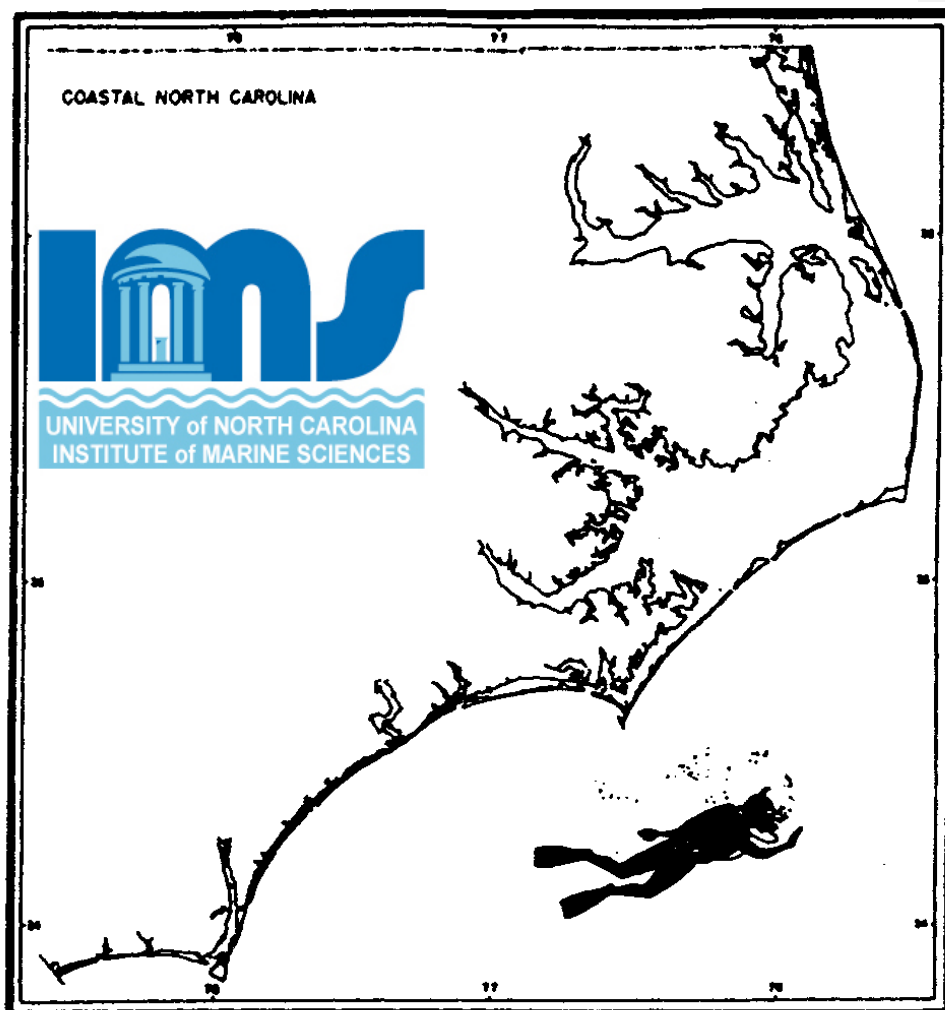


INSTITUTE OF MARINE SCIENCES  
THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL  
HILL  
STANDARDS MANUAL FOR SCIENTIFIC DIVING



MARCH 2008

IMS IS AN ORGANIZATIONAL MEMBER OF THE AAUS  
THIS MANUAL SUPERSEDES THE SCIENTIFIC DIVING MANUAL OF 2007

**INSTITUTE OF MARINE SCIENCES  
THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL  
STANDARDS MANUAL FOR SCIENTIFIC DIVING**



Revised Jan 2012  
To meet 2012 AAUS Standards

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THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL INSTITUTE OF MARINE SCIENCES  
DIVING STANDARDS

SECTION.....	PAGE
VOLUME 1.....	5
I. POLICY ON DIVING.....	5
A. SCIENTIFIC DIVING STANDARDS.....	5
B. OPERATIONAL CONTROL.....	6
C. DIVING CONTROL BOARD.....	7
D. DIVING SAFETY OFFICER.....	8
E. INSTRUCTIONAL PERSONNEL.....	8
F. LEAD DIVER.....	8
G. RECIPROCITY AND VISITING SCIENTIFIC DIVERS.....	9
H. WAIVER OF REQUIREMENTS.....	9
I. CONSEQUENCES OF VIOLATION OF REGULATIONS.....	9
J. RECORD MAINTENANCE.....	9
II. ENTRY LEVEL TRAINING REQUIREMENTS.....	10
A. EVALUATION.....	10
B. SCUBA TRAINING.....	10
III. SCIENTIFIC DIVER DOCUMENTS CERTIFICATION.....	12
A. GENERAL POLICY.....	12
B. CERTIFICATION TYPES.....	12
C. REQUIREMENTS FOR SCIENTIFIC DIVER CERTIFICATION.....	12
D. DEPTH CERTIFICATION.....	15
E. MAINTENANCE OF AUTHORIZATION.....	15
F. REVOCATION OF AUTHORIZATION.....	16
G. RE-CERTIFICATION.....	16
IV. DIVING REGULATIONS FOR SCUBA (OPEN CIRCUIT, COMPRESSED AIR).....	16
A. AUTHORIZATION.....	16
B. PRE-DIVE PROCEDURES.....	16
C. PERSONNEL REQUIREMENTS.....	17
D. PRE-DIVE SAFETY CHECKS.....	17
E. DIVING PROCEDURES.....	17
F. POST-DIVE PROCEDURES.....	18
G. EMERGENCY PROCEDURES PLAN.....	18
H. FLYING AFTER DIVING.....	18
I. RECORDKEEPING AND REQUIREMENTS.....	19
V. DIVING EQUIPMENT.....	20
A. GENERAL POLICY.....	20
B. EQUIPMENT.....	20
C. AUXILLARY EQUIPMENT.....	21
D. SUPPORT EQUIPMENT.....	21

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E.	EQUIPMENT MAINTENANCE.....	21
F.	COMPRESSOR OPERATION AND AIR TEST RECORDS.....	22
G.	AIR QUALITY STANDARDS.....	22
VI.	MEDICAL STANDARDS.....	22
A.	MEDICAL REQUIREMENTS OF DIVE TEAM.....	22
B.	FREQUENCY OF MEDICAL EXAMINATIONS.....	23
C.	INFORMATION PROVIDED EXAMINING PHYSICIAN.....	23
D.	CONTENT OF MEDICAL EXAMINATIONS.....	23
E.	LABORATORY REQUIREMENTS FOR DIVING MEDICAL EXAMINATION.....	24
F.	PHYSICIAN'S WRITTEN REPORT.....	24
	VOLUME 2.....	25
VII.	NITROX DIVING GUIDELINES.....	25
A.	PRE-REQUISITES.....	25
B.	REQUIREMENTS FOR AUTHORIZATION TO USE NITROX.....	25
C.	NITROX TRAINING GUIDELINES.....	25
D.	SCIENTIFIC NITROX DIVING REGULATIONS.....	27
E.	NITROX DIVING EQUIPMENT.....	29
VIII.	STAGED DECOMPRESSION DIVING.....	31
A.	MINIMUM EXPERIENCE AND TRAINING REQUIREMENTS.....	31
B.	MINIMUM EQUIPMENT REQUIREMENTS.....	32
C.	MINIMUM OPERATIONAL REQUIREMENTS.....	32
IX.	MIXED GAS DIVING.....	33
A.	MINIMUM EXPERIENCE AND TRAINING REQUIREMENTS.....	33
B.	EQUIPMENT AND GAS QUALITY REQUIREMENTS.....	34
C.	MINIMAL OPERATIONAL REQUIREMENTS.....	34
X.	REBREATHERS.....	35
A.	MINIMUM EXPERIENCE AND TRAINING REQUIREMENTS.....	35
B.	DEFINITIONS AND GENERAL INFORMATION.....	35
C.	PRE-REQUISITES.....	36
D.	EQUIPMENT REQUIREMENTS.....	40
E.	OPERATIONAL REQUIREMENTS.....	41
F.	OXYGEN REBREATHERS.....	44
G.	SEMI-CLOSED CIRCUIT REBREATHERS.....	44
H.	CLOSED-CIRCUIT REBREATHERS.....	45
XI.	OTHER DIVING TECHNOLOGY.....	45
A.	BLUE WATER DIVING.....	45
B.	ICE AND POLAR DIVING.....	45
C.	OVERHEAD ENVIRONMENTS.....	45
D.	SATURATION DIVING.....	45
E.	HOOKAH.....	45
F.	SURFACE SUPPLIED DIVING.....	45

#### APPENDIXES

1.	DIVING MEDICAL EXAM OVERVIEW FOR THE EXAMINING PHYSICIAN.....	46
2.	MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING REPORT.....	48
3.	DIVING MEDICAL HISTORY FORM.....	50
4.	RECOMMENDED PHYSICIANS WITH EXPERTISE IN DIVE MEDICINE.....	54
5.	DEFINITION OF TERMS.....	55
6.	AAUS REQUEST FOR DIVING RECIPROCITY FORM.....	59
7.	UNC-CH IMS DIVING SAFETY PROGRAM APPLICATION.....	60
8.	WAIVER, RELEASE, AND INDEMNITY AGREEMENT.....	61
9.	EMERGENCY PROCEDURES FLOW CHART.....	62
10.	EMERGENCY PROCEDURES FOR DIVING ACCIDENTS.....	63

11. EMERGENCY INFORMATION REQUIREMENTS.....	64
12. DIVE COMPUTER GUIDELINES .....	66
13. REVERSE DIVE PROFILES WORKSHOP .....	67
14. AAUS STATISTICS COLLECTION CRITERIA AND DEFINITIONS .....	68

**Volume 1**  
**Sections I. through VI.F**  
**Required For All AAUS Organizational Members**

**I. POLICY ON DIVING**

**A. SCIENTIFIC DIVING STANDARDS**

1. **Purpose** - The purpose of these scientific diving standards is to ensure that all scientific diving under the auspices of the University of North Carolina at Chapel Hill Institute of Marine Sciences (UNC/CH IMS) is conducted in a manner that will maximize protection of scientific divers from accidental injury and/or illness, and to set forth standards for training and certification which will allow a working reciprocity between UNC/CH IMS and other AAUS organizational members.

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

AAUS Standards were developed and written 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.

2. **Scientific Diving Definition** – Scientific diving is defined (29 CFR 1910.402) as diving performed solely as a necessary part of a scientific, research or educational activity by employees whose sole purpose for diving is to perform scientific diving research tasks.
3. **Scientific Diving Exemption** - OSHA has granted an exemption for scientific diving from commercial diving regulations under the following guidelines (Appendix B to 29CFR1910 Subpart T):
  - a. The Diving Control Board (DCB) consists of a majority of active scientific divers and has autonomous and absolute authority over the scientific diving program's operation.
  - b. The purpose of the project using scientific diving is the advancement of science; therefore information and data resulting from the project are non-proprietary.
  - c. The tasks of a scientific diver are those of an observer and data gatherer. Construction and trouble-shooting tasks traditionally associated with commercial diving are not included within scientific diving.
  - d. Scientific divers, based on the nature of their activities, must use scientific expertise in studying the underwater environment and therefore, are scientists or scientists-in-training.
  - e. In addition, the scientific diving program shall contain at least the following elements (29CFR1910.401):
    - i. Diving safety manual which includes at a minimum: Procedures covering all diving operations specific to the program; including procedures for emergency care, recompression and evacuation, and the criteria for diver training and certification.
    - ii. Diving control (safety) board, with the majority of its members being active scientific divers, which shall at a minimum have the authority to: approve and monitor diving projects, review

and revise the diving safety manual, assure compliance with the manual, certify the depths to which a diver has been trained, take disciplinary action for unsafe practices, and assure adherence to the buddy system (a diver is accompanied by and is in continuous contact with another diver in the water) for scuba diving.

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

## **B. OPERATIONAL CONTROL**

1. **Institute Auspices** - Diving under UNC/CH Institute of Marine Sciences auspices is limited to diving in connection with research, training, and authorization requirements, and other diving as approved by the DCB. Auspices of UNC/CH IMS includes any operation in which UNC/CH IMS is connected because of ownership of any equipment used, locations selected or relationship with the individual(s) concerned. This includes all cases involving the operations of employees of UNC/CH IMS or employees of auxiliary organizations where such employees are acting within the scope of their employment, and the operations of other persons who are engaged in authorized activities of UNC/CH IMS or are diving members of a organization recognized by UNC/CH IMS.

It is UNC/CH IMS's responsibility to adhere to the AAUS Standards for Scientific Diving Certification and Operation of Scientific Diving Programs.

The administration of UNC/CH IMS's diving program will reside with their Diving Control Board (DCB).

2. **Institute Scientific Diving Standards and Safety Manual**- Any person diving under UNC-CH Institute of Marine Sciences auspices is required to observe the provisions of this manual. The diving manual shall include, but not be limited to:
  - a. AAUS standards may be used as a set of minimal guidelines for the development of the scientific diving safety manual. Volume 1, Sections 1.00 through 6.00 and the Appendices are required for all manuals. Volume 2, Sections 7.00 through 9.00 are required only if IMS conducts that activity. IMS specific sections are placed in Volume 2.
  - b. Emergency evacuation and medical treatment procedures.
  - c. Criteria for diver training and certification.
  - d. Standards written or adopted by reference for each diving mode utilized which include the following:
    - i. Safety procedures for the diving operation.
    - ii. Responsibilities of the dive team members.
    - iii. Equipment use and maintenance procedures.
    - iv. Emergency procedures
3. **Equipment** - All diving equipment used by scientific divers shall conform to the standards set forth in Section V. of this manual. It is the responsibility of the diver to make certain their equipment meets all federal, state, local or University standards. Ultimately the care of the equipment must be the responsibility of the individual diver.
4. **Liability** - In adopting the policies set forth in this manual UNC-CH IMS assumes no liability not otherwise imposed by law. Each diver is assumed under this policy to be voluntarily performing activities for which he/she assumes all risks, consequences, and potential liability.

