive

The decision to dive is that of the diver. The ultimate responsibility for safety rests with the individual diver. It is the diver’s responsibility and duty to refuse to dive, without fear of penalty, if in his/her judgment, conditions are unsafe or unfavorable, or if he/she would be violating the precepts of regulations in this Manual.

No dive team member will be required to be exposed to hyperbaric conditions against his/her will.

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

Pre-dive Safety Checks

- Prior to commencing the dive, the team must assure that every team member is healthy, fit, and trained for the type of dive that is being attempted.
- Scientific divers must conduct a functional check of their diving equipment in the presence of the dive buddy or tender. They must ensure the equipment is functioning properly and
suitable for the type of diving operation being conducted.
- Each diver must have the capability of achieving and maintaining positive buoyancy at the surface.
- Environmental conditions at the site will be evaluated prior to entering the water.

**Pre-dive Briefings**

Before conducting any diving operations under the auspices of ASU, the dive team members must be briefed on:
- Dive Buddy assignments and tasks
- Dive objectives.
- Maximum depth(s) and bottom time
- Turn around pressure and required surfacing pressure
- Entry, exit, descent and ascent procedures
- Perceived environmental and operational hazards and mitigations
- Emergency and diver recall procedures

**2.30 Diving Procedures**

**Solo Diving Prohibition**

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

**Decompression Management**

- On any given dive, both divers in the buddy pair must follow the most conservative dive profile
- A safety stop performed during the ascent phase of the dive should be conducted on any dive that exceeds 30 feet (9.14m).

**Termination of the Dive**

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

It is the responsibility of the diver to terminate the dive that he/she considers unsafe, without fear of reprisal, in a way that does not compromise the safety of another diver already in the water.

**Emergencies and Deviations from Regulations**

Any diver may deviate from the requirements of this *Manual* to the extent necessary to prevent or minimize a situation likely to cause death, serious physical harm, or major environmental damage. A written report must be submitted to the DCB explaining the circumstances and justifications.

**2.40 Post-Dive Procedures**

**Post-Dive Safety Checks**

After the completion of a dive, each diver must report any physical problems, symptoms of decompression sickness, or equipment malfunctions to the Lead Diver, DSO, and/or DCB.

**2.50 Emergency Procedures**

ASU will develop emergency procedures which follow the standards of care of the community.
and must include procedures and implementation criteria for emergency care, recompression, evacuation, and incident reporting.

2.60 Flying After Diving or Ascending to Altitude (Over 1000 feet/304 meters)

- Following a Single No-Decompression Dive: Divers should have a minimum preflight surface interval of 12 hours.
- Following Multiple Dives per Day or Multiple Days of Diving: Divers should have a minimum preflight surface interval of 18 hours.
- Following Dives Requiring Decompression Stops: Divers should have a minimum preflight surface interval of 24 hours.
- Before Ascending to Altitude Above 1000 feet (304 meters): Divers should follow the appropriate guideline for preflight surface intervals unless the decompression procedure used has accounted for the increase in elevation.

2.70 Record Keeping Requirements

Personal Diving Log

Each authorized scientific diver must log every dive made under the auspices of ASU’s program and is encouraged to log all other dives. ASU may allow dives to be logged in any format of ASU’s choosing. Logs must be submitted per local protocol and must remain in the divers’ file. The dive log must include at least the following:

- Name of diver and buddy
- Date, time, and location
- Diving modes used
- General nature of diving activities
- Maximum depth and dive time
- Diving tables or computers used
- 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 must be reported to ASU’s DCB and AAUS in a timely manner. ASU must record and report occupational injuries and illnesses in accordance with requirements of the appropriate Labor Code section. ASU must 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.

- If pressure-related injuries are suspected, or if symptoms are evident, the following additional information must be recorded and retained by ASU, with the record of the dive, for a period of 5 years:
  - Written descriptive report shall include:
    - Name, address, phone numbers of the principal parties involved.
    - Summary of experience of divers involved.
    - Location, description of dive site, and description of conditions that led up to incident.
    - The circumstances of the incident and the extent of any injuries or illnesses.
• Description of symptoms, including depth and time of onset.
• Description and results of treatment.
• Disposition of case.
• Recommendations to avoid repetition of incident.

In addition to requirements specific to the OM, all diving incidents will be reported to the AAUS. This report must first be reviewed and released by the OM’s DCB and at a minimum contain:

• Complete AAUS Incident Report.
• Summary of experience of divers involved.
• Description of dive site, and description of conditions that led up to incident.
• The circumstances of the incident and the extent of any injuries or illnesses.
• Description of symptoms, including depth and time of onset.
• Description and results of treatment.
• Disposition of case.
• Recommendations to avoid repetition of incident.
SECTION 3.00 DIVING EQUIPMENT

3.10 General Policy
All equipment must meet standards as determined by the DSO and the DCB. All equipment must be regularly examined by the person using it and serviced according to manufacturer recommendations. Equipment that is subjected to extreme usage under adverse conditions should require more frequent testing and maintenance.

3.20 Equipment
ASU’s DCB must establish the minimum equipment configuration for all dives.

Regulators and Gauges
- Scuba regulators and gauges must be inspected and tested prior to each use and serviced, at a minimum, according to manufacturer’s recommendations
- Standard open circuit (OC) regulator configuration is:
  - A first stage
  - Primary 2nd stage
  - Back up 2nd stage
  - Submersible Pressure Gauge (SPG)
  - Inflator hose for a Buoyancy Compensator Device
- A Full Face Mask may be used in place of the primary 2nd stage according to manufacturer’s recommendations

Equipment for Determination of Decompression Status
- Each member of the buddy team must have an underwater timing device and depth indicator, or dive computer
- If dive tables are being used a set must be available at the dive location
- If a dive computer is used the diver must use the same computer used on repetitive dives.
- In an aquarium or other manmade structure of a known maximum obtainable depth:
  - A depth indicator is not required, except when a diver’s decompression status must be taken into consideration on repetitive dives.
  - Only one buddy must be equipped with a timing device.
  - The maximum obtainable depth of the aquarium must be used as the diving depth.

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

Buoyancy Compensation Devices (BCD)
- Each diver must have the capability of achieving and maintaining neutral buoyancy underwater and positive buoyancy at the surface.
- BCDs, dry suits, or other variable volume buoyancy compensation devices must be equipped with an exhaust valve.
- These devices must be functionally inspected and tested at intervals not to exceed 12 months.
• BCDs, dry suits, or other variable volume buoyancy compensation devices must not be used as a lifting device in lieu of lift bags.

3.30 Auxiliary Equipment

Handheld Underwater Power Tools
• Power tools and equipment used underwater must be specifically approved for this purpose.
• Tools and equipment supplied with power from the surface must be de-energized before being placed into or retrieved from the water.
• Handheld power tools must 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 appropriate for the diving being conducted must be available at the dive site.

Diver’s Flag
• A diver’s flag must be displayed prominently whenever diving is conducted under circumstances where required or where water traffic is probable.

Compressor Systems - Organizational Member Controlled
The following will be considered in design and location of compressor systems:
• Low-pressure compressors used to supply air to the diver if equipped with a volume tank must have a check valve on the inlet side, a relief valve, and a drain valve.
• Compressed air systems over 500 psig must have slow-opening shut-off valves.
• All air compressor intakes must 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 must be logged, including the date and nature of work performed, serial number of the item (if applicable), and the name of the person performing the work for the following equipment:
• Regulators
• Gauges (SPG, Depth Gauges, Timers, and Dive Computers)
• BCDs
• Dry suits
• Scuba cylinders and valves
• Full Face Masks
• Compressors, air filtration systems, gas control panels, and storage banks
• Surface supplied equipment
• Rebreather systems
• Additional equipment categories as determined by the DCB

Compressor Operation and Air Test Records
Gas analyses and air tests must be performed on each ASU-controlled breathing air compressor at regular intervals of no more than 100 hours of operation or 6 months, whichever occurs first. The results of these tests must be entered in a formal log and be maintained.
3.60 Air Quality Standards

Breathing Gas

Breathing gas must meet the following specifications as set forth by the Compressed Gas Association (CGA Pamphlet G-7.1; see table below).

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<td><strong>Component</strong></td>
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</tr>
<tr>
<td>Oxygen</td>
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<tr>
<td>Carbon Monoxide</td>
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<tr>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>Condensed Hydrocarbons</td>
</tr>
<tr>
<td>Total Hydrocarbons as Methane</td>
</tr>
<tr>
<td>Water Vapor ppm</td>
</tr>
<tr>
<td>Objectionable Odors</td>
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</tbody>
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For breathing air used in conjunction with self-contained breathing apparatus in extreme cold where moisture can condense and freeze, causing the breathing apparatus to malfunction, a dew point not to exceed -50°F (63 pm v/v) or 10 degrees lower than the coldest temperature expected in the area is required.

Remote Operations

For remote site operations using gas sources not controlled by ASU, every effort should be made to verify breathing gas meets the requirements of this standard. If CGA Grade E gas is not verifiable, the DCB must develop a protocol to mitigate risk to the diver.
SECTION 4.00 SCIENTIFIC DIVER CERTIFICATION AND AUTHORIZATIONS

This section describes the training and performance standards for ASU and AAUS Scientific Divers and represent the minimum required level of knowledge and skills presented in a generalized format. Individual diving programs are encouraged to expand upon and augment these requirements, develop or utilize appropriate educational materials, and optimize instructional programs to suit and reflect their specific needs.

4.10 Prerequisites

Administrative

The candidate must complete all administrative and legal documentation required by ASU.

Entry Level Diver Certification

The candidate must, at minimum, show documented proof of Diver Certification or equivalent from an internationally recognized training agency. Alternatively, ASU instructors can train and certify entry level divers under the standards of the most current version of the RSTC/WRSTC and/or ISO entry-level diver standards. Entry level diver training is a prerequisite to scientific diver training and therefore no part of entry level training may be counted in any way toward scientific diver training.

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


Medical Examination

The candidate must be medically qualified for diving as described in Section 5.0 and Appendices 1-4 of this Manual. ASU and AAUS medical standards may not be waived.

Swimming/Watermanship Evaluation

The candidate must demonstrate the following in the presence of the DSO or designee. All tests are to be performed without swim aids. However, where exposure protection is needed, the candidate must be appropriately weighted to provide for neutral buoyancy.

a) Swim underwater for a distance of 25 yards (23 meters) without surfacing.
b) Swim 400 yards (366 meters) in less than 12 minutes.
c) Tread water for 10 minutes, or 2 minutes without the use of hands.
d) Transport a passive person of equal size a distance of 25 yards (23 meters) in the water.
4.20 Training

The candidate must successfully complete prerequisites, theoretical aspects, practical training, and examinations for a minimum cumulative time of 100 hours and a minimum of 12 open water dives. Theoretical aspects must include principles and activities appropriate to the intended area of scientific study. Formats for meeting the 100 hour training requirement include ASU’s formalized training course (BIO276), or a combination of formalized and on the job training.

When a diver’s resume provides clear evidence of significant scientific diving experience, the diver can be given credit for meeting portions of the 100 hour course requirements. The DCB will identify specific overlap between on-the-job training, previous scientific diving training/experience and course requirements, and then determine how potential deficiencies will be resolved. However, ASU cannot “test-out” divers, regardless of experience, when they have no previous experience in scientific diving.

Any candidate who does not convince the DCB, through the DSO, that they possess the necessary judgment, under diving conditions, for the safety of the diver and his/her buddy, may be denied ASU scientific diving privileges.

<table>
<thead>
<tr>
<th>Theoretical Training / Knowledge Development</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Topics:</strong></td>
</tr>
<tr>
<td>Diving Emergency Care Training</td>
</tr>
<tr>
<td>• Cardiopulmonary Resuscitation (CPR)</td>
</tr>
<tr>
<td>• AED</td>
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<tr>
<td>• Standard or Basic First Aid</td>
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<tr>
<td>• Recognition of DCS and AGE</td>
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<tr>
<td>• Accident Management</td>
</tr>
<tr>
<td>• Field Neurological Exam</td>
</tr>
<tr>
<td>• Oxygen Administration</td>
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<tr>
<td><strong>Suggested Topics:</strong></td>
</tr>
<tr>
<td>Specific Dive Modes (methods of gas delivery)</td>
</tr>
<tr>
<td>• Open Circuit</td>
</tr>
<tr>
<td>• Hookah</td>
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<tr>
<td>• Surface Supplied diving</td>
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<tr>
<td>• Rebreathers (closed and/or semi-closed)</td>
</tr>
<tr>
<td>Dive Rescue</td>
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<tr>
<td>• To include procedures relevant to ASU specific protocols. (See water skills below)</td>
</tr>
<tr>
<td><strong>Suggested Topics:</strong></td>
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<tr>
<td>Specialized Breathing Gas</td>
</tr>
<tr>
<td>• Nitrox</td>
</tr>
<tr>
<td>• Mixed Gas</td>
</tr>
<tr>
<td>Scientific Method</td>
</tr>
<tr>
<td>Data Gathering Techniques</td>
</tr>
<tr>
<td>(Only items specific to area of study required)</td>
</tr>
<tr>
<td>• Transects and Quadrats</td>
</tr>
<tr>
<td>• Mapping</td>
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<tr>
<td>• Coring</td>
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<td>• Photography</td>
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<td>• Tagging</td>
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<td>• Collecting</td>
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<tr>
<td>• Animal Handling</td>
</tr>
<tr>
<td>• Archaeology</td>
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<tr>
<td>• Common Biota</td>
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<tr>
<td>• Organism Identification</td>
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<tr>
<td>• Behavior</td>
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<tr>
<td>• Ecology</td>
</tr>
<tr>
<td>• Site Selection, Location, and Re-location</td>
</tr>
<tr>
<td><strong>Suggested Topics:</strong></td>
</tr>
<tr>
<td>Specialized Environments and Conditions</td>
</tr>
<tr>
<td>• Blue Water Diving</td>
</tr>
<tr>
<td>• Altitude</td>
</tr>
<tr>
<td>• Ice and Polar Diving (Cold Water Diving)</td>
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<tr>
<td>• Zero Visibility Diving</td>
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<tr>
<td>• Polluted Water Diving</td>
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<tr>
<td>• Saturation Diving</td>
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<tr>
<td>• Decompression Diving</td>
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<tr>
<td>• Overhead Environments</td>
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<tr>
<td>• Aquarium Diving</td>
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<tr>
<td>• Night Diving</td>
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<tr>
<td>• Kelp Diving</td>
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<tr>
<td>• Strong Current Diving</td>
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<tr>
<td>• Potential Entanglement/Entrapment</td>
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<tr>
<td>• Live boating</td>
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<tr>
<td><strong>Required Topics:</strong></td>
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<td>----------------------</td>
</tr>
<tr>
<td><strong>Navigation</strong></td>
</tr>
<tr>
<td><strong>HazMat Training</strong></td>
</tr>
</tbody>
</table>
| • HP Cylinders       | • Chemical Hygiene, Laboratory Safety
                     | (Use of Chemicals) |
| **Decompression Management Tools** | Specialized Diving Equipment |
| • Dive Tables        | • Full face mask     |
| • Dive Computers     | • Dry Suit           |
| • PC Based Software  | • Communications     |
| **ASU and AAUS Scientific Diving Regulations and History** | • Dive Propulsion Vehicle (DPV) |
| • Scientific Dive Planning | • SMBs/Lift Bags |
| • Coordination with other Agencies | • Line Reels |
| • Appropriate Governmental Regulations |                     |
| **Hazards of breath-hold diving and ascents** | Other Topics and Techniques as Determined by the DCB |
| **Dive Physics (Beyond entry level scuba)** |                     |
| **Dive Physiology (Beyond entry level scuba)** |                     |
| **Dive Environments** |                     |
| **Decompression Theory and its Application** |                     |

### Practical Training / Skill Development

<table>
<thead>
<tr>
<th><strong>Confined Water</strong></th>
<th><strong>Open Water Skills</strong></th>
</tr>
</thead>
</table>
| At the completion of training, the trainee must satisfy the DSO or DCB-approved designee of their ability to perform the following, as a minimum, in a pool or in sheltered water:  
  - Enter water fully equipped for diving  
  - Clear fully flooded face mask  
  - Demonstrate air sharing and ascent using an alternate air source, as both donor and recipient, with and without a face mask  
  - Demonstrate buddy breathing as both donor and recipient, with and without a face mask  
  - Demonstrate understanding of underwater signs and signals  
  - Demonstrate ability to remove and replace equipment while submerged  
  - Demonstrate acceptable watermanship skills for anticipated scientific diving conditions | The trainee must satisfy the DSO, or DCB-approved designee, of their ability to perform at least the following in open water:  
  - Surface dive to a depth of 10 feet (3 meters) without scuba*  
  - Enter and exit water while wearing scuba gear* ^^  
  - Kick on the surface 400 yards (366 meters) while wearing scuba gear, but not breathing from the scuba unit*  
  - Demonstrate proficiency in air sharing ascent as both donor and receiver*  
  - Demonstrate the ability to maneuver efficiently in the environment, at and below the surface* ^^  
  - Complete a simulated emergency swimming ascent*  
  - Demonstrate clearing of mask and regulator while submerged* |
- Underwater communications^^
- Demonstrate ability to achieve and maintain neutral buoyancy while submerged*
- Demonstrate techniques of self-rescue and buddy rescue*
- Navigate underwater ^
- Plan and execute a dive^
- Demonstrate judgment adequate for safe scientific diving* ^^

<table>
<thead>
<tr>
<th>Rescue Skills:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Rescue from depth and transport 25 yards (23 meters), as a diver, a passive simulated victim of an accident: surface diver, establish buoyancy, stabilize victim</td>
</tr>
<tr>
<td>- Demonstrate simulated in-water mouth-to-mouth resuscitation</td>
</tr>
<tr>
<td>- Removal of victim from water to shore or boat</td>
</tr>
<tr>
<td>- Stressed and panicked diver scenarios</td>
</tr>
<tr>
<td>- Recommendations For Rescue Of A Submerged Unresponsive Compressed-Gas Diver – Appendix 9</td>
</tr>
</tbody>
</table>

Successfully complete a minimum of one checkout dive and at least eleven additional open water dives in a variety of dive sites, for a cumulative surface to surface time of 6 hours. Dives following the checkout dive(s) may be supervised by an active Scientific Diver holding the necessary depth authorization experienced in the type of diving planned, and with the knowledge and permission of the DSO.

The eleven dives (minimum) following the initial checkout dive may be conducted over a variety of depth ranges as specified by ASU’s DCB. Depth progression must proceed shallower to deeper after acceptable skills and judgement have been demonstrated, and are not to exceed 100 feet (30 m) during the initial 12 dive cycle.

* Checkout dive element
^^ Evaluated on all dives
^ Evaluated at some point during the training cycle

### Examinations
<table>
<thead>
<tr>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>The trainee will be subject to examination/review of:</td>
</tr>
<tr>
<td>- Personal diving equipment</td>
</tr>
<tr>
<td>- Task specific equipment</td>
</tr>
<tr>
<td>- Function and manipulation of decompression computer to be employed by the diver (if applicable)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Written Exams</th>
</tr>
</thead>
<tbody>
<tr>
<td>The trainee must pass a written examination reviewed and approved by ASU’s DCB that demonstrates knowledge of at least the following:</td>
</tr>
<tr>
<td>- Function, care, use, and maintenance of diving equipment</td>
</tr>
<tr>
<td>- Advanced physics and physiology of diving</td>
</tr>
<tr>
<td>- Diving regulations</td>
</tr>
<tr>
<td>- Applicable diving environments</td>
</tr>
<tr>
<td>- Emergency procedures for ASU-specific dive mode(s) and environments, including buoyant ascent and ascent by air sharing</td>
</tr>
<tr>
<td>- Currently accepted decompression theory and procedures</td>
</tr>
<tr>
<td>- Proper use of dive tables</td>
</tr>
<tr>
<td>- Hazards of breath-hold diving and ascents</td>
</tr>
<tr>
<td>- Planning and supervision of diving operations</td>
</tr>
</tbody>
</table>
| • Navigation  
• Diving hazards & mitigations  
• Cause, symptoms, treatment, and prevention of the following: near drowning, air embolism, hypercapnia, squeezes, oxygen toxicity, nitrogen narcosis, exhaustion and panic, respiratory fatigue, motion sickness, decompression sickness, hypothermia, and hypoxia/anoxia  
• Applicable theoretical training and knowledge development from the Required and Suggested Topics (above) |

### 4.30 Diver Certification and Authorizations

Only a person diving under the auspices of ASU that subscribes to the practices of the AAUS is eligible for a scientific diver certification.