### C. DIVING CONTROL BOARD

1. **Composition** - The Diving Control Board (DCB) shall consist of a majority of active scientific divers. Voting members shall include the the Diving Safety Officer, the responsible administrative officer, or designee, and should include other representatives of the diving program such as qualified divers and members selected by procedures established by UNC/CH IMS. A chair-person and a secretary may be chosen from the membership of the board according to local procedure.
2. **Authority** - The DCB has the autonomous and absolute authority over the scientific diving programs operation.
3. **Responsibilities** - The DCB shall:
  - a. Approve and monitor diving projects.
  - b. Review and revise the diving manual.
  - c. Establish and or approve training programs through which applicants for certification can satisfy the requirements of this diving manual.
  - d. Certify the depths to which a diver has been trained.
  - e. Establish criteria for equipment selection and use.
  - f. Recommend new equipment or techniques
  - g. Establish and/or approve facilities for the inspection and maintenance of diving and associated equipment.
  - h. Periodically review the Diving Safety Officer's performance and program.
  - i. Assure compliance with the diving safety manual.
  - j. Recommend the issue, reissue, or the revocation of diving certifications.
  - k. Assure adherence to the buddy system for scuba diving.
  - l. Act as the official representative of the membership organization in matters concerning the scientific diving program.
  - m. Take disciplinary action for unsafe practices.
  - n. Act as a board of appeal to consider diver related problems.
  - o. Recommend changes in policy and amendments to AAUS and the IMS diving safety manual as the need arises.
  - p. Establish and/or approve training programs through which the applicants for certification can satisfy the requirements of UNC/CH IMS diving safety manual.
  - q. Suspend diving programs that are considered to be unsafe or unwise.
  - r. Sit as a board of investigation to inquire into the nature and cause of diving accidents or violations of UNC/CH IMS's diving safety manual.



#### D. DIVING SAFETY OFFICER

1. **Authority** - The Diving Safety Officer (DSO) serves as a member of the Diving Control Board (DCB). This person should have broad technical and scientific expertise in research related diving.
2. **Qualifications** - The Diving Officer shall be:
  - a. Appointed by the Director with the advice and counsel of the DCB.
  - b. Trained as a scientific diver.
  - c. A full member as defined by AAUS
  - d. An active underwater instructor from an internationally recognized certifying agency.
3. **Duties and Responsibilities** - The Institute Diving Safety Officer
  - a. Shall be responsible through the Diving Control Board, to the Director of UNC/CH IMS for the conduct of the scientific diving program of UNC/CH IMS.
  - b. Shall be responsible for the operational authority of this program, including:
    - i. The conduct of training and certification.
    - ii. Approval of dive plans.
    - iii. Maintenance of diving records.
    - iv. Ensuring compliance with this manual and all relevant regulations of UNC/CH IMS.
  - c. May permit portions of the diving program to be performed by a qualified delegate, although the Diving Officer may not delegate responsibility for the safe conduct of the diving program.
  - d. Shall be guided in the performance of the required duties by the advice of the DCB, but operational responsibility for the conduct of the local diving program will be retained by the Diving Safety Officer.
  - e. Shall suspend diving operations considered to be unsafe or unwise.

#### E. INSTRUCTIONAL PERSONNEL

1. **Qualifications** – All personnel involved in diving instruction under the auspices of UNC/CH IMS shall be qualified for the type of instruction being given.
2. **Selection** – Instructional personnel will be selected by the responsible administrative officer, or designee, who will solicit the advice of the DCB in conducting preliminary screening of applicants for instructional positions.

#### F. LEAD DIVER

1. **Lead Diver designation** - For each diving operation one individual shall be designated as the Lead Diver. He/she shall be at the dive location during the diving operation and will be in charge of all aspects of the diving operation.
2. **Lead Diver Qualifications** - The lead diver must have at least a 60ft depth certification and experience commensurate with the planned activity to lead the dive. For dives > 60ft. the lead diver must have the necessary depth certification.
3. **The Lead Diver shall be responsible for:**
  - a. Coordination with other known activities in the vicinity that are likely to interfere with diving operations.

- b. Ensuring all dive team members possess current certification and are qualified for the type of diving operation. (Section IV.B.1.)
- c. Planning dives in accordance with Section IV.B.
- d. Ensuring safety and emergency equipment is in working order and at the dive site.(Section IV.B.2)
- e. Briefing the dive team members on:
  - i. Dive objectives.
  - ii. Unusual hazards or environmental conditions likely to affect the safety of the diving operation.
  - iii. Modifications to diving or emergency procedures necessitated by the specific diving operation.
- f. Suspending diving operations if in their opinion conditions are not safe.
- g. Reporting to the DSO and DCB any physical problems or adverse physiological effects including symptoms of pressure related injuries.

**G. RECIPROCITY AND VISITING SCIENTIFIC DIVERS**

- 1. **Joint Organizational Diving Activities** -Two or more AAUS Organizational Members engaged jointly in diving activities, or engaged jointly in the use of diving resources, shall designate one of the participating Diving Control Boards to govern the joint diving project.
- 2. **Letter of Reciprocity**-A scientific diver from one Organizational Member shall apply for permission to dive under the auspices of another Organizational Member by submitting to the Diving Safety Officer of the host Organizational Member a document containing all the information described in Appendix 6 (Letter of Reciprocity) signed by the DSO or Chairperson of the home Diving Control Board.
- 3. **Knowledge and skills demonstration**-A visiting scientific diver may be asked to demonstrate his/her knowledge and skills for the planned diving.
- 4. **Denial explanation**-If a host Organizational Member denies a visiting scientific diver permission to dive, the host Diving Control Board shall notify the visiting scientific diver and his/her Diving Control Board with an explanation of all reasons for the denial.

**H. WAIVER OF REQUIREMENTS** - The UNC/CH IMS Diving Control Board may grant a waiver for specific requirements of training, examinations, depth certification, and minimum activity to maintain certification.

**I. CONSEQUENCES OF VIOLATION OF REGULATIONS BY SCIENTIFIC DIVERS**

- 1. **IMS Revocation** - Failure to comply with the regulations of the UNC/CH IMS diving manual may be cause for the revocation or restriction of the diver’s scientific diving certificate by action of the UNC/CH IMS Diving Control Board.
- 2. **AAUS Revocation** - Failure to comply with the regulations of this manual may be cause for the revocation or restriction of UNC/CH IMS organizational member’s status by the AAUS.

**J. RECORD MAINTENANCE** - The Diving Safety Officer or designee shall maintain permanent records for each scientific diver certified. The file shall include evidence of certification level, log sheets, results of current physical examination, reports of disciplinary actions by the organizational member Diving Control Board, and other pertinent information deemed necessary.

- 1. **Availability of Records:** Medical records shall be available to the attending physician of a diver or former diver, when released in writing by the diver.
- 2. **Records and documents** required by this standard shall be retained by the organizational member for the following period:

- a. Physician's written reports of medical examinations for dive team members- 5 years.
- b. Manual for diving safety - current document only.
- c. Records of dive - 1 year, except 5 years where there has been an incident of pressure-related injury.
- d. Pressure-related injury assessment - 5 years.
- e. Equipment inspection and testing records - current entry or tag, or until equipment is withdrawn from service.

## II. ENTRY-LEVEL TRAINING REQUIREMENTS

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

### A. EVALUATION

1. **Medical Examination** - The applicant for training shall be certified by a licensed physician to be medically qualified for diving before proceeding with the training as designated in Section II.A.2 & II.B. (Section VI and Appendices 1 through 4).
2. **Swimming Evaluation** - The applicant for training shall successfully perform the following tests, or their equivalent, in the presence of the Diving Safety Officer, or an examiner approved by the Diving Safety Officer.
  - a. Swim underwater without swim aids for a distance of 25 yards without surfacing.
  - b. Swim 400 yards in less than 12 minutes without swim aids.
  - c. Tread water for 10 minutes, or 2 minutes without the use of hands or swim aids
  - d. Without swim aids, transport another person of equal size a distance of 25 yards in the water.

### B. SCUBA TRAINING

1. **Practical Training** - At the completion of training, the trainee must satisfy the Diving Safety Officer or the instructor of their ability to perform the following , as a minimum, in a pool or sheltered water:
  - a. Enter water with full equipment.
  - b. Clear face mask
  - c. Demonstrate air sharing, including both buddy breathing and the use of alternate air source, as both donor and recipient, with and without a face mask.
  - d. Demonstrate ability to alternate between snorkel and scuba while kicking.
  - e. Demonstrate understanding of underwater signs and signals.
  - f. Demonstrate simulated in-water mouth-to-mouth resuscitation.
  - g. Rescue and transport, as a diver, a passive simulated victim of an accident
  - h. Demonstrate ability to remove and replace equipment while submerged.
  - i. Demonstrate water competence which is acceptable to the instructor.

2. **Written examination** – Before completing training, the trainee must pass a written examination that demonstrates knowledge of at least the following:
  - a. Function, care, use, and maintenance of diving equipment.
  - b. Physics and physiology of diving.
  - c. Diving regulations and precautions.
  - d. Hazardous marine life.
  - e. Proper usage of dive tables.
  - f. Near-shore currents, waves, and tides.
  - g. Emergency procedures, including buoyant ascent and ascent by air sharing.
  - h. Currently accepted decompression procedures.
  - i. Hazards of breath-hold diving and ascents.
  - j. Underwater communications.
  - k. Aspects of freshwater and altitude diving.
  - l. Planning and supervision of diving operations.
  - m. Diving hazards.
  - n. Cause, symptoms, treatment, and prevention of the following: near drowning, air embolism, carbon dioxide excess, squeezes, oxygen poisoning, nitrogen narcosis, exhaustion and panic, respiratory fatigue, motion sickness, decompression sickness, hypothermia, and hypoxia/anoxia.
3. **OPEN WATER EVALUATION** - The trainee must satisfy an instructor, approved by the Diving Safety Officer of their ability to perform at least the following in open water:
  - a. Surface dive to a depth of 10 feet in open water without scuba.
  - b. Demonstrate ability to properly enter and exit open water or surf, or leave and board a diving vessel, while wearing scuba gear.
  - c. Kick on the surface 400 yards while wearing SCUBA gear, but not breathing from the unit.
  - d. Demonstrate proficiency in air sharing, as both donor and receiver.
  - e. Demonstrate judgment adequate for safe diving.
  - f. Demonstrate clearing of mask and regulator while submerged.
  - g. Demonstrate ability to achieve and maintain neutral buoyancy while submerged.
  - h. Navigate underwater.
  - i. Demonstrate understanding of underwater signals.
  - j. Demonstrate ability to maneuver safely and efficiently in the environment, at and below the surface.
  - k. Demonstrate the ability to monitor tank pressure, depth, and bottom time.

- l. Complete a simulated emergency swimming ascent.
- m. Demonstrate techniques of self-rescue and buddy rescue.
- n. Plan and execute a dive.
- o. Successfully complete 5 open water dives for a minimum total time of 3 hours, of which 1-1/2 hours cumulative bottom time must be on scuba. No more than 3 training dives shall be made in any 1 day.

### III. SCIENTIFIC DIVER DOCUMENTS CERTIFICATION

#### A. GENERAL POLICY

Eligibility - Only UNC-CH IMS personnel, visiting or co-operating investigators diving under Institute auspices are eligible for application to the UNC-CH IMS diving list. Visiting or cooperating scientist possessing valid diving certification from member organizations of the AAUS are eligible for a scientific diver certification.

#### B. CERTIFICATION TYPES

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

C. **REQUIREMENTS FOR SCIENTIFIC DIVER CERTIFICATION** - Submission of documents and participation in aptitude examinations does not automatically result in certification. The applicant must convince the Diving Safety Officer and members of the DCB that they are sufficiently skilled and proficient to be certified. This skill will be acknowledged by the signature of the DSO. Any applicant who does not possess the necessary judgment, under diving conditions, for the safety of the diver and their partner, may be denied scientific diving privileges. Minimum documentation and examination required are as follows:

##### 1. Pre-requisites

- a. **Application** for certification (Appendix 7)
- b. **Medical approval** – Each applicant for training shall submit a statement from a licensed physician, based on an approved medical examination, attesting to the applicants fitness for diving to be medically qualified for diving (Section VI. and Appendixes 1-4)
- c. **Scientific Diver-In-Training Permit** – This permit signifies that a diver has completed and been certified as at least an open water diver through an internationally recognized certifying agency or scientific diving program, and has the knowledge, skills, and experience gained by successful completion of training as specified in Section II.
- d. **DAN membership and Dive Accident Insurance**- Each applicant for Scientific Diver Certification shall show proof of current DAN membership and current dive insurance protection.(At least the Master Plan for DAN dive insurance)
- e. **Emergency Care Training** – The trainee must provide proof of training in the following:

- i. Adult CPR (must be current)
  - ii. Emergency oxygen administration (must be current)
  - iii. First aid for diving accidents (must be current)
2. **Theoretical and Practical Training** - The diver must complete theoretical aspects and practical training for a minimum cumulative time of 100 hours. Theoretical aspects shall include principles and activities appropriate to the intended area of scientific study.
- a. **Required Topics** (include, but not limited to):
    - i. Diving Emergency Care Training
      - (a) Cardiopulmonary Resuscitation (CPR)
      - (b) Recognition of DCS and AGE
      - (c) Accident Management
      - (d) Field Neurological Exam
      - (e) Oxygen Administration
    - ii. Dive Rescue
    - iii. Dive Physics
    - iv. Dive Physiology
    - v. Dive Environments
    - vi. Decompression Theory and its Application
    - vii. AAUS Scientific Diving Regulations and History
      - (a) Scientific Dive Planning
      - (b) Coordination with other Agencies
      - (c) Appropriate Governmental Regulations
    - viii. Scientific Method
    - ix. Data Gathering Techniques (Only Items specific to area of study are required)
      - (a) Quadrating
      - (b) Transecting
      - (c) Mapping
      - (d) Coring
      - (e) Photography
      - (f) Tagging
      - (g) Collecting
      - (h) Animal Handling
      - (i) Archaeology
      - (j) Common Biota
        - (i) Organism Identification
        - (ii) Behavior
        - (iii) Ecology
      - (k) Site Selection, Location, and Re-location
      - (l) Specialized Equipment for data gathering
    - x. Haz Mat Training

- (a) HP Cylinders
  - (b) Chemical Hygiene, Laboratory Safety (Use of Chemicals)
- b. **Suggested Topics** (Include, but not limited to):
- i. Specific Dive Modes (methods of gas delivery)
    - (a) Open Circuit
    - (b) Hookah
    - (c) Surface Supplied diving
  - ii. Small Boat Operation
  - iii. Re-breathers
    - (a) Closed
    - (b) Semi-closed
  - iv. Specialized Breathing Gas
    - (a) Nitrox
    - (b) Mixed Gas
  - v. Specialized Environments and Conditions
    - (a) Blue Water Diving
    - (b) Ice and Polar Diving (Cold Water Diving)
    - (c) Zero Visibility Diving
    - (d) Polluted Water Diving
    - (e) Saturation Diving
    - (f) Decompression Diving
    - (g) Overhead Environments
    - (h) Aquarium Diving
    - (i) Night Diving
    - (j) Kelp Diving
    - (k) Strong Current Diving (Live-boating)
    - (l) Potential Entanglement
  - vi. Specialized Diving Equipment
    - (a) Full face mask
    - (b) Dry Suit
    - (c) Communications
- c. **Practical training** must include a checkout dive with evaluation of the skills listed in Section II.B.3. with the DSO or qualified delegate followed by at least 11 ocean or open water dives in a variety of dive sites and diving conditions, for a cumulative bottom time of 6 hours. Dives following the checkout dive must be supervised by a certified Scientific Diver with experience in the type of diving planned, with the knowledge and permission of the DSO.
- d. **Examinations**
- i. Written examination
    - (a) General exam required for scientific diver certification.
    - (b) Examination covering the suggested topics at the DSO's discretion.

ii. Examination of equipment.