**Diver-In-Training (DIT) Authorization**

This is an authorization to dive, usable only while it is current and for the purpose intended. This authorization signifies that a diver has completed and been certified as at least an entry level diver through an internationally recognized certifying agency and has the knowledge skills and experience necessary to commence and continue training as a scientific diver under supervision, as approved by the DCB. DIT status must only be used when the diver is on his/her way to becoming certified as a scientific diver. While it is recommended for DIT’s to have hands-on scientific diver experience during their training, the DIT status is intended to be a temporary authorization, not a substitute for Scientific Diver Certification.

**Scientific Diver Certification**

Signifies a diver has completed all requirements in Section 4.20 and is certified by ASU to engage in scientific diving without supervision, as approved by the DCB through the DSO. Submission of documents and participation in aptitude examinations does not automatically result in certification. To be certified, the applicant must demonstrate to the DCB, through the DSO, that s/he is sufficiently skilled and proficient, and possess the necessary judgement for their safety and/or that of the dive team.

Scientific Diver Certification is only active when required authorizations are in place and current.

**Scientific Aquarium Diver Certification**

Scientific Aquarium Diver is a certification authorizing the diver to participate in scientific diving solely in the aquarium environment.

All requirements set forth for Scientific Diver certification must apply, except follows:

- Practical training must include at least 12 supervised aquarium dives for a cumulative bottom time of 6 hours.
- Training requirements for navigation and 400-yard (366-meter) surface swim in scuba gear may be waived at the discretion of the DCB.

**Temporary Diver Authorization**

Only a diver not under the auspices of an AAUS OM may be granted a Temporary Diver Authorization. The individual in question must demonstrate proficiency in diving and can contribute measurably to a planned dive. A Temporary Diver Authorization constitutes a waiver of selected requirements of Section 4.0 and is valid only for a limited time, as approved by the DCB. A Temporary Diver Authorization must be restricted to the planned diving operation and must comply with all other policies, regulations, and standards of this Manual, including medical requirements. This authorization is not to be utilized as a repeated mechanism to circumvent existing standards set forth in this Manual.
4.40 Depth Authorizations

Depth Ratings and Progression to Next Depth Level

Indicates the maximum depth in which a diver can conduct science and may supervise other divers holding a lesser depth authorization. A scientific diver requires a valid depth authorization to be considered active.

A diver may be authorized to the next depth level after successfully completing the requirements for that level. A diver may exceed his/her depth authorization when accompanied and supervised by a dive buddy holding a depth authorization greater or equal to the intended depth. Dives must be planned and executed with the permission of the DCB or designee.

In the event a diver within ASU does not hold an authorization at the desired next level, the DCB may authorize a required progression or procedure for a diver to attain a deeper authorization. If local conditions do not conform to traditional AAUS depth progressions, the DCB may devise a reasonable accommodation. However, the total number of dives to obtain a given depth authorization must follow the cumulative number of dives listed below.

a) Authorization to 30 Foot Depth - Initial science diver depth authorization, approved upon the successful completion of training listed in Section 4.00. Cumulative minimum supervised dives: 12.

b) Authorization to 60 Foot Depth - A diver holding a 30-foot authorization may be authorized to a depth of 60 feet after successfully completing and logging 12 supervised dives to depths between 31 and 60 feet under supervision of a diver authorized by the DCB, for a minimum total time of 4 hours. Cumulative minimum supervised dives: 24.

c) Authorization to 100 Foot Depth - A diver holding a 60-foot authorization may be authorized to a depth of 100 feet after successfully completing and logging 6 supervised dives to depths between 61 and 100 feet under supervision of a dive buddy authorized by the DCB. The diver must also demonstrate proficiency in the use of the appropriate decompression profiling method. Cumulative minimum supervised dives: 30.

d) Authorization to 130 Foot Depth - A diver holding a 100-foot authorization may be authorized to a depth of 130 feet after successfully completing and logging 6 supervised dives to depths between 100 and 130 feet under supervision of a dive buddy authorized by the DCB. The diver must also demonstrate proficiency in the use of the appropriate decompression profiling method. Cumulative minimum supervised dives: 36.

e) Authorization to 150 Foot Depth - A diver holding a 130-foot authorization may be authorized to a depth of 150 feet after successfully completing and logging 6 supervised dives to depths between 130 and 150 feet under supervision of a dive buddy authorized by the DCB. The diver must also demonstrate knowledge of the special problems of deep diving and of special safety requirements. Cumulative minimum supervised dives: 42.

f) Authorization to 190 Foot Depth - A diver holding a 150-foot authorization may be authorized to a depth of 190 feet after successfully completing and logging 6 dives to depths between 150 and 190 feet under supervision of a dive buddy authorized by the DCB. The diver must also demonstrate knowledge of the special problems of deep diving and of special safety requirements. Cumulative minimum supervised dives: 48.

Diving on air is not permitted beyond a depth of 190 feet. Dives beyond 190 feet require the use of mixed gas.

g) Authorization to 250 Foot Depth - A diver holding a 190-foot authorization may be authorized to a
depth of 250 feet after successfully completing and logging 6 supervised dives to depths between 190 and 250 feet under supervision of a dive buddy authorized by the DCB. The diver must also demonstrate knowledge of the special problems of deep diving and of special safety requirements.

h) Authorization to 300 Foot Depth - A diver holding a 250-foot authorization may be authorized to a depth of 300 feet after successfully completing and logging 6 supervised dives to depths between 200 and 250 feet under supervision of a dive buddy authorized by the DCB. The diver must also demonstrate knowledge of the special problems of deep diving and of special safety requirements.

i) Authorizations deeper than 300 Feet – Depth authorizations deeper than 300 feet progress in 50-foot depth/6 dive increments. A diver holding a 300 foot, or deeper authorization may be authorized to the next depth authorization increment after successfully completing and logging 6 supervised dives under supervision of a dive buddy authorized by the DCB. The diver must also demonstrate knowledge of the special problems of deep diving and of special safety requirements.

4.50 Maintaining Active Status

Minimum Activity to Maintain Authorizations

During any 12-month period, each scientific diver must log a minimum of 12 scientific, scientific training, or proficiency dives. At least one dive must be logged near the maximum depth, as defined by the DCB, of the diver’s authorization during each 6-month period. Divers authorized to 150 feet or deeper may satisfy these requirements with dives to 130 feet or deeper. Failure to meet these requirements will result in revocation or restriction of authorization by the DSO under procedures established by the DCB.

Requalification of Authorization

Once the initial requirements of Section 4.00 are met, divers whose depth authorization has lapsed due to lack of activity may be requalified by procedures adopted by the DCB.

Medical Examination

All scientific divers must pass a medical examination at the intervals specified in Section 5.0. A medically cleared diver experiencing any Conditions Which May Disqualify Candidates From Diving (Appendix 1) must receive clearance to return to diving from a physician before resuming diving activities. This medical examination requirement cannot be waived for any diver.

Emergency Care Training

The scientific diver must hold current training in the following:

- Adult CPR and AED
- Emergency oxygen administration
- First aid for diving accidents

4.60 Revocation of Authorization

An individual’s scientific diver certification can be restricted or revoked for cause by the DCB. Authorizations associated with an individual’s scientific diver certification may be restricted or suspended for cause by the DSO. Restrictions or suspensions issued by the DSO may be rescinded by the DSO; these issues will be reported to and reviewed by the DCB, and the outcomes or actions resulting from this review will be documented in the diver’s ASU record. Violations of regulations set forth in this Manual or other governmental subdivisions not in conflict with this Manual, or demonstration of poor judgement, may be considered cause. The DCB or designee must inform the diver in writing of the reason(s) for revocation. The diver will be given the opportunity to present their case in writing to the DCB for reconsideration. Following revocation, the diver may be reauthorized after complying with conditions the DCB may impose. All such written statements and requests, as
identified in this section, are formal documents, and therefore part of the diver’s file.
SECTION 5.00 MEDICAL STANDARDS

5.10 Medical Requirements

General

- All medical evaluations required by this Manual must be performed by, or under the direction of, a licensed physician of the applicant-diver’s choice, preferably one trained in diving/undersea medicine.
- The diver should be free of any chronic disabling disease and any conditions contained in the list of conditions for which restrictions from diving are generally recommended. (Appendix 1)
- ASU must verify that divers have been declared by the examining medical authority to be fit to engage in diving activities.

5.20 Frequency of Medical Evaluations

<table>
<thead>
<tr>
<th>Medical evaluation must be completed:</th>
<th>Before Age 40</th>
<th>After age 40 Before Age 60</th>
<th>After Age 60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before a diver may begin diving, unless an equivalent initial medical evaluation has been given within the preceding 5 years</td>
<td></td>
<td>Before a diver may begin diving, unless an equivalent initial medical evaluation has been given within the preceding 3 years</td>
<td>Before a diver may begin diving, unless an equivalent initial medical evaluation has been given within the preceding 2 years</td>
</tr>
<tr>
<td>At 5-year intervals</td>
<td></td>
<td>At 3-year intervals</td>
<td>At 2-year intervals</td>
</tr>
</tbody>
</table>

Clearance to return to diving must be obtained from a healthcare provider following a medically cleared diver experiencing any Conditions Which May Disqualify Candidates From Diving (Appendix 1), or following any major injury or illness, or any condition requiring chronic medication. If the condition is pressure related, the clearance to return to diving must come from a physician trained in diving medicine.

5.30 Information Provided Examining Physician

ASU must provide a copy of the medical evaluation requirements of this Manual to the examining physician. (Appendices 1, 2, and 3).

5.40 Content of Medical Evaluations

Medical examinations conducted initially and at the intervals specified in Section 5.20 must consist of the following:

1. Diving physical examination (Appendix 2). Modifications or omissions of required tests are not permitted

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

3. Medical history (Appendix 3)

5.50 Physician’s Written Report

- A Medical Evaluation of Fitness For Scuba Diving Report signed by the examining physician stating the individual’s fitness to dive, including any recommended restrictions or limitations will be submitted to the OM for the diver’s record after the examination is completed.
- The Medical Evaluation of Fitness For Scuba Diving Report will be reviewed by the DCB or designee and the diver’s record and authorizations will be updated accordingly.
• A copy of any physician’s written reports will be made available to the individual.
• It is the diver’s responsibility to provide to ASU a written statement from the examining medical authority listing any restrictions, limitations, or clearances to dive resulting from medical examinations obtained by the individual outside of their normal diving medical examination cycle. These statements will be reviewed by the DCB or designee and the diver’s record and authorizations will be updated accordingly.
Volume 2

Sections 6.00 through 12.00
Required Only When Conducting Described Diving Activities
and
Organizational Member Specific Sections
SECTION 6.00 NITROX DIVING

This section describes the requirements for authorization and use of nitrox for Scientific Diving.

6.10 Requirements for Nitrox Authorization

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

Prerequisites

Only a certified Scientific Diver or DIT diving under the auspices of ASU is eligible for authorization to use nitrox.

Application for authorization to use nitrox must be made to the DCB. Submission of documents and participation in aptitude examinations does not automatically result in authorization to use nitrox. The applicant must convince the DCB through the DSO that they are sufficiently knowledgeable, skilled and proficient in the theory and use of nitrox for diving.

Training

In lieu of writing/promulgating AAUS specific training standards for Nitrox divers, AAUS references the standards for Nitrox diver training as defined by the WRSTC and/or ISO. AAUS programs who wish to train Nitrox divers may do so using one of the following options:

a) Under the auspices and standards of an internationally recognized diver training agency.

b) Under the auspices of AAUS using the minimum guidelines presented by the most current version of the RSTC/WRSTC and/or ISO Nitrox diver training standards.

References:


“Recreational diving services- Requirements for training programs on enriches air nitrox (EAN) diving”. ISO 11107:2009 - International Organization for Standardization (ISO), www.iso.org

Practical Evaluation

- Oxygen analysis of nitrox mixtures.
- Determination of MOD, oxygen partial pressure exposure, and oxygen toxicity time limits, for various nitrox mixtures at various depths.
- Determination of nitrogen-based dive limits status by EAD method using air dive tables, and/or using nitrox dive tables, as approved by the DCB.
- Nitrox dive computer use may be included, as approved by the DCB.
- A minimum of two supervised open water dives using nitrox is required for authorization.
Written Evaluation

- Function, care, use, and maintenance of equipment cleaned for nitrox use.
- Physical and physiological considerations of nitrox diving (e.g.: O₂ and CO₂ toxicity)
- Diving regulations, procedures/operations, and dive planning as related to nitrox diving
- Equipment marking and maintenance requirements
- Dive table and/or dive computer usage
- Calculation of: MOD, pO₂, and other aspects of Nitrox diving as required by the DCB

6.20 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.

6.30 Operational Requirements

Oxygen Exposure Limits

- The inspired oxygen partial pressure experienced at depth should not exceed 1.6 ATA.
- The maximum allowable exposure limit should be reduced in cases where cold or strenuous dive conditions, or extended exposure times are expected.

Calculation of Decompression Status

- A set of DCB approved nitrox dive tables should be available at the dive site.
- Dive computers may be used to compute decompression status during nitrox dives. Manufacturers’ guidelines and operation instructions should be followed.
- Dive computers capable of pO₂ limit and fO₂ adjustment should be checked by the diver prior to the start each dive to ensure conformity with the mix being used.

Gas Mixture Requirements

- Only nitrox mixtures and mixing methods approved by the DCB may be used.
- OM personnel mixing nitrox must be qualified and approved by the DCB for the method(s) used.
- Oxygen used for mixing nitrox should meet the purity levels for “Medical Grade” (U.S.P.) or “Aviator Grade” standards.
- In addition to the AAUS Air Purity Guidelines outlined in Section 3.60, any air that may come in contact with oxygen concentrations greater than 40% (i.e., during mixing), must also have a hydrocarbon contaminant no greater than .01 mg/m³.
  - For remote site operations using compressors not controlled by the OM where this is not verifiable, the DCB must develop a protocol to mitigate risk to the diver.

Analysis Verification by User

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

Revised 3/2020
6.40 Nitrox Diving Equipment

Required Equipment

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

- Labeled SCUBA Cylinders in Accordance with Industry Standards
- Oxygen Analyzers
- Oxygen compatible equipment as applicable

Requirement for Oxygen Service

- All equipment, which during the dive or cylinder filling process is exposed to concentrations greater than 40% oxygen, should be cleaned and maintained for oxygen service.
- Any equipment used with oxygen or mixtures containing over 40% by volume oxygen must be designed and maintained for oxygen service. Oxygen systems over 125 psig must have slow-opening shut-off valves.

Compressor system

- Compressor/filtration system must produce oil-free air, or
- An oil-lubricated compressor placed in service for a nitrox system should be checked for oil and hydrocarbon contamination at least quarterly.
SECTION 8.00 STAGED DECOMPRESSION DIVING

Decompression diving is 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 must be observed when conducting dives requiring planned decompression stops.

8.10 Minimum Experience and Training Requirements

Prerequisites

1) Scientific Diver qualification according to Section 4.00.

2) Minimum of 100 logged dives with experience in the depth range where decompression dives will be conducted.

3) Demonstration of the ability to safely plan and conduct dives deeper than 100 feet.

4) Nitrox certification/authorization according to AAUS Section 6.00 recommended.

Training

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

4. A minimum of 6 hours of classroom training to ensure theoretical knowledge to include: physics and physiology of decompression; decompression planning and procedures; gas management; equipment configurations; decompression method, emergency procedures, and omitted decompression.

5. 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.

6. At least 6 open-water training dives simulating/requiring decompression must be conducted, emphasizing planning and execution of required decompression dives, and including practice of emergency procedures.

7. Progression to greater depths must be by 6-dive increments at depth intervals as specified in Section 5.50.

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

9. 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
10. Divers must demonstrate to the satisfaction of the DSO or the DSO’s qualified designee proficiency in planning and executing required decompression dives appropriate to the conditions in which diving operations are to be conducted.

11. Upon completion of training, the diver must be authorized to conduct required decompression dives with DSO approval.

8.20 Minimum Equipment Requirements

12. Valve and regulator systems for primary (bottom) gas supplies must 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.

13. Cylinders with volume and configuration adequate for planned diving operations

14. One of the second stages on the primary gas supply must be configured with a hose of adequate length to facilitate effective emergency gas sharing in the intended environment.

15. Minimum dive equipment should include:
   a) Diver location devices adequate for the planned diving operations and environment.
   b) Compass

16. Redundancy in the following components may be required at the discretion of the DCB:
   a) Decompression Schedules
   b) Dive Timing Devices
   c) Depth gauges
   d) Buoyancy Control Devices
   e) Cutting devices
   f) Lift bags and line reels

8.30 Minimum Operational Requirements

17. The maximum $pO_2$ to be used for planning required decompression dives is 1.6 for open circuit. It is recommended that a $pO_2$ of less than 1.6 be used during bottom exposure.

18. Decompression dives may be planned using dive tables, dive computers, and/or PC software approved by the DCB.

19. Breathing gases used while performing in-water decompression must contain the same or greater oxygen content as that used during the bottom phase of the dive.

20. The dive team prior to each dive must review emergency decompression procedures appropriate for the planned dive.

21. If breathing gas mixtures other than air are used for required decompression, their use must be in accordance with those regulations set forth in the appropriate sections of this Manual.

22. Use of additional nitrox and/or high-oxygen fraction decompression mixtures as travel and decompression gases to decrease decompression obligations is recommended.

23. Use of alternate inert gas mixtures to limit narcosis is recommended for depths greater than
150 feet.
24. The maximum depth for required decompression using air as the bottom gas is 190 feet.
25. If a period of more than 6 months has elapsed since the last decompression dive, a series of progressive workup dives defined by the DCB to return the diver(s) to proficiency status prior to the start of project diving operations are required.
26. 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

Prerequisites

1. Nitrox authorization (Section 6.00).

2. If the intended use entails required decompression stops, divers will be previously authorized in decompression diving (Section 8.00).

3. Divers must demonstrate to the DCB's satisfaction skills, knowledge, and attitude appropriate for training in the safe use of mixed gases.

Classroom training including

27. Review of topics and issues previously outlined in nitrox and required decompression diving training as pertinent to the planned operations

28. The use of helium or other inert gases, and the use of multiple decompression gases

29. Equipment configurations

30. Mixed gas decompression planning

31. Gas management planning

32. Thermal considerations

33. END determination

34. Mission planning and logistics

35. Emergency procedures

36. Mixed gas production methods

37. Methods of gas handling and cylinder filling

38. Oxygen exposure management

39. Gas analysis

40. Mixed gas physics and physiology

Practical Training

41. Confined water session(s) in which divers demonstrate proficiency in required skills and techniques for proposed diving operations.

42. A minimum of 6 open water training dives.

43. At least one initial dive must be in 130 feet or less to practice equipment handling and emergency procedures.

44. Subsequent dives will gradually increase in depth, with a majority of the training dives being conducted between 130 feet and the planned operational depth.

45. Planned operational depth for initial training dives must not exceed 260 feet.
46. Diving operations beyond 260 feet requires additional training dives.

9.20 Equipment and Gas Quality Requirements

47. Equipment requirements must be developed and approved by the DCB. Equipment must meet other pertinent requirements set forth elsewhere in this Manual.

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

9.30 Minimum Operational Requirements

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

50. The maximum pO₂ to be used for planning required open circuit decompression dives is 1.6. It is recommended that a pO₂ of less than 1.6 be used during bottom exposure.

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

52. If a period of more than 6 months has elapsed since the last decompression dive, a series of progressive workup dives defined by the DCB to return the diver(s) to proficiency status prior to the start of project diving operations are required.

53. Mission specific workup dives are recommended.
SECTION 10.00 SPECIALIZED DIVING ENVIRONMENTS

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

10.10 Blue Water Diving

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

10.20 Ice and Polar Diving

Divers planning to dive under ice or in polar conditions should use the following: “PESH-POL_2000.08 Standards for the Conduct of Scientific Diving”, National Science Foundation, Division of Polar Programs, 2015.

10.30 Overhead Environments

Overhead environments include water filled Caverns, Caves, Flooded Mines and Ice diving, as well as portions of Sunken Shipwrecks and other manmade structures.

For the purposes of this Manual, Ice diving is a specialized overhead environment addressed in Section 10.20 and supplemented by requirements and protocols established by the OM’s DCB.

Cavern, Cave, or Flooded Mine Diving see Section 12

It is the responsibility of the OM’s DCB to establish the requirements and protocol under which diving will be safely conducted in overhead environment portions of sunken shipwrecks and other manmade structures.

10.40 Saturation Diving

If conducting saturation diving operations, divers must comply with the saturation diving guidelines of the OM.

10.50 Aquarium Diving

An aquarium is an artificial, confined body of water, which is operated by or under the control of an institution and is used for the purposes of specimen exhibit, education, husbandry, or research.

It is recognized that within scientific aquarium diving there are environments and equipment that fall outside the scope of those addressed in this Manual. In those circumstances it is the responsibility of the OM’s DCB to establish the requirements and protocol under which diving will be safely conducted.
SECTION 11.00 REBREATHERS

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

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

Application of this standard is in addition to pertinent requirements of all other sections of this Manual.