- (a) Personal diving equipment
- (b) Task specific equipment.

**D. DEPTH CERTIFICATION - Depth Certifications and Progression to Next Depth Level**

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

**1. Certification to 30 Foot Depth**

This is the initial certification, approved upon the successful completion of training listed in Section II and III.C. The first 12 dives are to be to a depth of 30 feet or less.

**2. Certification to 60 Foot Depth**

A diver holding a 30 foot certificate may be certified to a depth of 60 feet after successfully completing, under supervision, a total of 24 dives (consisting of 12 logged training dives to depths between 31 and 60 feet for a minimum total time of 4 hours plus the 12 dives to a depth of 30 feet or less listed in Section III.C.2.c.)

**3. Certification to 100 Foot Depth**

A diver holding a 60 foot certificate may be certified to a depth of 100 feet, after completing four dives to depths between 61 and 100 feet. The diver shall also demonstrate proficiency in the use of the appropriate Dive Tables.

4. **Certification to 130 Foot Depth** – A diver holding a 100 foot certificate may be certified to a depth of 130 feet after successfully completing, 4 dives to depths between 100 and 130 feet. The diver shall also demonstrate proficiency in the use of the appropriate Dive Tables.

5. **Certification to 150 Foot Depth** – A diver holding a 130 foot certificate may be certified to a depth of 150 feet after successfully completing, 4 dives to depths between 130 and 150 feet. The diver must also demonstrate knowledge of the special problems of deep diving, and of special safety requirements.

6. **Certification to 190 Foot Depth** – A diver holding a 150 foot certificate may be certified to a depth of 190 feet after successfully completing, 4 dives to depths between 150 and 190 feet. The diver must also demonstrate knowledge of the special problems of deep diving, and of special safety requirements.

**DIVING ON AIR IS NOT PERMITTED BEYOND A DEPTH OF 190 FEET.**

**E. MAINTENANCE OF AUTHORIZATION**

1. **Medical Examination** - All diving authorization shall expire anytime the medical examination is not current. All certified scientific divers shall pass a medical examination at the intervals specified in Sec.VI.B. After each major illness or injury, as described in Sec.VI.B.3., a certified scientific diver shall receive clearance to return to diving from a physician before resuming diving activities.
2. **Minimum Activity to Maintain Certification** - During any twelve-month period each authorized diver shall normally log a total of twelve dives.(See Section IV.H.1.) At least one dive must be logged near the maximum depth of the diver's certification during each 6 month period. Divers certified to 150 feet or deeper may satisfy these requirements with dives to 130 feet or over. Credit for qualifying dives must be supported by the diver's log. No credit will be given for dives improperly logged and thus may be cause for revocation or restriction of an authorization.



3. **Re-qualification of Depth Certificate** – Once the initial certification requirements of Section are met, divers whose depth certification has lapsed due to lack of activity may be re-qualified by procedures adopted by the organization's DCB.

**F. REVOCATION OF AUTHORIZATION** - Diving authorization may be revoked or restricted for cause by the Diving Safety Officer or Diving Control Board. Violations of regulations in this manual or of pertinent rules, regulations, or laws (i.e., N.C. Division of Marine Fisheries, Federal Fisheries Regulations) may be considered cause. The DSO shall inform the diver in writing of the reason(s) for revocation. The diver will be given the opportunity to present his/her case in writing for reconsideration and/or re-certification. All such written statements and requests are formal documents and will become part of the diver's file.

**G. RE-CERTIFICATION** - If a diver's certificate expires or is revoked, they may be re-certified after complying with conditions imposed by the DSO or the DCB. The diver shall be given an opportunity to present their case to the DCB before conditions for re-certification are stipulated.

#### **IV. DIVING REGULATIONS FOR SCUBA (OPEN CIRCUIT, COMPRESSED AIR)**

**A. AUTHORIZATION** - No person shall engage in scientific diving operations under the auspices of UNC/CH IMS unless they hold a current certification issued pursuant to the provisions of this standard (See active Divers list at <http://www.dive-log.com/UNC>)

**B. PRE-DIVE PROCEDURES** - Dive Plans - Dives should be planned around the competency of the least experienced diver. Before any diving activity can be authorized an Operational Dive Plan (ODP) must be submitted to the DSO by the Principal Investigator or Lead Diver and be approved by the Diving Control Board (DCB). It is preferable that The ODP be reviewed before the grant proposal is submitted for funding, so if revisions are required they may be completed before the grant is approved. When the proposal involves diving to be conducted through a federal agency such as NOAA NURC, US ARMY CORPS Of ENGINEERS, a copy of the dive proposal to be submitted to the facility will suffice. Advantages to having the grant reviewed by the DCB are as follows: (1) Dive equipment costs, equipment maintenance costs, and dive physical costs can be included in the grant (2) Additional gear costs required to ensure the safety of the diver, can be added into the grant proposal and, (3) If hazardous conditions exist, DCB review will ensure a safer dive operation. If you have questions about filing the ODP please direct them to the DSO at [gsafrit@email.unc.edu](mailto:gsafrit@email.unc.edu).

1. **Operational Dive Plan** - It is preferable that the ODP be submitted to the DCB before the grant proposal is submitted. The lead diver for a proposed operation must formulate a dive plan that should include the following information:
  - a. Divers qualifications, and the type of certificate or certification held by each diver.
  - b. Emergency plan (see Appendices 9 - 11) with the following information:
    - i. Name, telephone number, and relationship of person to be contacted for each diver in the event of an emergency.
    - ii. Nearest operational recompression chamber.
    - iii. Nearest accessible hospital.
    - iv. Available means of transport.
  - c. Approximate number of proposed dives.
  - d. Location(s) of proposed dives.
  - e. Estimated depth(s) and bottom time(s) anticipated.
  - f. Decompression status and repetitive dive plans if required.

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

h. Any hazardous conditions anticipated.

2. **Required Safety Equipment** - The following safety equipment shall be available at the dive location:

a. Dive Flag

b. First Aid kit

c. Appropriate dive tables (At least as safe as USN DIVE TABLES)

d. Emergency Procedures for Diving Accidents (APPENDIX-9, A-10,+A-11)

e. VHF radio and/or cell phone (Cellular phone may be substituted if distance from shore is 3 miles or less, cellular phone is recommended for all shore based diving)

f. Emergency Oxygen Kit and sufficient oxygen to reach nearest medical help.

**C. PERSONNEL REQUIREMENTS** - All offshore (> 3miles) and remote dive operations require a minimum of three people, one person serving as attendant during diving operations. Vessel attendant must have boating certification. Questions regarding dive site location information should be addressed to the Dive Officer.

**D. PRE-DIVE SAFETY CHECKS**

1. **Diver's Responsibility** - Ultimate responsibility for safety rests with the individual diver.

a. Each scientific diver shall conduct a functional check of their diving equipment in the presence of the diving buddy or tender.

b. It is the diver's responsibility and duty to refuse to dive if in their judgment conditions are unsafe or unfavorable, or if they would be violating the precepts of their training or the regulations of this manual.

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

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

2. **Equipment Evaluations**

a. Each diver shall insure that their equipment is in proper working order and that the equipment is suitable for the type of diving operation.

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

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

**E. DIVING PROCEDURES**

1. **Solo Diving - SOLO SCUBA DIVING IS PROHIBITED.** All diving activities shall assure adherence to the buddy system for scuba diving. This buddy system is based upon mutual assistance especially in the case of an emergency.

2. **Divers Flag** - A diver's flag, international code flag "A" (Blue and White) and the standard diving flag (red with diagonal white stripe) shall be prominently displayed whenever offshore diving is conducted, inshore diving requires at least the standard diving flag (red with diagonal white stripe).
3. **Refusal to Dive**
  - a. The decision to dive is that of the diver. A diver may refuse to dive, without fear of penalty, whenever they feel it is unsafe for them to make the dive (see Sec. IV.D.1.b)
  - b. Safety - The ultimate responsibility for safety rests with the individual diver. It is the diver's responsibility and duty to refuse to dive if, in their judgment, conditions are unsafe or unfavorable, or if they would be violating the precepts of their training or the regulations in this manual.
4. **Termination of the Dive**
  - a. It is the responsibility of the diver to terminate the dive, without fear of penalty, whenever they feel it is unsafe to continue the dive, unless it compromises the safety of another diver already in the water.
  - b. The dive shall be terminated while there is still sufficient cylinder pressure to permit the diver to safely reach the surface, including decompression time, or to safely reach an additional air source at the decompression station.
5. **Emergencies and Deviations from Standards**-Any diver may deviate from the requirements of this manual to the extent necessary to prevent or minimize a situation which is likely to cause death, serious physical harm, or major environmental damage. A written report of all such incidents shall be submitted to the Diving Control Board explaining the circumstances and justifications for actions taken.

**F. POST-DIVE PROCEDURES**

1. After the completion of a dive, each diver shall report any physical problems, symptoms of decompression sickness, or equipment malfunctions.
2. When dive time is close to or outside the maximum no decompression limit, divers should remain awake for at least one hour after diving, and in the company of a dive team member who is prepared to transport them to a hyperbaric chamber if necessary.

**G. EMERGENCY PROCEDURES** - An Emergency Procedures Plan which follows the community standard of care and must include procedures for emergency care, recompression and evacuation will be developed for each dive location.

**H. FLYING AFTER DIVING OR ASCENDING TO ALTITUDE(Over 1000 feet) –**

1. Following a single no-decompression dive: Divers should have a minimum preflight surface interval of 12 hours before ascending to altitude.
2. Following multiple dives per day or multiple days of diving: Divers should have a minimum preflight surface interval of 18 hours.
3. Following dives requiring decompression stops: Divers should have a minimum preflight surface interval of 24 hours.
4. Before ascending to Altitude above (1000 feet) by land transport: Divers should follow appropriate guideline for preflight surface intervals unless the decompression procedure used has accounted for the increase in elevation.

## I. RECORDKEEPING AND REQUIREMENTS

1. **Personal Diving Log** - Each certified scientific diver shall log every dive made under the auspices of UNC/CH IMS dive program, and is encouraged to log all other dives. Dives can be logged at [www.dive-log.com/UNC/](http://www.dive-log.com/UNC/).  
The diving log shall include at least the following:
  - a. Name of diver, partner, and Lead Diver.
  - b. Date, time in, time out location, and site.
  - c. Diving modes used. (Open Circuit SCUBA, Hookah, Surface Supplied ,Re-breather)
  - d. General nature of diving activities. (Scientific, Training or Proficiency)
  - e. Approximate surface and underwater conditions.
  - f. Maximum depths, bottom time and surface interval time.
  - g. Diving tables or computers used.
  - h. Detailed report of any near or actual incidents.
2. **Required Incident Reporting** – All diving incidents requiring recompression treatment, or resulting in moderate or serious injury, or death shall be reported to UNC/CH IMS Diving Control Board and the AAUS. This incident or accident report shall be received, reviewed, and released by the UNC/CH IMS DCB before being sent to the AAUS. The report will specify the circumstances of the incident and the extent of any injuries or illnesses. Additional information must meet the following reporting requirements:
  - a. Occupational injuries and illnesses at UNC/CH IMS shall be recorded and reported in accordance with requirements of the appropriate Labor Code section.
  - b. If pressure-related injuries are suspected, or if symptoms are evident, the following additional information shall be recorded and retained by UNC/CH IMS, with the record of the dive, for a period of 5 years:
    - i. Complete AAUS Incident Report at <http://www.aaus.org>.
    - ii. Written descriptive report to include:
      - (a) Name, address, phone numbers of the principal parties involved.
      - (b) Summary of experience of divers involved.
      - (c) Location, description of dive site and description of conditions that led up to incident.
      - (d) Description of symptoms, including depth and time of onset.
      - (e) Description and results of treatment.
      - (f) Disposition of case.
      - (g) Recommendations to avoid repetition of incident.
    - iii. UNC-CH IMS shall investigate and document any incident of pressure-related injury and prepare a report which is to be forwarded to the AAUS during the annual reporting cycle. This report must first be reviewed and released by the UNC/CH IMS Diving Control Board.

## V. DIVING EQUIPMENT

### A. GENERAL POLICY –

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

### B. EQUIPMENT

#### 1. Regulator

- a. Approval – Only those makes and models specifically approved by the Diving Safety Officer and the Diving Control Board shall be used.
- b. Inspection and Maintenance – All regulators used for diving under Institute auspices shall be inspected and tested prior to the first use and every twelve months thereafter.
- c. Regulators will consist of a primary second stage and an alternate air source (such as an octopus second stage or redundant air supply).

#### 2. Breathing Masks and Helmets - Breathing masks and helmets shall have:

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

#### 3. Scuba Cylinders

- a. Scuba cylinders shall be designed, constructed, and maintained in accordance with the applicable provisions of the Unfired Pressure Vessel Safety Orders.
- b. Internal Inspection – Scuba cylinders must have an internal and external inspection at intervals not to exceed twelve months.
- c. Hydrostatic Testing – Scuba cylinders must be hydrostatically tested in accordance with DOT standards.
- d. Cylinder Valve Testing – Scuba cylinder valves shall be functionally tested at intervals not to exceed 12 months.