For rebreather dives that also involve staged decompression and/or mixed gas diving, all requirements for each of the relevant diving modes must be met. The DCB 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 must be qualified for the type of instruction to be provided. Training must be conducted by agencies or instructors approved by DSO and DCB.

11.10 Definition

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

B. There are three classes of rebreathers:

1. Oxygen Rebreathers: Oxygen rebreathers recycle breathing gas, consisting of pure oxygen, replenishing the oxygen metabolized by the diver. Oxygen rebreathers are generally the least complicated design but are limited in depth of use due to the physiological limits associated with oxygen toxicity.

2. Semi-Closed Circuit Rebreathers: Semi-closed circuit rebreathers (SCR) recycle the majority of exhaled breathing gas, venting a portion into the water and replenishing it with a constant or variable amount of a single oxygen-enriched gas mixture. Gas addition and venting is balanced against diver metabolism to maintain safe oxygen levels.

3. Closed-Circuit Rebreathers: Closed-circuit mixed gas rebreathers (CCR) recycle all of the exhaled gas. Electronically controlled CCRs (eCCR) replace metabolized oxygen via an electronically controlled valve, governed by oxygen sensors. Manually controlled CCR (mCCR) rely on mechanical oxygen addition and diver monitoring to control oxygen partial pressure (pO2). Depending on the design, manual oxygen addition may be available on eCCR units as a diver override, in case of electronic system failure. Systems are equipped with two cylinders; one with oxygen, the other with a diluent gas source used to make up gas volume with depth increase and to dilute oxygen levels. CCR systems operate to maintain a constant pO2 during the dive,
regardless of depth.

11.20 Prerequisites for use of any rebreather

A. Active scientific diver status, with depth authorization sufficient for the type, make, and model of rebreather, and planned application.
B. Completion of a minimum of 25 open-water dives on open circuit SCUBA. The DCB may require increased dive experience depending upon the intended use of the rebreather system for scientific diving.
C. For SCR or CCR, a minimum 60-feet-depth authorization 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 authorization may be allowed with the approval of the DCB.
D. Nitrox training. Training in use of nitrox mixtures containing 25% to 40% oxygen is required. Training in use of mixtures containing 40% to 100% oxygen may be required, as needed for the planned application and rebreather system.

11.30 Training

A. Specific training requirements for use of each rebreather model must be defined by DCB on a case-by-case basis. Training must include factory-recommended requirements, but may exceed this to prepare for the type of mission intended (e.g., staged decompression or heliox/trimix CCR diving). (See training section for details.)
B. Successful completion of training does not in itself authorize the diver to use rebreathers. The diver must demonstrate to the DCB or its designee that the diver possesses the proper attitude, judgment, and discipline to safely conduct rebreather diving in the context of planned operations.
C. Post training supervised dives are required before the Scientific rebreather diver is authorized to use rebreather for research dives. (See training section for details).

Individual Equipment Requirements

<table>
<thead>
<tr>
<th>Individual Equipment Requirements</th>
<th>O₂</th>
<th>SCR</th>
<th>CCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diving rebreather make and model</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Bottom timer, and depth gauge</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Dive computer (separate from rebreather unit)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Approved dive tables</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
</tr>
<tr>
<td>SMB (surface marker buoy) and line reel or spool with sufficient line to deploy an SMB from the bottom in the training environment</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
</tr>
<tr>
<td>Access to an oxygen analyzer</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Cutting implement</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>BCD capable of floating a diver with a flooded loop and/or dry suit at the</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Bailout gas supply of sufficient volume for planned diving activities</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Approved CO₂ absorbent and other consumables</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
11.40 Equipment Requirements

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

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

11.50 Operational Requirements

A. Dive Plan
   In addition to standard dive plan components, at a minimum all dive plans that include the use of rebreathers must include:
   a) Information about the specific rebreather model(s) to be used
   b) Type of CO₂ absorbent material
   c) Composition and volume(s) of supply gasses d) Bailout procedures
   e) Other specific details as required by the DCB

B. Particular attention should be paid to using rebreathers under conditions where vibration or pulsating water movement could affect electronics or control switches and systems.

C. Particular attention should be paid to using rebreathers under conditions where heavy physical exertion is anticipated.

D. Respired gas densities should be less than 5 g·L⁻¹, and should not exceed 6 g·L⁻¹ under normal circumstances.

E. User replaceable consumable rebreather components should be replaced per manufacture recommendations or as defined by the DCB.

F. If performed, periodic field validation of oxygen cells should be conducted per DCB designated procedure.

G. Diver carried off-board bailout is not required under conditions where the onboard reserves are adequate to return the diver to the surface while meeting proper ascent rate and stop requirements, and the system is configured to allow access to onboard gas.
These calculations must take into consideration mixed mode operations where an open circuit diver could require assistance in an out of gas situation.

H. Use and reuse of CO₂ scrubber media should be per manufacture recommendations or as defined by the DCB.

I. Planned oxygen partial pressure in the breathing gas must not exceed 1.4 atmospheres at depths greater than 30 feet, or 1.6 at depths less than 30 feet.

J. Both CNS and Oxygen Tolerance Units (OTUs) should be tracked for each diver. Exposure limits should be established by the DCB.

K. The DCB or their designee will:
   1. Establish policies for the use of checklists related to rebreather operations.
   2. Establish policies for pre- and post- dive equipment checks to be conducted by their divers.
   3. Establish policies for disinfection of rebreathers to be used by their divers.
   4. Establish policies for pre-breathing of rebreathers used by their divers.
   5. Establish policies for the use of mixed mode and mixed rebreather platform dive teams under their auspices.
      a) Mixed mode and/or mixed platform dive teams are permitted.
      b) At minimum, divers must be cross briefed on basic system operations for establishing positive buoyancy, closing a rebreather diver’s breathing loop, and procedures for gas sharing.
   6. Establish policies for the maximum depth of dives conducted using a particular class of rebreather within the auspices of their diving operations.
   7. Establish policies for depth authorization and maintenance for divers using rebreathers.
   8. Establish policies for implementing workup dives within program
      a) Pre-operation workup dives, including review and practice of emergency recognition and response skills, and management of task loading are required for operations defined by the DCB as beyond the scope of normal operating conditions.
   9. Establish policies for the minimum use of rebreathers to maintain proficiency.
      a) The minimum Annual rebreather diving activity should be 12 rebreather dives, with a minimum of 12 h underwater time.
      b) To count, dives should be no less than 30 min in duration. A required element of maintaining proficiency is the periodic performance and reevaluation of skills related to in-water problem recognition and emergency procedures.

L. Establish policies for reauthorization for the use of rebreathers if minimum proficiency requirements are not met.
   1. Reestablishment of authorization to use rebreathers must require more than just performing a dive on a particular make or model of rebreather.
2. At minimum demonstrated skills included in the required training elements for the level of rebreather operation must be performed and reevaluated.

11.60 REBREATHER TRAINING SECTION

A. Entry Level Training

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

Rebreather Entry Level Training Requirements

<table>
<thead>
<tr>
<th>Key: X = include, IA = If Applicable, ISE = If So Equipped</th>
<th>O₂</th>
<th>SCR</th>
<th>CCR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Training Topic</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Academic</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History of technology</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Medical &amp; physiological aspects of:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen toxicity</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Chemical burns &amp; caustic cocktail</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Hypoxia – insufficient O₂</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Hypercapnia – excessive CO₂</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Arterial gas embolism</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Middle Ear Oxygen Absorption Syndrome (oxygen ear)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Hygienic concerns</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Nitrogen absorption &amp; decompression sickness</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>CO₂ retention</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Hyperoxia-induced myopia</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

**System design, assembly, and operation, including:**
| Layout and design | X | X | X |
| Oxygen control systems | X | X | X |
| Diluent control systems | | | ISE |
| Use of checklists | X | X | X |
| Complete assembly and disassembly of the unit | X | X | X |
| Canister design & proper packing and handling of chemical absorbent | X | X | X |
| Decompression management and applicable tracking methods | | | ISE |
| Oxygen and high pressure gas handling and safety | X | X | X |
| Fire triangle | X | X | X |
| Filling of cylinders | X | X | X |
| Pre-dive testing & trouble shooting | X | X | X |
| Post-dive break-down and maintenance | X | X | X |
| Trouble shooting and manufacturer authorized field repairs | X | X | X |
| Required maintenance and intervals | X | X | X |
| Manufacturer supported additional items (ADV, temp stick, CO2 monitor, etc.) | ISE | ISE | ISE |

**Dive planning:**

| Operational planning | X | X | X |
| Gas requirements | X | X | X |
| Oxygen exposure and management | X | X | X |
| Gas density calculations | | X | X |
| Oxygen metabolizing calculations | X | X | X |
| Scrubber limitations | X | X | X |
| Mixed mode diving (buddies using different dive modes) | X | X | X |
| Mixed platform diving (buddies using different rebreather platforms) | X | X | X |

**Problem Recognition & Emergency Procedures:**

<p>| Applicable open circuit emergency procedures for common gear | X | X | X |
| Loss of electronics | ISE | ISE | X |
| Partially flooded loop | X | X | X |
| Fully flooded loop | X | X | X |
| Cell warnings | ISE | ISE | X |
| Battery warnings | ISE | ISE | X |
| High O2 warning | ISE | ISE | X |
| Low O2 warning | ISE | ISE | X |
| High CO2 warning | ISE | ISE | ISE |
| Recognizing issues as indicated by onboard scrubber monitors | ISE | ISE | ISE |
| Recognizing hypercapnia signs and symptoms in self or buddy | X | X | X |
| Excluded O2 cell(s) | ISE | ISE | ISE |
| Loss of Heads Up Display (HUD) | ISE | ISE | ISE |
| Loss of buoyancy | X | X | X |
| Diluent manual add button not functioning | ISE | ISE | ISE |
| O2 manual add button not functioning | | | |
| Exhausted oxygen supply | X | X | X |
| Exhausted diluent supply | | | ISE |
| Lost or exhausted bailout | ISE | ISE | ISE |
| Handset not functioning | ISE | ISE | ISE |
| Solenoid stuck open | ISE | ISE | ISE |
| Solenoid stuck closed | ISE | ISE | ISE |
| ADV stuck open | ISE | ISE | ISE |</p>
<table>
<thead>
<tr>
<th>ADV stuck closed</th>
<th>ISE</th>
<th>ISE</th>
<th>ISE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolator valve(s) not functioning</td>
<td>ISE</td>
<td>ISE</td>
<td>ISE</td>
</tr>
<tr>
<td>Oxygen sensor validation</td>
<td>ISE</td>
<td>ISE</td>
<td>X</td>
</tr>
<tr>
<td>CO₂ sensor validation</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
</tr>
<tr>
<td>Gas sharing</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Diver assist and diver rescue</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Other problem recognition and emergency procedures specific to the particular unit, environment, or diving conditions</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

### Practical Training and Evaluations

**Demonstrated skills must include, at a minimum:**

| Use of checklists | X | X | X |
| Carbon dioxide absorbent canister packing | X | X | X |
| Supply gas cylinder analysis and pressure check | X | X | X |
| Test of one-way valves | X | X | X |
| System assembly and breathing loop leak testing | X | X | X |
| Oxygen control system calibration | ISE | ISE | X |
| Proper pre-breathe procedure | X | X | X |
| In-water bubble check | X | X | X |
| Proper buoyancy control during descent, dive operations, and ascent | X | X | X |
| System monitoring & control during descent, dive operations, and ascent | X | X | X |
| Proper interpretation and operation of system instrumentation | X | X | X |
| Proper buddy contact and communication | X | X | X |
| Use of a line reel or spool to deploy an SMB from planned dive depth and while controlling buoyancy in the water column | X | X | X |
| Proper management of line reel or spool, and SMB during ascents and safety or required stops | X | X | X |
| Unit removal and replacement on the surface | X | X | X |

**Bailout and emergency procedures for self and buddy, including:**

| System malfunction recognition and solution | X | X | X |
| Manual system control | ISE | ISE | ISE |
| Flooded breathing loop recovery | IA | IA | IA |
| Absorbent canister failure | X | X | X |
| Alternate bailout options | X | X | X |
| Manipulation of on board and off board cylinder valves | X | X | X |
| Manipulation of bailout cylinders (removal, replacement, passing and receiving while maintaining buoyancy control) | ISE | ISE | ISE |
| Manipulation of quick disconnects, isolator valves, and manual controls specific to the unit and gear configuration | ISE | ISE | ISE |

### Proper system maintenance, including:

| Breathing loop disassembly and disinfection | X | X | X |
| Oxygen sensor replacement | ISE | ISE | ISE |
| Battery removal and replacement or recharging | ISE | ISE | ISE |
| Other tasks as required by specific rebreather models | X | X | X |

### Written Evaluation

| X | X | X |

### Supervised Rebreather Dives

<table>
<thead>
<tr>
<th>Pool/Confined Water</th>
<th>Open water</th>
<th>Supervised Dives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>O2</strong></td>
<td>1 Dive, 90 – 120 minutes</td>
<td>4 dives, 120 minute cumulative</td>
</tr>
</tbody>
</table>
B. Rebreather Required Decompression, Normoxic, and Hypoxic Mix Training

1. Required Decompression and Normoxic Training may be taught separately or combined.
2. Prerequisites:
   a) Required Decompression 25 rebreather dives for a minimum cumulative dive time of 25 hours
   b) Mixed Gas:
      (1) Normoxic Mixes – 25 rebreather dives for a minimum cumulative dive time of 25 hours
      (2) Hypoxic Mixes – Rebreather Required Decompression Certification and Normoxic Certification and 25 decompression rebreather dives for a minimum cumulative dive time of 40 hours on dives requiring decompression
3. Who may teach: Individuals authorized as a CCR/SRC required decompression and/or Normoxic and/or Hypoxic Mix instructor by the DCB or their designee (this is in addition to the original authorization from section A #5)
4. Maximum Student/Instructor Ratio: 2 to 1. This ratio is to be reduced as required by environmental conditions or operational constraints
5. Upon completion of practical training, the diver must demonstrate proficiency in pre-dive, dive, and post-dive operational procedures for the particular model of rebreather to be used
6. Supervised dives target activities associated with the planned science diving application. Supervisor for these dives is the DSO or designee, experienced with the make/model rebreather being used

<p>| Rebreather Required Decompression, Normoxic &amp; Hypoxic Mix Training Requirements |</p>
<table>
<thead>
<tr>
<th>Deco</th>
<th>Normoxic</th>
<th>Hypoxic Mixes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Training Topic</strong></td>
<td><strong>Academic</strong></td>
<td><strong>Medical &amp; physiological aspects of:</strong></td>
</tr>
<tr>
<td>Review of applicable subject matter from previous training</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Hypercapnia, hypoxia, hyperoxia</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Oxygen limitations</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Nitrogen limitations</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Helium absorption and elimination</td>
<td>X</td>
<td>X</td>
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<tr>
<td>High Pressure Nervous Syndrome (HPNS)</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Gear considerations and rigging</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Gas switching</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Decompression calculation</td>
<td>X</td>
<td>X</td>
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<tr>
<td>---------------------------------</td>
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<tr>
<td>Gradient Factors</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Scrubber duration and the effects of depth on scrubber function</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Gas requirements including bailout scenarios</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Bailout gas management – individual vs team bailout</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Gas density calculations</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Operational Planning</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Equivalent narcosis depth theory</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Gas selection, gas mixing and gas formulas</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

**Problem Recognition & Emergency Procedures:**

| Applicable open circuit emergency procedures for common gear | X | X | X |
| Flooded loop | X | X | X |
| Cell warnings | X | X | X |
| Battery warnings | X | X | X |
| Hypercapnia, hypoxia, hyperoxia | X | X | X |

**Practical Training and Evaluations**

**Demonstrated skills must include, at a minimum:**

<p>| Proper demonstration of applicable skills from previous training | X | X | X |
| Proper manipulation of DSV and/or BOV | X | X | X |
| Proper descent and bubble check procedures | X | X | X |
| Proper monitoring of setpoint switching and pO2 levels | X | X | X |
| Proper interpretation and operation of system instrumentation | X | X | X |
| System monitoring &amp; control during descent, dive operations, and ascent | X | X | X |
| Demonstrate the ability to manually change setpoint and electronics settings during the dive | ISE | ISE | ISE |
| Demonstrate buoyancy control; ability to hover at fixed position in water column without moving hands or feet | X | X | X |
| Demonstrate controlled ascent with an incapacitated diver including surface tow at least 30 meters / 100 feet with equipment removal on surface, in water too deep to stand | X | X | X |
| Onboard and off board valve manipulation for proper use, and reduction of gas loss | X | X | X |
| Diagnosis of and proper reactions for a flooded absorbent canister | X | X | X |
| Diagnosis of and proper reactions for CO2 breakthrough | X | X | X |
| Diagnosis of and proper response to Cell Errors | X | X | X |
| Diagnosis of and proper reactions for Low oxygen drills | X | X | X |
| Diagnosis of and proper reactions for Flooded Loop | X | X | X |
| Diagnosis of and proper reactions for High Oxygen Drills | X | X | X |
| Diagnosis of and proper reactions for electronics and battery | X | X | X |
| Operation in semi-closed mode | X | X | X |
| Properly execute the ascent procedures for an incapacitated | X | X | X |
| Proper buddy contact and communication | X | X | X |</p>
<table>
<thead>
<tr>
<th>Task</th>
<th>Pool/Confined</th>
<th>Openwater</th>
<th>Supervised Dives**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of a line reel or spool to deploy an SMB from planned dive depth and while controlling buoyancy in the water column</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Proper management of line reel or spool, and SMB during ascents and safety or required stops</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Demonstrate the ability to maintain minimum loop volume</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Demonstrate comfort swimming on surface and at depth carrying a single bailout/decompression cylinder/bailout rebreather</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demonstrate ability to pass and retrieve a single bailout/decompression cylinder or bailout rebreather while maintaining position in the water column</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demonstrate ability to pass and receive multiple bailout/decompression cylinders or bailout rebreather while maintaining position in the water column</td>
<td>IA</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Demonstration of the ability to perform simulated decompression stops at pre-determined depths for scheduled times</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Demonstration of the ability to perform decompression stops at pre-determined depths for scheduled times</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Demonstrate competence managing multiple bailout cylinders, including drop and recovery while maintaining position in the water column</td>
<td>IA</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Demonstrate appropriate reaction to simulated free-flowing deco regulator</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Gas share of deco gas for at least 1 minute</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Demonstrate oxygen rebreather mode at appropriate stop depth</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete bailout scenarios from depth to include decompression obligation on open circuit</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Written Evaluation</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Supervised Rebreather Dives</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tbody>
</table>

**Minimum Underwater Requirements**

<table>
<thead>
<tr>
<th>Diving Environment</th>
<th>Pool/Confined</th>
<th>Openwater</th>
<th>Supervised Dives**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deco</strong></td>
<td>1 Dive / 60 min</td>
<td>7 Dives / 420 min</td>
<td>4 Dives / 240 min.</td>
</tr>
<tr>
<td><strong>Normoxic</strong></td>
<td>1 Dive / 60 min</td>
<td>7 Dives / 420 min</td>
<td>4 Dives / 240 min.</td>
</tr>
<tr>
<td><strong>Deco/Normoxic Combined</strong></td>
<td>1 Dive / 60 min</td>
<td>7 Dives / 420 min</td>
<td>4 Dives / 240 min.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Normoxic Dives / 180 min</td>
<td></td>
</tr>
<tr>
<td><strong>Hypoxic Mixes</strong></td>
<td></td>
<td>7 Dives / 420 min</td>
<td>4 Dives / 240 min.</td>
</tr>
</tbody>
</table>

**A minimum of three supervised dives should comply with authorization parameters**

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

Appendix 1 Through 8 Or Equivalent
Required For All Organizational Members
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 Arizona State University. Their answers on the Diving Medical History Form (attached) may indicate potential health or safety risks as noted. Your evaluation is requested on the attached scuba Diving Fitness Medical Evaluation Report. If you have questions about diving medicine, you may wish to consult one of the references on the attached list or contact one of the physicians with expertise in diving medicine whose names and phone numbers appear on an attached list, the Undersea Hyperbaric and Medical Society, or the Divers Alert Network. Please contact the undersigned Diving Safety Officer if you have any questions or concerns about diving medicine or the Arizona State University standards. 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. Recent deaths in the scientific diving community have been attributed to cardiovascular disease. Please consult the following list of conditions that usually restrict candidates from diving.
(Adapted from Bove, 1998: bracketed numbers are pages in Bove)

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

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

APPENDIX 2
AAUS MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING
REPORT

To The Examining Physician: Scientific divers require periodic scuba diving medical examinations to assess their fitness to engage in diving with self-contained underwater breathing apparatus (scuba). Their answers on the Diving Medical History Form may indicate potential health or safety risks as noted. Scuba diving is an activity that puts unusual stress on the individual in several ways. Your evaluation is requested on this Medical Evaluation form. Your opinion on the applicant's medical fitness is requested. Scuba diving requires heavy exertion. The diver must be free of cardiovascular and respiratory disease (see references, following page). An absolute requirement is the ability of the lungs, middle ears and sinuses to equalize pressure. Any condition that risks the loss of consciousness should disqualify the applicant. Please proceed in accordance with the AAUS Medical Standards (Sec. 5.00). If you have questions about diving medicine, please consult with the Undersea Hyperbaric Medical Society or Divers Alert Network.