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

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

#### 6. Flotation Devices

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

- b. Personal flotation systems, buoyancy compensators, dry suits, or other variable volume buoyancy compensation devices shall be equipped with an exhaust valve.
- c. These devices shall be functionally inspected and tested at intervals not to exceed twelve months.

7. **Timing Devices, Depth and Pressure Gauges,** - Both members of the diving pair must have an underwater timing device, an approved depth indicator, and a submersible pressure gauge.

8. **Determination of Decompression Status: Dive Tables, Dive Computers**

- a. A set of diving tables, approved by the Diving Control Board, must be available at the dive location.
- b. Dive computers may be utilized in place of diving tables, but must first be approved by the Diving Control Board. AAUS recommendations on dive computers (see Appendix 13)

C. **AUXILLARY EQUIPMENT**

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

D. **SUPPORT EQUIPMENT**

- 1. **First aid supplies** - A first aid kit and emergency oxygen shall be available.
- 2. **Diver's Flag** - A diver's flag shall be displayed prominently whenever diving is conducted under circumstances where required or where water traffic is probable.(Sec.IV.E.2.)
- 3. **Compressor Systems** – The following will be considered in design and location of compressor systems:
  - a. Low pressure compressors used to supply air to the diver if equipped with a volume tank shall have a check valve on the inlet side, a relief valve, and a drain valve.
  - b. Compressed air systems over 500 psig shall have slow-opening shut-off valves.
  - c. All air compressor intakes shall be located away from areas containing exhaust or other contaminants.

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

- a. Regulators
- b. Submersible pressure gauges
- c. Depth gauges
- d. Scuba cylinders
- e. Cylinder valves
- f. Diving helmets
- g. Submersible breathing masks

- h. Compressors
- i. Gas control panels
- j. Air storage cylinders
- k. Air filtration systems
- l. Analytical instruments
- m. Buoyancy control devices
- n. Dry suits

**F. COMPRESSOR OPERATION AND AIR TEST RECORDS**

1. Gas analyses and air tests shall be performed on each organizational Member controlled breathing air compressor at regular intervals of no more than 100 hours of operation or six months, whichever occurs first. The results of these tests shall be entered in a formal log and be maintained.
2. A log shall be maintained showing operation, repair, overhaul, filter maintenance, and temperature adjustment for each compressor.

**G. AIR QUALITY STANDARDS** – breathing air for scuba shall meet the following Specifications as set forth by the Compressed Gas Association (CGA Pamphlet G-7.1)

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

For breathing air used in conjunction with self-contained breathing apparatus in extreme cold where moisture can condense and freeze, causing the breathing apparatus to malfunction, a dew point not to exceed -50 F (63 pm v/v) or 10 degrees lower than the coldest temperature expected in the area is required.

**VI. MEDICAL STANDARDS**

**A. MEDICAL REQUIREMENTS OF DIVE TEAM**

1. UNC CH-IMS dive team members who are to be exposed to hyperbaric conditions must have passed a current diving physical examination and have been declared by the examining physician to be fit to engage in diving activities as may be limited or restricted in the medical evaluation report.
2. All medical evaluations required by this standard shall be performed by, or under the direction of, a licensed physician of the applicant-diver's choice, preferably one trained in diving/undersea medicine.
3. The diver should be free of any chronic disabling disease and be free of any conditions contained in the list of conditions for which restrictions from diving are generally recommended. (Appendix 1)

**B. FREQUENCY OF MEDICAL EXAMINATION** - Medical evaluations shall be completed:

1. Before a diver may begin diving unless an equivalent initial medical examination has been given within the preceding five years (3 years if over the age of 40, 2 years if over the age of 60), IMS has obtained the results of that examination and those results have been reviewed and found satisfactory by IMS.
2. Thereafter at 5 year intervals up to age 40, every 3 years after the age of 40, and every 2 years after the age of 60.
3. Clearance to return to diving must be obtained from a physician following any major injury or illness, or any condition requiring hospital care. If the injury or illness is pressure related then the clearance to return to diving must come from a physician trained in diving medicine.

**C. INFORMATION PROVIDED EXAMINING PHYSICIAN** – UNC-CH IMS shall provide a copy of the medical evaluation requirements of this standard for the applicant to take to the examining physician. (Appendices 1, 2, and 3).

**D. CONTENT OF MEDICAL EXAMINATIONS**

Medical examinations for diving conducted initially and at the intervals specified in Section VI.B. shall consist of the following:

1. Signed applicant agreement for medical information release to the DSO and DCB. (Appendix 2)
2. Medical history. (Appendix 3)
3. Diving physical examination. (Required tests are listed in Section VI.E. and Appendix 2)
4. Conditions Which May Disqualify Candidates From Diving (Adapted from Bove, 1998)
  - a. Abnormalities of the tympanic membrane, such as perforation, presence of a monomeric membrane, or inability to auto inflate the middle ears.
  - b. Hearing loss; Vertigo including Meniere's Disease.
  - c. Stapedectomy or middle ear reconstructive surgery.
  - d. Recent ocular surgery.
  - e. Psychiatric disorders including claustrophobia, suicidal ideation, psychosis, anxiety states, depression.
  - f. Substance abuse, including alcohol.
  - g. Episodic loss of consciousness.
  - h. History of seizure.
  - i. History of stroke or a fixed neurological deficit.
  - j. Recurring neurologic disorders, including transient ischemic attacks.
  - k. History of intracranial aneurysm, other vascular malformation or intracranial hemorrhage.
    - i. History of neurological decompression illness with residual deficit.
    - ii. Head injury.
    - iii. Hematologic disorders including coagulopathies.
    - iv. Risk factors or evidence of coronary artery disease
    - v. Atrial septal defects.
    - vi. Significant valvular heart disease - isolated mitral valve prolapse is not disqualifying.
    - vii. Significant cardiac rhythm or conduction abnormalities.
    - viii. Implanted cardiac pacemakers and cardiac defibrillators (ICD).
    - ix. Inadequate exercise tolerance.
    - x. Hypertension.
    - xi. History of pneumothorax.
    - xii. Asthma
    - xiii. Chronic pulmonary disease, including radiographic evidence of pulmonary blebs, bullae or cysts.



- xiv. Diabetes mellitus.
- xv. Pregnancy.

**E. LABORATORY REQUIREMENTS FOR DIVING MEDICAL EXAMINATION**

**1. Initial examination under age forty:**

- a. Medical History
- b. Complete Physical Exam, emphasis on neurological and otological components
- c. Urinalysis
- d. Any further tests deemed necessary by the physician

**2. Periodic re-examination under age 40, (every 5 years):**

- a. Medical History
- b. Complete Physical Exam, emphasis on neurological and otological components
- c. Urinalysis
- d. Any further tests deemed necessary by the physician

**3. First exam over age 40:**

- a. Medical History
- b. Complete Physical Exam, emphasis on neurological and otological components
- c. Detailed assessment of coronary artery disease using Multiple-Risk-Factor Assessment<sup>1,2</sup> (age, family history, lipid profile, blood pressure, diabetic screening, smoking history) Further cardiac screening may be indicated based on risk assessment.
- d. Resting EKG
- e. Chest X - ray
- f. Urinalysis
- g. Any further tests deemed necessary by the physician

**4. Periodic re-examination over age 40 (every 3 years), over age 60 (every 2 years).**

- a. Medical History
- b. Complete Physical Exam, emphasis on neurological and otological components
- c. Detailed assessment of coronary artery disease using Multiple-Risk-Factor Assessment.<sup>1</sup> (age, family history, lipid profile, blood pressure, diabetic screening, smoking history) Further cardiac screening may be indicated based on risk factor assessment.
- d. Resting EKG
- e. Urinalysis
- f. Any further tests deemed necessary by the physician

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

2. Bove, A. A. 2011. The cardiovascular system and diving risk. *Undersea and Hyperbaric Medicine* 38(4): 261-269.

**F. PHYSICIAN'S WRITTEN REPORT**

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

**VOLUME 11**  
**Sections VII through IX**  
**Required Only When Conducting Described Diving Activities**  
**AAUS Organizational Member Specific Sections**

VII. **NITROX DIVING GUIDELINE** - Nitrox is defined for these guidelines as breathing mixtures composed predominantly of nitrogen and oxygen, most commonly produced by the addition of oxygen or the removal of nitrogen from the air.

**A. PRE-REQUISITES**

1. **Eligibility** - Only a certified Scientific Diver or Scientific Diver In Training (see IMS standards Sec.II. & III.) under the auspices of UNC/CH IMS is eligible for authorization to use nitrox. After completion, review and acceptance of application materials, training and qualification, an applicant will be authorized to use nitrox within their depth authorization, as specified in IMS Standards Sec.III.D.
2. **Application and documentation** - Application and documentation for authorization to use nitrox should be made on forms specified by the Diving Control Board.

**B. REQUIREMENTS FOR AUTHORIZATION TO USE NITROX**

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

1. **Training** - The diver must complete additional theoretical and practical training beyond the Scientific Diver in Training air certification level, to the satisfaction of the member organizations DSO and DCB.(see Section III.C.2.)
2. **Examinations** - Each diver should demonstrate proficiency in skills and theory in written, oral, and practical examinations covering:
  - a. Written examinations covering the information presented in the classroom training session(s) (i.e., gas theory, oxygen toxicity, partial pressure determination, etc.)
  - b. Practical examinations covering the information presented in the practical training sessions(s) (i.e., gas analysis, documentation procedures, etc.)
  - c. Open water checkout dives to appropriate depths, to demonstrate the application of theoretical and practical skills learned.
3. **Minimum activity to maintain authorization** - The diver should log at least one (1) nitrox dive per year. Failure to meet the minimum activity level may be cause for restriction or revocation of nitrox authorization.

C. **NITROX TRAINING GUIDELINES** - Training in these guidelines should be in addition to training for Diver-In-Training authorization (Sec. III.C.2.). It may be included as part of training to satisfy the Scientific Diver in training requirements.

## 1. Classroom Instruction

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

## 2. Practical Training - The practical training portion will consist of a review of skills as stated for scuba (IMS Standards Sec. II), with additional training as follows:

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

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

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

- a. Function, care, use, and maintenance of equipment cleaned for nitrox use.
- b. Physical and physiological consideration of nitrox diving (ex. O<sub>2</sub> and CO<sub>2</sub> toxicity).
- c. Diving regulations and procedures as related to nitrox diving ,either scuba or surface-supplied (depending on intended mode).
- d. Given the proper information, calculation of:
  - i. Equivalent air depth (EAD) for a given fO<sub>2</sub> and actual depth.
  - ii. PO<sub>2</sub> exposure for a given fO<sub>2</sub> and depth.
  - iii. Optimal nitrox mixture for a given pO<sub>2</sub> exposure limit and planned depth.
  - iv. Maximum operational depth (MOD) for a given mix and pO<sub>2</sub> exposure limit.
  - v. For nitrox production purposes, percentages/psi of oxygen present in a given mixture, and psi of each gas required to produce a fO<sub>2</sub> by partial pressure mixing.
- e. Dive table and dive computer selection and usage;
- f. Nitrox production methods and considerations;
- g. Oxygen analysis.

- h. Nitrox operational guidelines (Section VII.D), dive planning, and dive station components.
4. **Open water Dives** - A minimum of two supervised open water dives using nitrox is required for authorization. The mode used in the dives should correspond to the intended application (scuba) If the MOD for the mix being used can be exceeded at the training location, direct, in-water supervision is required.

## D. SCIENTIFIC NITROX DIVING REGULATIONS

### 1. Dive Personnel Requirements

- a. **Nitrox Diver In Training** – A Diver in Training, who has completed the requirements of UNC/CH IMS Section II. and the training and authorization sections of these guidelines (Section VII.B+C), may be authorized by the DSO to use nitrox under the direct supervision of a Scientific Diver who also holds nitrox authorization. Dive depths should be restricted to those specified in the diver’s authorization.
- b. **Scientific Diver** – A Scientific Diver who has completed the requirements of IMS Standards Section III. and the training and authorization sections of these guidelines, may be authorized by the DSO to use nitrox. Depth authorization to use nitrox should be the same as those specified in the diver’s authorization, as described in Sec.III.D.
- c. **Lead Diver** – On any dive during which nitrox will be used by any team member, the Lead Diver should be authorized to use nitrox, and hold appropriate authorizations required for the dive as specified in AAUS Standards. Lead Diver authorization for nitrox dives by the DSO and /or DCB should occur as part of the dive plan approval process.  
In addition to responsibilities listed in Section IV.C., the Lead diver should:
  - i. As part of the dive planning process, verify that all divers using nitrox on a dive are properly qualified and authorized;
  - ii. As part of the pre-dive procedures, confirm with each diver the nitrox mixture the diver is using, and establish dive team maximum depth and time limits, according to the shortest time limit or shallowest depth limit among the team members.
  - iii. The Lead Diver should also reduce the maximum allowable pO<sub>2</sub> exposure limit for the dive team if on-site conditions so indicate (see Sec.VII.D.2.a.ii.)

### 2. Dive Parameters

#### a. Oxygen Exposure Limits

- i. The inspired oxygen partial pressure experienced at depth should not exceed 1.6ATA. All dives performed using nitrox breathing mixtures should comply with the current NOAA Diving Manual “Oxygen Partial Pressure Limits for ‘Normal’ Exposures”
- ii. The maximum allowable exposure limit should be reduced in cases where cold or strenuous dive conditions, or extended exposure times are expected. The DCB should consider this in the review of any dive plan application which proposes to use nitrox. The Lead Diver should also review on-site conditions and reduce the allowable pO<sub>2</sub> exposure limits if conditions indicate.
- iii. If using the equivalent air depth (EAD) method the maximum depth of a dive should be based on the oxygen partial pressure for the specific nitrox breathing mix to be used.

**b. Bottom Time Limits**

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

**c. Decompression Tables and Gases**

- i. A set of DCB approved nitrox decompression tables should be available at the dive site.
- ii. When using the equivalent air depth (EAD) method, dives should be conducted using air decompression tables approved by the DCB.
- iii. If nitrox is used to increase the safety margin of air-based dive tables, the MOD and oxygen exposure and time limits for the nitrox mixture being dived should not be exceeded
- iv. Breathing mixtures used while performing in-water decompression, or for bail-out purposes, should contain the same or greater oxygen content as that being used during the dive, within the confines of depth limitations and oxygen partial pressure limits set forth in Sec.VII.D.2.