TESTS: THE FOLLOWING TESTS ARE REQUIRED:

DURING ALL INITIAL AND PERIODIC RE-EXAMS (UNDER AGE 40):
• Medical history
• Complete physical exam, with emphasis on neurological and otological components
• Urinalysis
• Any further tests deemed necessary by the physician

ADDITIONAL TESTS DURING FIRST EXAM OVER AGE 40 AND PERIODIC RE-EXAMS (OVER AGE 40):
• Chest x-ray (Required only during first exam over age 40)
• Resting EKG
• Assessment of coronary artery disease using Multiple-Risk-Factor Assessment\(^1\) (age, lipid profile, blood pressure, diabetic screening, smoking)
Note: Exercise stress testing may be indicated based on Multiple-Risk-Factor Assessment\(^1\)

PHYSICIAN'S STATEMENT:
I have evaluated the above mentioned individual according to the tests listed above. I have discussed with the patient any medical condition(s) that would not disqualify him/her from diving but which may seriously compromise subsequent health. The patient understands the nature of the hazards and the risks involved in diving with these conditions.

01   I find no medical conditions that may be disqualifying for participation in scuba diving.
Diver IS medically qualified to dive for:

2 years (over age 60)
3 years (age 40-59)
5 years (under age 40)

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

___________________________________________ MD or DO
Signature
Date

Name (Print or Type)
_________________________________________________________
Address
Telephone Number
E-Mail Address

My familiarity with applicant is: This exam only  Regular physician for years
My familiarity with diving medicine is: ____________________________
APPENDIX 2b
ASU MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING
REPORT
APPLICANT'S RELEASE OF MEDICAL INFORMATION FORM

Name of Applicant (Print or Type)

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

Signature of Applicant __________________________________________ Date ______________________

REFERENCES

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

Name ______________________________________ DOB ____ Age ___ Wt.___ Ht. ___

Sponsor ____________________________________________ Date ___/___/___
(Dept./Project/Program/School, etc.) (Mo/Day/Yr)

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

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

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

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Please indicate whether or not the following apply to you</th>
<th>Comments</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td></td>
<td>Convulsions, seizures, or epilepsy</td>
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</tr>
<tr>
<td>2</td>
<td></td>
<td>Fainting spells or dizziness</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Been addicted to drugs</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Diabetes</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Motion sickness or sea/air sickness</td>
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</tr>
<tr>
<td>6</td>
<td></td>
<td>Claustrophobia</td>
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<tr>
<td>7</td>
<td></td>
<td>Mental disorder or nervous breakdown</td>
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</tr>
<tr>
<td>8</td>
<td></td>
<td>Are you pregnant?</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Do you suffer from menstrual problems?</td>
<td></td>
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<tr>
<td>10</td>
<td></td>
<td>Anxiety spells or hyperventilation</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Frequent sour stomachs, nervous stomachs or vomiting spells</td>
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<tr>
<td>12</td>
<td></td>
<td>Had a major operation</td>
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<tr>
<td>13</td>
<td></td>
<td>Presently being treated by a physician</td>
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<tr>
<td>14</td>
<td></td>
<td>Taking any medication regularly (even non-prescription)</td>
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<tr>
<td>15</td>
<td></td>
<td>Been rejected or restricted from sports</td>
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<tr>
<td>16</td>
<td></td>
<td>Headaches (frequent and severe)</td>
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<td>17</td>
<td></td>
<td>Wear dental plates</td>
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</tr>
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<td>18</td>
<td></td>
<td>Wear glasses or contact lenses</td>
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<tr>
<td>19</td>
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<td>Bleeding disorders</td>
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<td>20</td>
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<td>Alcoholism</td>
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<td>21</td>
<td></td>
<td>Any problems related to diving</td>
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<td>22</td>
<td></td>
<td>Nervous tension or emotional problems</td>
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<td></td>
<td>Yes</td>
<td>No</td>
<td>Please indicate whether or not the following apply to you</td>
</tr>
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<td>----------------------------------------------------------</td>
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<tr>
<td>23</td>
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<td></td>
<td>Take tranquilizers</td>
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<td>24</td>
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<td></td>
<td>Perforated ear drums</td>
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<td></td>
<td>Hay fever</td>
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<tr>
<td>26</td>
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<td></td>
<td>Frequent sinus trouble, frequent drainage from the nose, post-nasal drip, or stuffy nose</td>
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<td>27</td>
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<td>Frequent earaches</td>
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<td></td>
<td>Drainage from the ears</td>
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<td>Difficulty with your ears in airplanes or on mountains</td>
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<td>Ear surgery</td>
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<td>Ringing in your ears</td>
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<td></td>
<td>Frequent dizzy spells</td>
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<td>Hearing problems</td>
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<td></td>
<td>Trouble equalizing pressure in your ears</td>
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<td></td>
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<td>Asthma</td>
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<td>36</td>
<td></td>
<td></td>
<td>Wheezing attacks</td>
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<td>37</td>
<td></td>
<td></td>
<td>Cough (chronic or recurrent)</td>
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<td>38</td>
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<td></td>
<td>Frequently raise sputum</td>
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<td>Pleurisy</td>
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<td>Collapsed lung (pneumothorax)</td>
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<td>Lung cysts</td>
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<td>Pneumonia</td>
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<td>Tuberculosis</td>
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<td>Shortness of breath</td>
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<td>45</td>
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<td></td>
<td>Lung problem or abnormality</td>
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<td></td>
<td></td>
<td>Spit blood</td>
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<td>Breathing difficulty after eating particular foods, after exposure to particular pollens or animals</td>
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<td></td>
<td>Are you subject to bronchitis</td>
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<td>Subcutaneous emphysema (air under the skin)</td>
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<td>Air embolism after diving</td>
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<td>Decompression sickness</td>
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<td>52</td>
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<td></td>
<td>Rheumatic fever</td>
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<td>Scarlet fever</td>
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<td>Heart murmur</td>
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<td>Large heart</td>
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<td>High blood pressure</td>
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<td>Angina (heart pains or pressure in the chest)</td>
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<td>Heart attack</td>
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<td>Yes/No</td>
<td>Description</td>
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<td>--------</td>
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<tr>
<td>59</td>
<td>Low blood pressure</td>
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<td>60</td>
<td>Recurrent or persistent swelling of the legs</td>
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<td>61</td>
<td>Pounding, rapid heartbeat or palpitations</td>
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<tr>
<td>62</td>
<td>Easily fatigued or short of breath</td>
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<tr>
<td>63</td>
<td>Abnormal EKG</td>
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<td>64</td>
<td>Joint problems, dislocations or arthritis</td>
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<tr>
<td>65</td>
<td>Back trouble or back injuries</td>
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<td>66</td>
<td>Ruptured or slipped disk</td>
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<tr>
<td>67</td>
<td>Limiting physical handicaps</td>
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<tr>
<td>68</td>
<td>Muscle cramps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>Varicose veins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>Amputations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>71</td>
<td>Head injury causing unconsciousness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>72</td>
<td>Paralysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>Have you ever had an adverse reaction to medication?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>Do you smoke?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>Have you ever had any other medical problems not listed? If so, please list or describe below;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>76</td>
<td>Is there a family history of high cholesterol?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>Is there a family history of heart disease or stroke?</td>
<td></td>
<td></td>
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<tr>
<td>78</td>
<td>Is there a family history of diabetes?</td>
<td></td>
<td></td>
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<tr>
<td>79</td>
<td>Is there a family history of asthma?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>Date of last tetanus shot?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vaccination dates?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

A List of Medical Doctors that have training and expertise in diving or undersea medicine can be found through the Undersea and Hyperbaric Medical Society or Divers Alert Network. See links below
https://www.uhms.org/resources/diving-medical-examiners-list.html
https://www.diversalertnetwork.org/medical/physicians.asp

1. Name: Dr. Kenneth Anaeme (UHMS certified)
   Address: 1800 E Van Buren St, Phoenix AZ 85006
   Telephone: 602-680-0236

2. Name: Dr. John Dominguez (UHMS certified)
   Address: 150 S 12th St, Phoenix AZ 85034
   Telephone: 602-495-5797

3. Name: Dr. James Eitner (UHMS certified)
   Address: 1626 S Priest Dr Suite 101, Tempe AZ 85281
   Telephone: 602-244-9500

4. Name: Dr. Christopher Crowe
   Address: 10250 N 92nd St Suite 203, Scottsdale AZ 85258
   Telephone: 480-949-2080

5. Name: Dr. Jeffrey Taffet
   Address: 4400 N 32nd St, Phoenix AZ 85018
   Telephone: 602-956-1250
**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.

*Alternate Gas Supply* - Fully redundant system capable of providing a gas source to the diver should their primary gas supply fail.

*Authorization* - The DCB authorizes divers to dive using specialized modes of diving, and the depth they may dive to.

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

*Bubble Check* - Visual examination by the dive team of their diving systems, looking for O-ring leaks or other air leaks conducted in the water prior to entering a cave. Usually included in the "S" Drill.

*Buddy Breathing* - Sharing of a single air source between divers.

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

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

*Cave Dive* - A dive, which takes place partially or wholly underground, in which one or more of the environmental parameters defining a cavern dive are exceeded.

*Cavern Dive* - A dive which takes place partially or wholly underground, in which natural sunlight is continuously visible from the entrance.

*Certified Diver* - A diver who holds a recognized valid certification from an AAUS OM or internationally recognized certifying agency.

*(Scientific Diver) Certification* - A diver who holds a recognized valid certification from an AAUS OM

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

*Designated Person-In-Charge* – Surface Supplied diving mode manning requirement. An individual designated by the OM DCB or designee with the experience or training necessary to direct, and oversee in the surface supplied diving operation being conducted.

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

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

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

*Dive Site* - Physical location of a diver during a dive.
**Dive Table** - A profile or set of profiles of depth-time relationships for ascent rates and breathing mixtures to be followed after a specific depth-time exposure or exposures.