**d. Nitrox Dive Computers**

- i. Dive Computers may be used to compute decompression status during nitrox dives. Manufacturers’ guidelines and operations instructions should be followed.
- ii. Use of Nitrox dive computers should comply with dive computer guidelines included in the AAUS Standards. (See Appendix 13)
- iii. Nitrox Dive computer users should demonstrate a clear understanding of the display, operations, and manipulation of the unit being used for nitrox diving prior to using the computer, to the satisfaction of the DSO or his/her designee.
- iv. If nitrox is used to increase the safety margin of an air-based dive computer, the MOD and oxygen exposure and time limits for the nitrox mixture being dived should not be exceeded.
- v. Dive computers capable of pO<sub>2</sub> limit and fO<sub>2</sub> adjustment should be checked by the diver prior to the start of each dive to assure compatibility with the mix being used.

**e. Repetitive Diving**

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

### 3. Oxygen Parameters

- a. Authorized Mixtures - Mixtures meeting the criteria outlined in Sec.VII.D.2. may be used for nitrox diving operations, upon approval of the DCB.
- b. Purity
  - i. Oxygen used for mixing nitrox breathing gas should meet the purity levels for “Medical Grade” (U.S.P.) or “Aviator Grade” standards.
  - ii. In addition to the AAUS Air Purity Guidelines (AAUS Sec. 3.60), the following standard should be met for breathing air that is either:
    - (a) placed in contact with oxygen concentrations greater than 40%, or
    - (b) used in nitrox production by the partial pressure mixing method with gas mixture containing greater than 40% oxygen as the enriching agent

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

### 4. Gas Mixing and Analysis for Organizational Members

#### a. Personnel Requirements

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

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

#### c. Analysis Verification by User

- i. It is the responsibility of each diver to analyze prior to the dive the oxygen content of his/her scuba cylinder and acknowledge in writing the following information for each cylinder: fO<sub>2</sub>, MOD, cylinder pressure, date of analysis, and user’s name.
- ii. Individual dive log reporting forms should report fO<sub>2</sub> of nitrox used, if different than 21%.

### E. NITROX DIVING EQUIPMENT - All of the designated equipment and stated requirements regarding scuba equipment required in the AAUS Standards should apply to nitrox scuba operations.

#### 1. Additional minimal equipment necessary for nitrox diving operations includes;

- a. labeled SCUBA cylinders
- b. and oxygen analyzers.

#### 2. Oxygen Cleaning and Maintenance Requirements

- a. Requirement for Oxygen Service

- i. All equipment which during the dive or cylinder filling process is exposed to concentrations greater than 40% oxygen at pressures above 150 psi should be cleaned and maintained for oxygen service.
  - ii. Equipment used with oxygen or mixtures containing over forty percent (40%) by volume oxygen shall be designed and maintained for oxygen service.
  - iii. Oxygen systems over 125 psig shall have slow-opening shut-off valves. This should include the following equipment: scuba cylinders, cylinder valves, scuba and other regulators, cylinder pressure gauges, hoses, diver support equipment, compressors, and fill station components and plumbing.
3. **Scuba Cylinder Identification Marking** - Scuba cylinders to be used with nitrox mixtures should have the following identification documentation affixed to the cylinder.
  - a. Cylinders should be marked "NITROX", or "EANx", or "Enriched Air"
  - b. Nitrox identification color coding should include a 4-inch wide green band around the cylinder, starting immediately below the shoulder curvature. If the cylinder is not yellow, the green band should be bordered above and below by a 1-inch yellow band.
  - c. The alternate marking of a yellow cylinder by painting the cylinder crown green and printing the word "NITROX" parallel to the length of the cylinder in green print is acceptable.
  - d. Other markings which identify the cylinder as containing gas mixes other than air may be used at the approval of the DCB.
  - e. A contents label should be affixed, to include the current fO<sub>2</sub>, date of analysis, and MOD.
  - f. The cylinder should be labeled to indicate whether the cylinder is prepared for oxygen or nitrox mixtures containing greater than 40% oxygen.
4. **Regulators** - Regulators to be used with nitrox mixtures containing greater than 40% oxygen should be cleaned and maintained for oxygen service, and marked in an identifying manner.
5. **Other Support Equipment**
  - a. An oxygen analyzer is required which is capable of determining the oxygen content in the scuba cylinder. Two analyzers are recommended to reduce the likelihood of errors due to a faulty analyzer. The analyzer should be capable of reading a scale of 0 to 100% oxygen, within (one) 1% accuracy.
  - b. All diver and support equipment should be suitable for the fO<sub>2</sub> being used.
6. **Compressor and Fill Station**
  - a. **Compressor system**
    - i. The compressor/filtration system must produce oil-free air.
    - ii. An oil-lubricated compressor placed in service for a nitrox system should be checked for oil and hydrocarbon contamination at least quarterly.
  - b. **Fill Station Components** - All components of a nitrox fill station that will contact nitrox mixtures containing greater than 40% oxygen should be cleaned and maintained for oxygen service. This includes cylinders, whips, gauges, valves, and connecting lines.

VIII. **STAGED DECOMPRESSION DIVING** – Decompression diving shall be defined as any diving during which the diver cannot perform a direct return to the surface without performing a mandatory decompression stop to allow the release of inert gas from the diver’s body. The following procedures shall be observed when conducting dives requiring planned decompression stops.

**A. MINIMUM EXPERIENCE AND TRAINING REQUIREMENTS**

1. Pre-requisites:
  - a. Scientific Diver qualification according to Section III.
  - b. Minimum of 100 logged dives.
  - c. Demonstration of the ability to safely plan and conduct dives deeper than 100 feet.
  - d. Nitrox certification/authorization according to Section VII.
2. Training shall be appropriate for the conditions in which dive operations are to be conducted.
3. Minimum Training shall include the following:
  - a. 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.
  - b. 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.
  - c. At least 6 open – water training dives simulating/requiring decompression shall be conducted, emphasizing planning and execution of required decompression dives, and including practice of emergency procedures.
  - d. Progression to greater depths shall be by four dive increments at depth intervals as specified in Section III.D.
  - e. No training dives requiring decompression shall be conducted until the diver has demonstrated acceptable skills under simulated conditions.
  - f. The following are the minimum skills the diver must demonstrate proficiently during dives simulating and requiring decompression:
    - i. Buoyancy control
    - ii. Proper ascent rate
    - iii. Proper depth control
    - iv. Equipment manipulation
    - v. Stage/decompression bottle use as pertinent to planned diving operation
    - vi. Buddy skills
    - vii. Gas management
    - viii. Time management



- ix. Task loading
- x. Emergency skills
- g. Divers shall demonstrate to the satisfaction of the DSO or the DSO's designee proficiency in planning and executing required decompression dives appropriate to the conditions in which diving operations are to be conducted.
- h. Upon completion of training, the diver shall be authorized to conduct required decompression dives with DCB approval.

**B. MINIMUM EQUIPMENT REQUIREMENTS**

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

**C. MINIMUM OPERATIONAL REQUIREMENTS**

1. Approval of dive plan applications to conduct required decompression dives shall be on a case-by-case basis.
2. The maximum pO<sub>2</sub> to be used for planning required decompression dives is 1.6. It is recommended that a pO<sub>2</sub> of less than 1.6 be used during bottom exposure.
3. Divers gas supplies shall be adequate to meet planned operational requirements and foreseeable emergency situations.
4. Decompression dives may be planned using dive tables, dive computers, and/or PC software approved by the DSO/DCB.

5. Breathing gases used while performing in-water decompression shall contain the same or greater oxygen content as that used during the bottom phase of the dive.
6. The dive team prior to each dive shall review emergency procedures appropriate for the planned dive.
7. If breathing gas mixtures other than air are used for required decompression, their use shall be in accordance with those regulations set forth in the appropriate sections of this standard.
8. The maximum depth for required decompression using air as the bottom gas shall be 190 feet.
9. Use of additional nitrox and/or high-oxygen fraction decompression mixtures as travel and decompression gases to decrease decompression obligations is encouraged.
10. Use of alternate inert gas mixtures to limit narcosis is encouraged for depths greater than 150 feet.
11. If a period or more than 6 months has elapsed since the last mixed gas dive, a series of progressive workup dives to return the diver(s) proficiency status prior to the start of project diving operations are recommended.
12. Mission specific workup dives are recommended.

IX. **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.

**A. MINIMUM EXPERIENCE AND TRAINING REQUIREMENTS**

**1. Pre-requisites:**

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

**2. Classroom training including:**

- a. Review of topics and issues previously outlined in nitrox and required decompression diving training as pertinent to the planned operations.
- b. The use of helium or other inert gases, and the use of multiple decompression gases.
- c. Equipment configurations
- d. Mixed gas decompression planning
- e. Gas management planning
- f. Thermal considerations
- g. END determination
- h. Mission planning and logistics
- i. Emergency procedures
- j. Mixed gas production methods

- k. Methods of gas handling and cylinder filling
- l. Oxygen exposure management
- m. Gas analysis
- n. Mixed gas physics and physiology

**3. Practical Training:**

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

**B. EQUIPMENT AND GAS QUALITY REQUIREMENTS**

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

**C. MINIMUM OPERATIONAL REQUIREMENTS**

- 1. Approval of dive plan applications to conduct mixed gas dives shall be on a case-by-case basis.
- 2. All applicable operational requirements for nitrox and decompression diving shall be met.
- 3. The maximum pO<sub>2</sub> to be used for planning required decompression dives is 1.6. It is recommended that a pO<sub>2</sub> of less than 1.6 be used during bottom exposure.
- 4. Maximum planned Oxygen Toxicity Units (OTU) will be considered based on mission duration.
- 5. Divers decompressing on high-oxygen concentration mixtures shall closely monitor one another for signs of acute oxygen toxicity.
- 6. If a period of more than 6 months has elapsed since the last mixed gas dive, a series of progressive workup dives to return the diver(s) to proficiency status prior to the start of project diving operations are recommend.

X. **REBREATHERS** - This section defines specific considerations regarding the following issues for the use of rebreathers.

**A. MINIMUM EXPERIENCE AND TRAINING REQUIREMENTS**

1. Equipment requirements
2. Operational requirements and additional safety protocols to be used
3. Application of this standard is in addition to pertinent requirements of all other sections of the AAUS Standards for Scientific Diving, Volumes 1 and 2.
4. For rebreather dives that also involve staged decompression and/or mixed gas diving, all requirements for each of the relevant diving modes shall be met. Diving Control Board reserves the authority to review each application of all specialized diving modes, and include any further requirements deemed necessary beyond those listed here on a case-by-case basis.
5. No diver shall conduct planned operations using rebreathers without prior review and approval of the DCB.
6. In all cases, trainers shall be qualified for the type of instruction to be provided. Training shall be conducted by agencies or instructors approved by DSO and DCB.

**B. DEFINITIONS AND GENERAL INFORMATION:**

1. 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.
2. Advantages of rebreathers may include increased gas utilization efficiencies that are often independent of depth, extended no-decompression bottom times and greater decompression efficiency, and reduction or elimination of exhaust bubbles that may disturb aquatic life or sensitive environments.
3. Disadvantages of rebreathers include high cost and, in some cases, a high degree of system complexity and reliance on instrumentation for gas composition control and monitoring, which may fail. The diver is more likely to experience hazardous levels of hypoxia, hyperoxia, or hypercapnia, due to user error or equipment malfunction, conditions which may lead to underwater blackout and drowning. Inadvertent flooding of the breathing loop and wetting of the carbon dioxide absorbent may expose the diver to ingestion of an alkaline slurry ("caustic cocktail").
4. An increased level of discipline and attention to rebreather system status by the diver is required for safe operation, with a greater need for self-reliance. Rebreather system design and operation varies significantly between make and model. For these reasons when evaluating any dive plan incorporating rebreathers, risk-management emphasis should be placed on the individual qualifications of the diver on the specific rebreather make and model to be used, in addition to specific equipment requirements and associated operational protocols.
5. Oxygen Rebreathers. Oxygen rebreathers recycle breathing gas, consisting of pure oxygen, replenishing the oxygen metabolized by the diver. Oxygen rebreathers are generally the least complicated design, but are normally limited to a maximum operation depth of 20fsw due to the risk of unsafe hyperoxic exposure.
6. Semi-Closed Circuit Rebreathers. Semi-closed circuit rebreathers (SCR) recycle the majority of exhaled breathing gas, venting a portion into the water and replenishing it with a constant or variable amount of a single oxygen-enriched gas mixture. Gas addition and venting is balanced against diver metabolism to maintain safe oxygen levels by means which differ between SCR models, but the mechanism usually provides a semi-constant fraction of oxygen (FO<sub>2</sub>) in the breathing loop at all depths, similar to open-circuit SCUBA.

7. Closed-Circuit Mixed Gas Rebreathers. Closed-circuit mixed gas rebreathers (CCR) recycle all of the exhaled gas and replace metabolized oxygen via an electronically controlled valve, governed by electronic oxygen sensors. Manual oxygen addition is available as a diver override, in case of electronic system failure. A separate inert gas source (diluent), usually containing primarily air, heliox, or trimix, is used to maintain oxygen levels at safe levels when diving below 20fsw. CCR systems operate to maintain a constant oxygen partial pressure (PPO<sub>2</sub>) during the dive, regardless of depth.
- C. **PRE-REQUISITES** - Specific training requirements for use of each rebreather model shall be defined by DCB on a case-by-case basis. Training shall include factory-recommended requirements, but may exceed this to prepare for the type of mission intended (e.g., staged decompression or heliox/trimix CCR diving).
1. Training Pre-requisites
    - a. Active scientific diver status, with depth qualification sufficient for the type, make, and model of rebreather, and planned application.
    - b. Completion of a minimum of 50 open-water dives on SCUBA.
    - c. For SCR or CCR, a minimum 100-fsw-depth qualification is generally recommended, to ensure the diver is sufficiently conversant with the complications of deeper diving. If the sole expected application for use of rebreathers is shallower than this, a lesser depth qualification may be allowed with the approval of the DCB.
    - d. Nitrox training. Training in use of nitrox mixtures containing 25% to 40% oxygen is required. Training in use of mixtures containing 40% to 100% oxygen may be required, as needed for the planned application and rebreather system. Training may be provided as part of rebreather training.
  2. Training - Successful completion of the following training program qualifies the diver for rebreather diving using the system on which the diver was trained, in depths of 130fsw and shallower, for dives that do not require decompression stops, using nitrogen/oxygen breathing media.
  3. Satisfactory completion of a rebreather training program authorized or recommended by the manufacturer of the rebreather to be used, or other training approved by the DCB. Successful completion of training does not in itself authorize the diver to use rebreathers. The diver must demonstrate to the DCB or its designee that the diver possesses the proper attitude, judgment, and discipline to safely conduct rebreather diving in the context of planned operations.
  4. Classroom training shall include:
    - a. A review of those topics of diving physics and physiology, decompression management, and dive planning included in prior scientific diver, nitrox, staged decompression and/or mixed gas training, as they pertain to the safe operation of the selected rebreather system and planned diving application.
    - b. In particular, causes, signs and symptoms, first aid, treatment and prevention of the following must be covered:
      - i. Hyperoxia (CNS and Pulmonary Oxygen Toxicity)
      - ii. Middle Ear Oxygen Absorption Syndrome (oxygen ear)
      - iii. Hyperoxia-induced myopia
      - iv. Hypoxia
      - v. Hypercapnia
      - vi. Inert gas narcosis

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

5. Practical Training (with model of rebreather to be used)

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

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

Dives should not exceed 20 fsw.  
 \*\* First two dives should not exceed 60 fsw. Subsequent dives should be at progressively greater depths, with at least one dive in the 80 to 100 fsw range.  
 \*\*\* Total underwater time (pool and open water) of approximately 500 minutes. First two open water dives should not exceed 60 fsw. Subsequent dives should be at progressively greater depths, with at least 2 dives in the 100 to 130 fsw range.

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

6. Practical Evaluations - Upon completion of practical training, the diver must demonstrate to the DCB or its designee proficiency in pre-dive, dive, and post-dive operational procedures for the particular model of rebreather to be used. Skills shall include, at a minimum:
  - a. Oxygen control system calibration and operation checks
  - b. Carbon dioxide absorbent canister packing
  - c. Supply gas cylinder analysis and pressure check
  - d. Test of one-way valves
  - e. System assembly and breathing loop leak testing
  - f. Pre-dive breathing to test system operation
  - g. In-water leak checks
  - h. Buoyancy control during descent, bottom operations, and ascent
  - i. System monitoring and control during descent, bottom operations, and ascent
  - j. Proper interpretation and operation of system instrumentation (PO2 displays, dive computers, gas supply pressure gauges, alarms, etc. as applicable)
  - k. Unit removal and replacement on the surface.
  - l. Bailout and emergency procedures for self and buddy, including:
    - i. System malfunction recognition and solution
    - ii. Manual system control
    - iii. Flooded breathing loop recovery (if possible)
    - iv. Absorbent canister failure
    - v. Alternate bailout options
    - vi. Symptom recognition and emergency procedures for hyperoxia, hypoxia, and hypercapnia
    - vii. Proper system maintenance, including:
      - (a) Full breathing loop disassembly and cleaning (mouthpiece, check-valves, hoses, counterlung, absorbent canister, etc.)
      - (b) Oxygen sensor replacement (for SCR and CCR)
  - m. Other tasks required by specific rebreather models
7. Written Evaluation - A written evaluation approved by the DCB with a pre-determined passing score, covering concepts of both classroom and practical training, is required.
  - a. Supervised Rebreather Dives -, Upon successful completion of open water training dives, the diver is authorized to conduct a series of supervised rebreather dives, during which the diver gains additional experience and proficiency.
    - i. Supervisor for these dives should be the DSO or designee, and should be an active scientific diver experienced in diving with the make/model of rebreather being used.

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

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

Dives should not exceed 20 fsw.  
 \*\* First two dives should not exceed 60 fsw. Subsequent dives should be at progressively greater depths, with at least one dive in the 80 to 100 fsw range.  
 \*\*\* Total underwater time (pool and open water) of approximately 500 minutes. First two open water dives should not exceed 60 fsw. Subsequent dives should be at progressively greater depths, with at least 2 dives in the 100 to 130 fsw range.

- iii. Maximum ratio of divers per designated dive supervisor is 4:1. The supervisor may dive as part of the planned operations.
- b. Extended Range, Required Decompression and Helium-Based Inert Gas - Rebreather dives involving operational depths in excess of 130 fsw, requiring staged decompression, or using diluents containing inert gases other than nitrogen are subject to additional training requirements, as determined by DCB on a case-by-case basis. Prior experience with required decompression and mixed gas diving using open-circuit SCUBA is desirable, but is not sufficient for transfer to dives using rebreathers without additional training.
    - i. As a prerequisite for training in staged decompression using rebreathers, the diver shall have logged a minimum of 25 hours of underwater time on the rebreather system to be used, with at least 10 rebreather dives in the 100 fsw to 130 fsw range.
    - ii. As a prerequisite for training for use of rebreathers with gas mixtures containing inert gas other than nitrogen, the diver shall have logged a minimum of 50 hours of underwater time on the rebreather system to be used and shall have completed training in stage decompression methods using rebreathers. The diver shall have completed at least 12 dives requiring staged decompression on the rebreather model to be used, with at least 4 dives near 130 fsw.
    - iii. Training shall be in accordance with standards for required-decompression and mixed gas diving, as applicable to rebreather systems, starting at the 130 fsw level.
  - c. Maintenance of Proficiency
    - i. To maintain authorization to dive with rebreathers, an authorized diver shall make at least one dive using a rebreather every 8 weeks. For divers authorized for the conduct of extended range, stage decompression or mixed-gas diving, at least one dive per month should be made to a depth near 130 fsw, practicing decompression protocols.
    - ii. For a diver in arrears, the DCB shall approve a program of remedial knowledge and skill tune-up training and a course of dives required to return the diver to full authorization. The extent of this program should be directly related to the complexity of the planned rebreather diving operations.

**D. EQUIPMENT REQUIREMENTS**



1. General Requirements
2. Only those models of rebreathers specifically approved by DCB shall be used.
3. Rebreathers should be manufactured according to acceptable Quality Control/Quality Assurance protocols, as evidenced by compliance with the essential elements of ISO 9004. Manufacturers should be able to provide to the DCB supporting documentation to this effect.
4. Unit performance specifications should be within acceptable levels as defined by standards of a recognized authority (CE, US Navy, Royal Navy, NOAA, etc...).
5. Prior to approval, the manufacturer should supply the DCB with supporting documentation detailing the methods of specification determination by a recognized third-party testing agency, including unmanned and manned testing. Test data should be from a recognized, independent test facility.
6. The following documentation for each rebreather model to be used should be available as a set of manufacturer's specifications. These should include:
  - a. Operational depth range
  - b. Operational temperature range
  - c. Breathing gas mixtures that may be used
  - d. Maximum exercise level which can be supported as a function of breathing gas and depth
  - e. Breathing gas supply durations as a function of exercise level and depth
  - f. CO<sub>2</sub> absorbent durations, as a function of depth, exercise level, breathing gas, and water temperature
  - g. Method, range and precision of inspired PPO<sub>2</sub> control, as a function of depth, exercise level, breathing gas, and temperature
  - h. Likely failure modes and backup or redundant systems designed to protect the diver if such failures occur
  - i. Accuracy and precision of all readouts and sensors
  - j. Battery duration as a function of depth and temperature
  - k. Mean time between failures of each subsystem and method of determination
7. A complete instruction manual is required, fully describing the operation of all rebreather components and subsystems as well as maintenance procedures.
8. A maintenance log is required. The unit maintenance shall be up-to-date based upon manufacturer's recommendations.
9. Minimum Equipment
  - a. A surface/dive valve in the mouthpiece assembly, allowing sealing of the breathing loop from the external environment when not in use.
  - b. An automatic gas addition valve, so that manual volumetric compensation during descent is unnecessary.

- c. Manual gas addition valves, so that manual volumetric compensation during descent and manual oxygen addition at all times during the dive are possible.
  - d. The diver shall carry alternate life support capability (open-circuit bail-out or redundant rebreather) sufficient to allow the solution of minor problems and allow reliable access to a pre-planned alternate life support system.
10. Oxygen Rebreathers - Oxygen rebreathers shall be equipped with manual and automatic gas addition valves.
11. Semi-Closed Circuit Rebreathers. - SCR's shall be equipped with at least one manufacturer-approved oxygen sensor sufficient to warn the diver of impending hypoxia. Sensor redundancy is desirable, but not required.
12. Closed Circuit Mixed-gas Rebreathers.
- a. CCR shall incorporate a minimum of three independent oxygen sensors.
  - b. A minimum of two independent displays of oxygen sensor readings shall be available to the diver.
  - c. Two independent power supplies in the rebreather design are desirable. If only one is present, a secondary system to monitor oxygen levels without power from the primary battery must be incorporated.
  - d. CCR shall be equipped with manual diluent and oxygen addition valves, to enable the diver to maintain safe oxygen levels in the event of failure of the primary power supply or automatic gas addition systems.
  - e. Redundancies in onboard electronics, power supplies, and life support systems are highly desirable.

## **E. OPERATIONAL REQUIREMENTS**

1. General Requirements
- a. All dives involving rebreathers must comply with applicable operational requirements for open-circuit SCUBA dives to equivalent depths.
  - b. No rebreather system should be used in situations beyond the manufacturer's stated design limits (dive depth, duration, water temperature, etc).
  - c. Modifications to rebreather systems shall be in compliance with manufacturer's recommendations.
  - d. Rebreather maintenance is to be in compliance with manufacturer's recommendations including sanitizing, replacement of consumables (sensors, CO2 absorbent, gas, batteries, etc) and periodic maintenance.
  - e. Dive Plan. In addition to standard dive plan components stipulated in AAUS Section 2.0, all dive plans that include the use of rebreathers must include, at minimum, the following details:
    - i. Information about the specific rebreather model to be used
    - ii. Make, model, and type of rebreather system
    - iii. Type of CO2 absorbent material
    - iv. Composition and volume(s) of supply gases

- v. Complete description of alternate bailout procedures to be employed, including manual rebreather operation and open-circuit procedures
  - vi. Other specific details as requested by DCB
2. Buddy Qualifications.
- a. A diver whose buddy is diving with a rebreather shall be trained in basic rebreather operation, hazard identification, and assist/rescue procedures for a rebreather diver.
  - b. If the buddy of a rebreather diver is using open-circuit scuba, the rebreather diver must be equipped with a means to provide the open-circuit scuba diver with a sufficient supply of open-circuit breathing gas to allow both divers to return safely to the surface.
3. Oxygen Exposures
- a. Planned oxygen partial pressure in the breathing gas shall not exceed 1.4 atmospheres at depths greater than 30 feet.
  - b. Planned oxygen partial pressure set point for CCR shall not exceed 1.4 atm. Set point at depth should be reduced to manage oxygen toxicity according to the NOAA Oxygen Exposure Limits.
  - c. Oxygen exposures should not exceed the NOAA oxygen single and daily exposure limits. Both CNS and pulmonary (whole-body) oxygen exposure indices should be tracked for each diver.
4. Decompression Management
- a. DCB shall review and approve the method of decompression management selected for a given diving application and project.
  - b. Decompression management can be safely achieved by a variety of methods, depending on the type and model of rebreather to be used. Following is a general list of methods for different rebreather types:
    - i. Oxygen rebreathers: Not applicable.
    - ii. SCR (presumed constant FO<sub>2</sub>):
      - (a) Use of any method approved for open-circuit scuba diving breathing air, above the maximum operational depth of the supply gas.
      - (b) Use of open-circuit nitrox dive tables based upon expected inspired FO<sub>2</sub>. In this case, contingency air dive tables may be necessary for active-addition SCR's in the event that exertion level is higher than expected.
      - (c) Equivalent air depth correction to open-circuit air dive tables, based upon expected inspired FO<sub>2</sub> for planned exertion level, gas supply rate, and gas composition. In this case, contingency air dive tables may be necessary for active-addition SCR's in the event that exertion level is higher than expected.
  - c. CCR (constant PPO<sub>2</sub>):
    - i. Integrated constant PPO<sub>2</sub> dive computer.
    - ii. Non-integrated constant PPO<sub>2</sub> dive computer.
    - iii. Constant PPO<sub>2</sub> dive tables.

- iv. Open-circuit (constant FO<sub>2</sub>) nitrox dive computer, set to inspired FO<sub>2</sub> predicted using PPO<sub>2</sub> set point at the maximum planned dive depth.
  - v. Equivalent air depth (EAD) correction to standard open-circuit air dive tables, based on the inspired FO<sub>2</sub> predicted using the PPO<sub>2</sub> set point at the maximum planned dive depth.
  - vi. Air dive computer, or air dive tables used above the maximum operating depth (MOD) of air for the PPO<sub>2</sub> setpoint selected.
5. Maintenance Logs, CO<sub>2</sub> Scrubber Logs, Battery Logs, and Pre-And Post-Dive Checklists
- a. Logs and checklists will be developed for the rebreather used, and will be used before and after every dive. Diver shall indicate by initialing that checklists have been completed before and after each dive. Such documents shall be filed and maintained as permanent project records. No rebreather shall be dived which has failed any portion of the pre-dive check, or is found to not be operating in accordance with manufacturer's specifications. Pre-dive checks shall include:
    - i. Gas supply cylinders full
    - ii. Composition of all supply and bail-out gases analyzed and documented
    - iii. Oxygen sensors calibrated
    - iv. Carbon dioxide canister properly packed
    - v. Remaining duration of canister life verified
    - vi. Breathing loop assembled
    - vii. Positive and negative pressure leak checks
    - viii. Automatic volume addition system working
    - ix. Automatic oxygen addition systems working
    - x. Pre-breathe system for 3 minutes (5 minutes in cold water) to ensure proper oxygen addition and carbon dioxide removal (be alert for signs of hypoxia or hypercapnia)
    - xi. Other procedures specific to the model of rebreather used
    - xii. Documentation of ALL components assembled
    - xiii. Complete pre-dive system check performed
    - xiv. Final operational verification immediately before to entering the water:
      - (a) PO<sub>2</sub> in the rebreather is not hypoxic
      - (b) Oxygen addition system is functioning;
      - (c) Volumetric addition is functioning
      - (d) Bail-out life support is functioning
6. Alternate Life Support System - The diver shall have reliable access to an alternate life support system designed to safely return the diver to the surface at normal ascent rates, including any required decompression in the event of primary rebreather failure. The complexity and extent of such systems are

directly related to the depth/time profiles of the mission. Examples of such systems include, but are not limited to:

- a. Open-circuit bailout cylinders or sets of cylinders, either carried or pre-positioned
  - b. Redundant rebreather
  - c. Pre-positioned life support equipment with topside support
7. CO2 Absorbent Material
- a. CO2 absorption canister shall be filled in accordance with the manufacturer's specifications.
  - b. CO2 absorbent material shall be used in accordance with the manufacturer's specifications for expected duration.
  - c. If CO2 absorbent canister is not exhausted and storage between dives is planned, the canister should be removed from the unit and stored sealed and protected from ambient air, to ensure the absorbent retains its activity for subsequent dives.
  - d. Long-term storage of carbon dioxide absorbents shall be in a cool, dry location in a sealed container. Field storage must be adequate to maintain viability of material until use.
8. Consumables (e.g., batteries, oxygen sensors, etc.) - Other consumables (e.g., batteries, oxygen sensors, etc.) shall be maintained, tested, and replaced in accordance with the manufacturer's specifications.
9. Unit Disinfections - The entire breathing loop, including mouthpiece, hoses, counterlungs, and CO2 canister, should be disinfected periodically according to manufacturer's specifications. The loop must be disinfected between each use of the same rebreather by different divers.