**Diver** – A person who stays underwater for long periods by having compressed gas supplied from the surface or by carrying a supply of compressed gas.

**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.

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

**Diving Control Board (DCB)** - Group of individuals who act as the official representative of the membership organization in matters concerning the scientific diving program (See Diving Control Board under Section 1.0).

**Diving Safety Officer (DSO)** - Individual responsible for the safe conduct of the scientific diving program of the membership organization (See Diving Safety Officer under Section 1.0).

**DPIC** – See Designated Person-In-Charge.

**EAD** - Equivalent Air Depth (see below).

**Emergency Swimming Ascent** - An ascent made under emergency conditions where the diver may exceed 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 6.00).

**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.

**Flooded Mine Diving** - Diving in the flooded portions of a man-made mine. Necessitates use of techniques detailed for cave diving.

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

**FSW** - Feet of seawater.

**Gas Management** - Gas planning rule which is used in cave diving environments in which the diver reserves a portion of their available breathing gas for anticipated emergencies (See Rule of Thirds, Sixths).

**Gas Matching** – The technique of calculating breathing gas reserves and turn pressures for divers using different volume cylinders. Divers outfitted with the same volume cylinders may employ the Rule of Thirds for gas management purposes. Divers outfitted with different volume cylinders will not observe the same gauge readings when their cylinders contain the same gas volume, therefore the Rule of Thirds will not guarantee adequate reserve if both divers must breathe from a single gas volume at a Rule of Thirds turn pressure. Gas Matching is based on individual consumption rates in volume consumed per minute. It allows divers to calculate turn pressures based on combined consumption rates and to convert the required reserve to a gauge based turn pressure specific to each diver’s cylinder configuration.

**Guideline** - Continuous line used as a navigational reference during a dive leading from the team position to a point where a direct vertical ascent may be made to the surface.

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

Hyperbaric Chamber - See Recompression chamber.

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

Independent 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.

Jump/Gap Reel - Spool or reel used to connect one guide line to another thus ensuring a continuous line to the exit.

Life Support Equipment – Underwater equipment necessary to sustain life.

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

Organizational Member (OM) - 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 Manual.

Manifold with Isolator Valve - A manifold joining two diving cylinders, that allows the use of two completely independent regulators. If either regulator fails, it may be shut off, allowing the remaining regulator access to the gas in both of the diving cylinders.

Mixed Gas - Breathing gas containing proportions of inert gas other than nitrogen greater than 1% by volume.

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

MOD - Maximum Operating Depth, usually determined as the depth at which the pO$_2$ for a given gas mixture reaches a predetermined maximum.

Nitrox - Any gas mixture comprised predominately of nitrogen and oxygen, most frequently containing between 22% and 40% oxygen. Also be referred to as Enriched Air Nitrox, abbreviated EAN.

Normal Ascent - An ascent made with an adequate air supply at a rate of 30 feet per minute or less.

OTU - Oxygen Toxicity Unit

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

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

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

Penetration Distance - Linear distance from the entrance intended or reached by a dive team during a dive at a dive site.

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.

pO$_2$ - Inspired partial pressure of oxygen, usually expressed in units of atmospheres absolute.
Primary Reel - Initial guideline used by the dive team from open water to maximum penetration or a permanently installed guideline.

Psi - Unit of pressure, “pounds per square inch.

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

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

Restriction - Any passage through which two divers cannot easily pass side by side while sharing air.

Rule of Thirds - Gas planning rule which is used in cave diving environments in which the diver reserves 2/3's of their breathing gas supply for exiting the cave or cavern.

Rule of Sixths - Air planning rule which is used in cave or other confined diving environments in which the diver reserves 5/6's of their breathing gas supply (for DPV use, siphon diving, etc.) for exiting the cave or cavern.

Safety Drill - (“S” Drill) - Short gas sharing, equipment evaluation, dive plan, and communication exercise carried out prior to entering a cave or cavern dive by the dive team.

Safety Reel - Secondary reel used as a backup to the primary reel, usually containing 150 feet of guideline that is used in an emergency.

Safety Stop – A stop made between 15-20 feet (5-6 meters) for 3-5 minutes during the final ascent phase of a dive.

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.

Side Mount - A diving mode utilizing two independent SCUBA systems carried along the sides of the diver's body; either of which always has sufficient air to allow the diver to reach the surface unassisted.

Siphon - Cave into which water flows with a generally continuous in-current.

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

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

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

Tender - Used in Surface supplied and tethered diving. The tender comprises the topsides buddy for the in-water diver on the other end of the tether. The tender must have the experience or training to perform the assigned tasks in a safe and healthful manner.

Turn Pressure – The gauge reading of a diver’s open circuit scuba system designating the gas limit for terminating the dive and beginning the exit from the water.

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

Diver: _____________________________ Date: ______________

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

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

______________

(Date)

_____ Original diving authorization
_____ Written scientific diving examination
_____ Last diving medical examination Medical examination expiration date _________________
_____ Most recent checkout dive
_____ Scuba regulator/equipment service/test
_____ CPR training (Agency) CPR Exp. _______________
_____ Oxygen administration (Agency) 02 Exp. _____________
_____ First aid for diving F.A. Exp. ________________
_____ Date of last dive Depth

Number of dives completed within previous 12 months? ______ Depth Authorization ______ feet

Total number of career dives? ______

Any restrictions or Waivers of Requirements? (Y/N)______ if yes, explain:

Please indicate any pertinent authorizations or training:

Emergency Information:
Name: _____________________________ Relationship: _____________________________
Telephone: __________________________ (work) (home)
Address: _____________________________

This is to verify that the above information is complete and correct

Diving Safety Officer:

______________________________ ________________
(Signature) (Date)

______________________________
(Print)
APPENDIX 7
EMERGENCY ACTION PLAN

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

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

1. Make appropriate contact with victim or rescue as required.
2. Establish (A)irway (B)reathing (C)irculation or (C)irculation (A)irway (B)reathing as appropriate
3. Stabilize the victim
4. Administer 100% oxygen, if appropriate (in cases of Decompression Illness, or Near Drowning).
5. Call local Emergency Medical System (EMS) for transport to nearest medical treatment facility.
   Explain the circumstances of the dive incident to the evacuation teams, medics and physicians.
   Do not assume that they understand why 100% oxygen may be required for the diving accident victim or that recompression treatment may be necessary.
6. Call appropriate Diving Accident Coordinator for contact with diving physician and recompression chamber, etc.
7. Notify DSO or designee according to the Emergency Action Plan of the OM.
8. Complete and submit Incident Report Form (www.aaus.org) to the DCB of the organization and the AAUS (Section 2.70 Required Incident Reporting).

List of Emergency Contact Numbers Appropriate For Dive Location

Available Procedures
- Emergency care
- Recompression
- Evacuation

Emergency Plan Content
- Name, telephone number, and relationship of person to be contacted for each diver in the event of an emergency.
- Nearest operational recompression chamber.
- Nearest accessible hospital.
- Available means of transport.
APPENDIX 8
ASU STATISTICS COLLECTION CRITERIA AND DEFINITIONS

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

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

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

A Dive is defined as a descent underwater utilizing compressed gas and subsequent ascent/return to the surface with a minimum surface interval of 10 minutes.

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

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

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

DEFINITIONS:

Dive Classification:

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

Breathing Gas:

- Air: Dives where the bottom gas used for the dive is air.
- Nitrox: Dives where the bottom gas used for the dive is a combination of nitrogen and oxygen percentages different from those of air.
• Mixed Gas: Dives where the bottom gas used for the dive is a combination of oxygen, nitrogen, and helium (or other inert gas), or any other breathing gas combination not classified as air or nitrox.

**Diving Mode:**

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

**Decompression Planning and Calculation Method:**

• Dive Tables
• Dive Computer
• PC Based Decompression Software

**Depth Ranges:**

Depth ranges for sorting logged dives are: 0-30, 31-60, 61-100, 101-130, 131-150, 151-190, 191-250, 251-300, and 301->. Depths are in feet seawater (when measured in meters: 0-10, >10-30, >30-40, >40-45, >45-58, >58-76, >76-92, and >92->). A dive is logged to the maximum depth reached during the dive. Note: Only "The Number of Dives Logged" and "The Number of Divers Logging Dives" will be collected for this category.

**Specialized Environments:**

• Required Decompression: Any dive where the diver exceeds the no-decompression limit of the decompression planning method being employed.
• Overhead Environments: Any dive where the diver does not have direct access to the surface due to a physical obstruction.
• Blue Water Diving: Openwater diving where the bottom is generally greater than 200 feet deep and requires the use of multiple-tethers diving techniques.
• Ice and Polar Diving: Any dive conducted under ice or in polar conditions. Note: An Ice Dive would also be classified as an Overhead Environment dive.
• Saturation Diving: Excursion dives conducted as part of a saturation mission are to be logged by "classification", "mode", "gas", etc. The "surface" for these excursions is defined as leaving and surfacing within the Habitat. Time spent within the Habitat or chamber must not be logged by AAUS.
Aquarium: An aquarium is a shallow, confined body of water, which is operated by or under the control of an institution and is used for the purposes of specimen exhibit, education, husbandry, or research (Not a swimming pool).

Incident Types:

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

Incident Classification Rating Scale:

- Minor: Injuries that the OM considers being minor in nature. Examples of this classification of incident would include, but not be limited to:
  - Mask squeeze that produced discoloration of the eyes.
  - Lacerations requiring medical attention but not involving moderate or severe bleeding.
  - Other injuries that would not be expected to produce long term adverse effects on the diver’s health or diving status.
- Moderate: Injuries that the OM considers being moderate in nature. Examples of this classification would include, but not be limited to:
  - DCS symptoms that resolved with the administration of oxygen, hyperbaric treatment given as a precaution.
  - DCS symptoms resolved with the first hyperbaric treatment.
  - Broken bones.
  - Torn ligaments or cartilage.
  - Concussion.
  - Ear barotrauma requiring surgical repair.
- Serious: Injuries that the OM considers being serious in nature. Examples of this classification would include, but not be limited to:
  - Arterial Gas Embolism.
  - DCS symptoms requiring multiple hyperbaric treatment.
  - Near drowning.
  - Oxygen Toxicity.
  - Hypercapnea.
  - Spinal injuries.
  - Heart attack.
  - Fatality.
Appendix 9

Recommendations For Rescue Of A Submerged Unresponsive Compressed-Gas Diver

From: S.J. Mitchell et al., Undersea and Hyperbaric Medicine 2012, Vol. 39, No. 6, pages 1099-1108