#### **F. OXYGEN REBREATHERS**

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

#### **G. SEMI-CLOSED RECIRCUIT REBREATHERS**

1. The composition of the injection gas supply of a semi-closed rebreather shall be chosen such that the partial pressure of oxygen in the breathing loop will not drop below 0.2 atm, even at maximum exertion at the surface.
2. The gas addition rate of active addition SCR (e.g., Draeger Dolphin and similar units) shall be checked before every dive, to ensure it is balanced against expected workload and supply gas FO2.
3. The intermediate pressure of supply gas delivery in active-addition SCR shall be checked periodically, in compliance with manufacturer's recommendations.
4. Maximum operating depth shall be based upon the FO2 in the active supply cylinder.

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

#### H. CLOSED-CIRCUIT REBREATHERS

1. The FO<sub>2</sub> of each diluent gas supply used shall be chosen so that, if breathed directly while in the depth range for which its use is intended, it will produce an inspired PPO<sub>2</sub> greater than 0.20 atm but no greater than 1.4 atm.
2. Maximum operating depth shall be based on the FO<sub>2</sub> of the diluent in use during each phase of the dive, so as not to exceed a PO<sub>2</sub> limit of 1.4 atm.
3. Divers shall monitor both primary and secondary oxygen display systems at regular intervals throughout the dive, to verify that readings are within limits, that redundant displays are providing similar values, and whether readings are dynamic or static (as an indicator of sensor failure).
4. The PPO<sub>2</sub> set point shall not be lower than 0.4 atm or higher than 1.4 atm.

XI. **OTHER DIVING TECHNOLOGY** - The AAUS has developed Standards for Aquarium Diving Operations, and Rebreathers (See AAUS Standards, 2006 at [www.aaus.org](http://www.aaus.org).) These types of diving and the types listed below, require equipment or procedures which require special training and are beyond the scope of UNC/CH IMS at this time. Supplementary guidelines for the types of technologies below are in development by the AAUS. Organizational member's using these, must have guidelines established by their Diving Control Board. Divers shall comply with all scuba diving procedures in this standard unless specified.

- A. **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).
- B. **ICE AND POLAR DIVING** – Divers planning to dive under ice or in polar conditions should use the following: "Guidelines for Conduct of Research Diving", National Science Foundation, division of Polar Programs, 1990.
- C. **OVERHEAD ENVIRONMENTS** – Where an enclosed or confined space is not large enough for two divers, a diver shall be stationed at the underwater point of entry and an orientation line shall be used.
- D. **SATURATION DIVING** - If using open circuit compressed air scuba in saturation diving operations, divers shall comply with the saturation diving guidelines of the organizational member in charge of the diving operation.
- E. **HOOKAH** – Hookah dives shall not be planned or conducted without prior approval from the UNC/CH IMS Diving Control Board. 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. Hookah dives shall not be planned or conducted without prior approval from the UNC/CH IMS Diving Control Board.
- F. **SURFACE SUPPLIED DIVING** – Surface supplied dives shall not be planned or conducted without prior approval from the UNC/CH IMS Diving Control Board. Surface Supplied: Dives where the breathing gas is supplied from the surface by means of a pressurized umbilical hose. The umbilical generally consists of a gas supply hose, strength member, pneumofathometer hose, and communication line. The umbilical supplies a helmet or full – face mask. The diver may rely on the tender at the surface to keep up with the divers' depth time and diving profile. Surface supplied dives shall not be planned or conducted without prior approval from the UNC/CH IMS Diving Control Board.

## APPENDIX 1

### DIVING MEDICAL EXAM OVERVIEW FOR THE EXAMINING PHYSICIAN

TO THE EXAMINING PHYSICIAN:

This person, \_\_\_\_\_, requires a medical examination to assess his/her fitness for certification as a Scientific Diver for the UNC/CH Institute of Marine Sciences. 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 at Divers Alert Network (DAN) America Information Line (919-684-2948) 9a.m. – 5p.m. Eastern Time USA. Please contact me if you have any questions or concerns about the diving physical requirements. Thank you for your assistance.

Glenn W. Safrit Jr \_\_\_\_\_ Phone 252-726-6841  
Diving Safety Officer                      Date

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 which usually restrict candidates from diving.

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

#### CONDITIONS WHICH MAY DISQUALIFY CANDIDATES FROM DIVING

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

### SELECTED REFERENCES IN DIVING MEDICINE

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

Elliott, D.H. ed. 1996. *Are Asthmatics Fit to Dive?* Kensington, MD: Undersea and Hyperbaric Medical Society.

Bove, A.A. 2011. The cardiovascular system and diving risk. *Undersea and Hyperbaric Medicine* 38(4): 261-269.

Thompson, P.D. 2011. The cardiovascular risks of diving. *Undersea and Hyperbaric Medicine* 38(4): 271-277.

Douglas, P.S. 2011. Cardiovascular screening in asymptomatic adults: Lessons for the diving world. *Undersea and Hyperbaric Medicine* 38(4): 279-287.

Mitchell, S.J., and A.A. Bove. 2011. Medical screening of recreational divers for cardiovascular disease: Consensus discussion at the Divers Alert Network Fatality Workshop. *Undersea and Hyperbaric Medicine* 38(4): 289-296.

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

Bove, A.A. and Davis, J. 2003. DIVING MEDICINE, Fourth Edition. Philadelphia: W.B. Saunders Company.

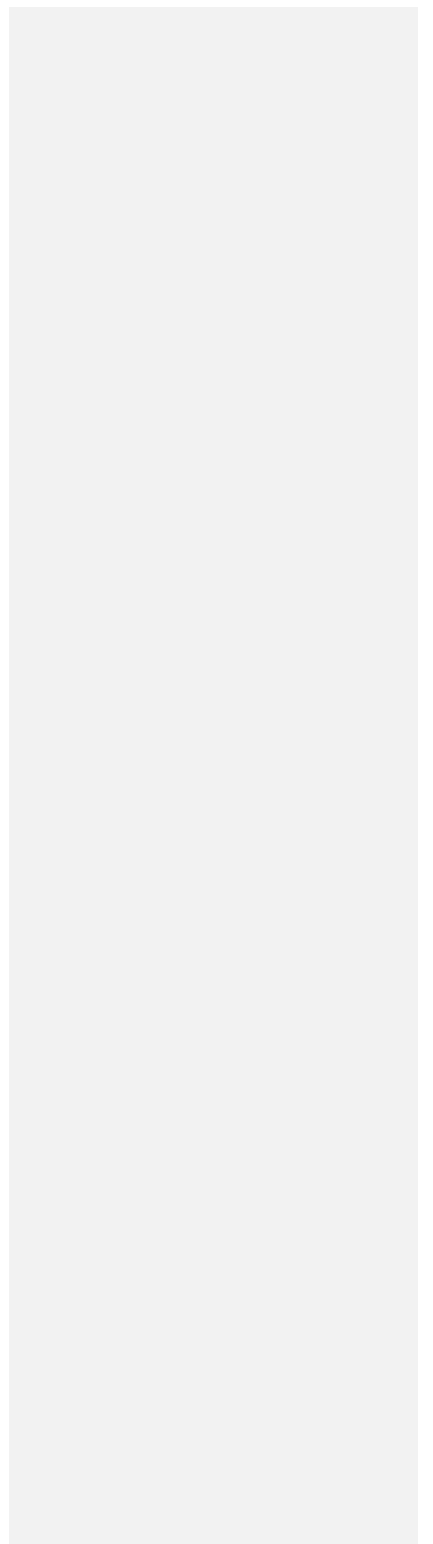
Edmonds, C., Lowry, C., Pennefather, J. and Walker, R. 2002. DIVING AND SUBAQUATIC MEDICINE, Fourth Edition. London: Hodder Arnold Publishers.

Bove, A.A. ed. 1998. MEDICAL EXAMINATION OF SPORT SCUBA DIVERS, San Antonio, TX: Medical Seminars, Inc.

NOAA DIVING MANUAL, NOAA. Superintendent of Documents. Washington, DC: U.S. Government Printing Office.

U.S. NAVY DIVING MANUAL. Superintendent of Documents, Washington, DC: U.S. Government Printing Office, Washington, D.C.





**APPENDIX 2  
AAUS MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING REPORT**

\_\_\_\_\_  
Name of Applicant (Print or Type)

\_\_\_\_\_  
Date of Medical Evaluation (Month/Day/Year)

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

**TESTS: THE FOLLOWING TESTS ARE REQUIRED:**

**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<sup>1</sup> (age, lipid profile, blood pressure, diabetic screening, smoking)  
Note: Exercise stress testing may be indicated based on Multiple-Risk-Factor Assessment<sup>2</sup>

**PHYSICIAN'S STATEMENT:**

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

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

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

\_\_\_\_\_ MD or DO \_\_\_\_\_

Signature .....

.....

.....

Date

\_\_\_\_\_  
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: \_\_\_\_\_

Remarks: \_\_\_\_\_  
\_\_\_\_\_

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**APPENDIX 2b**  
**AAUS 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 \_\_\_\_\_

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**REFERENCES**

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

**APPENDIX 3  
DIVING MEDICAL HISTORY FORM**

(To Be Completed By Applicant-Diver)

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

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

**TO THE APPLICANT:**

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

This form shall 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 shall 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.

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

	Yes	No	Please indicate whether or not the following apply to you	Comments
18			Wear glasses or contact lenses	
19			Bleeding disorders	
20			Alcoholism	
21			Any problems related to diving	
22			Nervous tension or emotional problems	
23			Take tranquilizers	
24			Perforated ear drums	
25			Hay fever	
26			Frequent sinus trouble, frequent drainage from the nose, post-nasal drip, or stuffy nose	
27			Frequent earaches	
28			Drainage from the ears	
29			Difficulty with your ears in airplanes or on mountains	
30			Ear surgery	
31			Ringing in your ears	
32			Frequent dizzy spells	
33			Hearing problems	
34			Trouble equalizing pressure in your ears	
35			Asthma	
36			Wheezing attacks	
37			Cough (chronic or recurrent)	
38			Frequently raise sputum	
39			Pleurisy	
40			Collapsed lung (pneumothorax)	
41			Lung cysts	
42			Pneumonia	
43			Tuberculosis	

	Yes	No	Please indicate whether or not the following apply to you	Comments
44			Shortness of breath	
45			Lung problem or abnormality	
46			Spit blood	
47			Breathing difficulty after eating particular foods, after exposure to particular pollens or animals	
48			Are you subject to bronchitis	
49			Subcutaneous emphysema (air under the skin)	
50			Air embolism after diving	
51			Decompression sickness	
52			Rheumatic fever	
53			Scarlet fever	
54			Heart murmur	
55			Large heart	
56			High blood pressure	
57			Angina (heart pains or pressure in the chest)	
58			Heart attack	
59			Low blood pressure	
60			Recurrent or persistent swelling of the legs	
61			Pounding, rapid heartbeat or palpitations	
62			Easily fatigued or short of breath	
63			Abnormal EKG	
64			Joint problems, dislocations or arthritis	
65			Back trouble or back injuries	
66			Ruptured or slipped disk	
67			Limiting physical handicaps	
68			Muscle cramps	
69			Varicose veins	

	Yes	No	Please indicate whether or not the following apply to you	Comments
70			Amputations	
71			Head injury causing unconsciousness	
72			Paralysis	
73			Have you ever had an adverse reaction to medication?	
74			Do you smoke?	
75			Have you ever had any other medical problems not listed? If so, please list or describe below;	
76			Is there a family history of high cholesterol?	
77			Is there a family history of heart disease or stroke?	
78			Is there a family history of diabetes?	
79			Is there a family history of asthma?	
80			Date of last tetanus shot? Vaccination dates?	

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

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

Signature

Date

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

List of local Medical Doctors that have training and expertise in diving or undersea medicine. Level I graduates of the Undersea Hyperbaric and Medical Society (UHMS) Fitness to Dive courses (approximately 250 physicians) are listed at <http://membership.uhms.org/?page=DivingMedical> (UHMS website, go to Resources, go to Library, go to Diving Medical Examiners)

1. Name: Dr. Jeff Anderson  
Address: Beachcare Urgent Care  
Telephone: 252-808-3696
  
2. Name: \_\_\_\_\_  
Address: \_\_\_\_\_  
Telephone: \_\_\_\_\_
  
3. Name: \_\_\_\_\_  
Address: \_\_\_\_\_  
Telephone: \_\_\_\_\_
  
4. Name: \_\_\_\_\_  
Address: \_\_\_\_\_  
Telephone: \_\_\_\_\_
  
5. Name: \_\_\_\_\_  
Address: \_\_\_\_\_  
Telephone: \_\_\_\_\_



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

**ATA(s)** - "Atmospheres Absolute", defines as the total pressure exerted on an object, by a gas or mixture of gases, at a specific depth or elevation, including normal atmospheric pressure.

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

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

**Buddy Diver** - Second member of the dive team.

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

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

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

**Certified Diver** - A diver who holds a recognized valid certificate from a member organization or internationally recognized certifying agency.

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

**Cylinder** - A pressure vessel for the storage of gases.

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

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

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

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

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

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

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

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

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

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

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

**Diving Control Board (DCB)** – The group of individuals who act as the official representative of the membership organization in matters concerning the scientific diving program (Section I.C.)

**Diving Safety Officer (DSO)** – The individual responsible for the safe conduct of the scientific diving program, of the membership organization (see section I.D..)

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

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

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

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

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

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

**FFW** - Feet of freshwater, or equivalent static head.

**FSW** - Feet of seawater, or equivalent static head.

**Hookah Diving** – 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 of his/her own depth, time and diving profile.

**Hyperbaric Chamber** - See decompression chamber.

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

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

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

**MG** – Mixed Gas

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

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

**MSW** - Meters of seawater or equivalent static head.

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

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

**No-Decompression Limits** - The depth-time limits of the "no-decompression limits and repetitive dive group designations table for no-decompression air dives" of the U.S. Navy Diving Manual or equivalent limits.

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

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

**Oxygen Clean** - All combustible contaminants have been removed.

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

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

**Oxygen Toxicity Unit - OTU**

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

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

**Pressure Vessel** - See cylinder.

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

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

**psi** - Unit of pressure, "pounds per square inch."

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

**Recompression Chamber** - See decompression chamber.

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

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

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

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

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

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

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

APPENDIX 6

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 the UNC/CH Institute of Marine Sciences Diving Safety Manual, and has demonstrated competency in the indicated areas. UNC/CH IMS 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) \_\_\_\_\_      O2 Exp. \_\_\_\_\_

\_\_\_\_\_  
First aid for diving \_\_\_\_\_      F.A. Exp. \_\_\_\_\_

\_\_\_\_\_  
Date of last dive \_\_\_\_\_      Depth \_\_\_\_\_

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

Total number of career dives? \_\_\_\_\_

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

Please indicate any pertinent specialty certifications or training:

Emergency Information:

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

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

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

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

Diving Safety Officer:

\_\_\_\_\_  
(Signature)      \_\_\_\_\_  
(Date)

\_\_\_\_\_  
(Print)

**APPENDIX 7  
UNC/CH IMS DIVING SAFETY PROGRAM APPLICATION**

Name \_\_\_\_\_  
Address \_\_\_\_\_  
Telephone H( ) - W( ) - E-mail address \_\_\_\_\_  
Dept. \_\_\_\_\_ Classification: Fr. So. Jr. Sr. Grad. Faculty Staff Visiting Scientist

DIVING EXPERIENCE

Agency / Institution	Date of Certification	Certified Depth
_____	_____	_____
_____	_____	_____
_____	_____	_____

Total Number of Dives

0--30' \_\_\_\_ 31' --60' \_\_\_\_ 61'--100' \_\_\_\_ 101' --130' \_\_\_\_ 130' + \_\_\_\_

Date of Last Dive \_\_\_\_\_ Depth \_\_\_\_ Dive time \_\_\_\_\_

List Diving Activities during the past 12 months:

List any other training/experience related to diving safety:

I will be involved in:

- \_\_\_ Course work at UNC/CH IMS: Department / Program \_\_\_\_\_
- \_\_\_ A Research Project at IMS: Dates \_\_\_\_\_ Scientific Supervisor \_\_\_\_\_
- \_\_\_ Other: (please specify) \_\_\_\_\_

CPR. Date certified /agency \_\_\_\_\_ First Aid. Date certified /agency \_\_\_\_\_  
Emergency Oxygen. Date certified /agency \_\_\_\_\_

I certify that the above information is correct and that I am in good health. I have read and agree to follow the regulations of the Institute Of Marine Sciences, The University Of North Carolina At Chapel Hill Standards Manual for Scientific Diving, and abide by whatever limitation or restriction may be imposed by the Diving Officer or Diving Control Board. I agree to assume all risks involved with participation in the program and hereby release The University of North Carolina At Chapel Hill Institute of Marine Sciences, the Director of the Marine Laboratory, the Marine Laboratory Diving Safety Officer, and the Diving Control Board, from any liability for any injury or illness, including death, due to my participation in this program.

\_\_\_\_\_  
(Signature of Applicant) (Date)

APPENDIX - 8

THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL  
INSTITUTE OF MARINE SCIENCES

WAIVER, RELEASE, AND INDEMNITY AGREEMENT

I am fully aware of the risks and hazards associated with participation in marine science activities in laboratories, fieldwork, boats and vessels, wading, diving and the like. I hereby elect voluntarily to participate in said activities and fully acknowledge that they may be hazardous to me and my property. I acknowledge that by signing this document I hereby release, hold harmless, and forever discharge The University of North Carolina at Chapel Hill, its employees and agents, from any and all liability, claims, demands, actions, and causes of actions whatsoever arising out of or related to any loss, property damage, or personal injury, including death, that may be sustained by me or to any property belonging to me while participating in marine science activities.

I voluntarily assume full responsibility for any risk of loss, property damage, or any personal injury, including death, that may be sustained by me or any loss or damage to property owned by me as a result of being engaged in such activities. I further agree to indemnify and hold harmless the University, its employees and agents, from any loss, liability, damage, or cost, including court costs and attorneys' fees that they might incur due to my participation in said activities.

This release and hold harmless agreement is binding on myself, my heirs, assigns, and personal representatives. I acknowledge that I am 18 years old or more.

This is the \_\_\_\_ day of \_\_\_\_ 20\_\_\_\_.

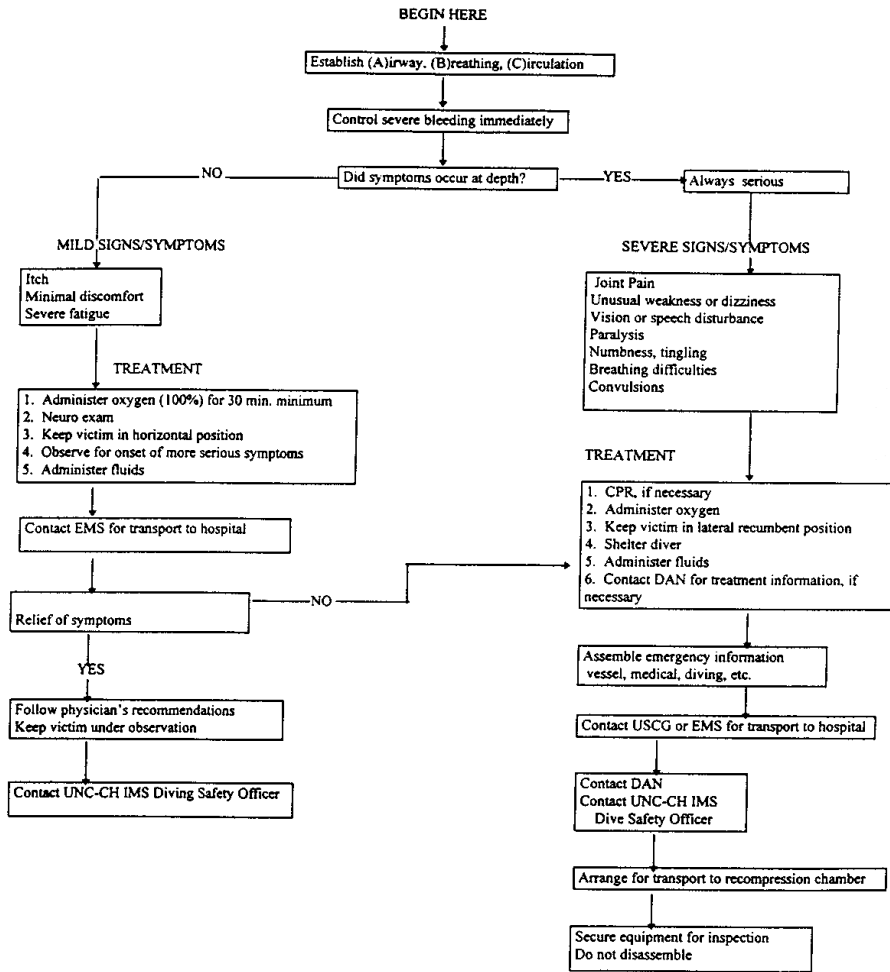
\_\_\_\_\_  
Participant

\_\_\_\_\_  
Date

\_\_\_\_\_  
Witness

\_\_\_\_\_  
Date

UNC-CH IMS DIVING ACCIDENT FLOW CHART





**APPENDIX 10**  
**EMERGENCY PROCEDURES FOR DIVING ACCIDENTS**  
(Decompression Sickness, Air Embolism)

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

- A. Make appropriate contact with victim or rescue as required.
  - B. Establish (A)irway, (B)reathing, (C)irculation as required
  - C. Administer 100% oxygen.
  - D. Contact local Emergency Medical System (EMS) for transport to medical facility.
  - E. 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.
- II. See DIVING ACCIDENT MANAGEMENT FLOW CHART (APPENDIX-9)
- III. If a life threatening situation exists:
- A. At sea, call the Coast Guard on channel 16, VHF radio or cell phone, Coast Guard Search and Rescue SAR **(252)-247-4570**. Before calling USCG, have the required emergency information available (See APPENDIX-11). Marine Corps Search and Rescue (Pedro) can be activated by the Coast Guard or you can call them direct at **(252)-466-5745**. If medical assistance is needed to treat the injury call **Divers Alert Network (DAN)+1- 919-684-9111 collect** and physician on duty will tell you steps to follow.
  - B. If boat diving in inland waters or within three miles of shore, decide if you will be transporting injured diver to the dock (Call **911 for Emergency Medical Services**) or if Coast Guard assistance is needed, the Fort Macon Coast Guard Search and Rescue number is **(252)-247-4570**, you can ask the CG to call EMS to meet you at the boat ramp or dock :
    1. State nature of problem.
    2. Give condition of injured diver and location of boat ramp or dock you will arrive at, if you transport the injured diver to shore.
    3. Request rescue vehicle (**Dial 911**) be at dock for transport of injured diver to hospital.
    4. After injured diver is taken to hospital, if medical personnel have problems with diagnosis, they can call **Divers Alert Network (DAN) +1-919-684-9111**
- IV. Notify UNC IMS Diving Safety Officer: Work (252) -726-6841, Home (252) -726-1775.
- V. Store injured divers gear as is without modification.
- VI. If necessary a diver can be transported by air or ambulance to Duke University, home of DAN, the nearest recompression chamber. Dr. Jeff Anderson of Beachcare Urgent Care (252) 808 -3696 has an operational chamber.
- VII. Complete and submit Incident Report Form to the DCB of IMS.

**APPENDIX 11**

**EMERGENCY INFORMATION REQUIREMENTS (1 of 2)**

The following information should be available BEFORE calling USCG for assistance:

**VESSEL INFORMATION**

Name of vessel \_\_\_\_\_ Radio call sign \_\_\_\_\_

Description of vessel \_\_\_\_\_

Position (LL or TDS) \_\_\_\_\_

Type of distress and assistance requested \_\_\_\_\_

**MEDICAL INFORMATION**

Patient's Name \_\_\_\_\_ Age \_\_\_\_\_ Sex \_\_\_\_\_

**Describe symptoms in detail:**

What \_\_\_\_\_

Where \_\_\_\_\_

Intensity \_\_\_\_\_

**First Aid Given:**

Oxygen (time on/off,%) \_\_\_\_\_

Record time and volume of liquid intake + output \_\_\_\_\_

Vital Signs: Conscious \_\_\_\_\_ Breathing \_\_\_\_\_ Pulse \_\_\_\_\_

First Aid Given \_\_\_\_\_

Further Treatment Advised \_\_\_\_\_

**DIVING INFORMATION**

Name of buddy diver \_\_\_\_\_

Details of Dive: Depth \_\_\_\_\_ Bottom Time \_\_\_\_\_

Breathing gas (air, nitrox, mix) \_\_\_\_\_

If repetitive dives were made give: Depths \_\_\_\_\_ Bottom times \_\_\_\_\_

and Surface Intervals \_\_\_\_\_

Decompression table or dive computer used \_\_\_\_\_

Time of dive and time of occurrence of symptoms? \_\_\_\_\_

Does buddy exhibit symptoms? \_\_\_\_\_

**EMERGENCY MEDICAL TELEPHONE NUMBERS (05/06/11)**

DIVERS ALERT NETWORK HOTLINE (DAN) .....  
+1-(919)-684-9111 (Call collect)

For diving questions that are of a **non-Emergency** nature ..... +1-(919)-684-2948

**EMERGENCY MEDICAL SERVICES**

Rescue Squad ..... 911

**HOSPITALS**

**North Carolina**

Carteret General Emergency Room (Morehead City) ..... (252)-808-6133

Craven Regional Medical Center (New Bern) ..... (252)-633-8104

**Florida Keys**

Lower Florida Keys Medical Center ..... (305)-294-5531

Fisherman's Hospital (Marathon) Emergency room ..... (305)-743-5533

**EMERGENCY EVACUATION**

U.S. Coast Guard for entire North Carolina Coast Non-emergency ..... (252)-247-4598

U.S. Coast Guard for entire North Carolina Coast **EMERGENCY** ..... (252)-247-4570

U.S. Marine Corps Search & Rescue (SAR) ..... (252)-466-5745

Radio ..... 2182

Radio VHF ..... Channel 16

**DIVING PHYSICIANS**

Dr. Jeff Anderson ..... (252)-808-3696

**UNC-CH IMS DIVE PERSONNEL**

Diving Safety Officer ..... Glenn Safrit ..... IMS (252)-726-6841 ... Home (252)-726-1775

**APPENDIX 12**  
**DIVE COMPUTER GUIDELINES**

1. Only those makes and models of dive computers specifically approved by the Diving Control Board may be used.
2. Any diver desiring the approval to use a dive computer as a means of determining decompression status must apply to the Diving Control Board, complete an appropriate practical training session and pass a written examination.
3. Each diver relying on a dive computer to plan dives and indicate or determine decompression status must have their own unit.
4. On any given dive, both divers in the buddy pair must follow the most conservative dive computer.
5. If the dive computer fails at any time during the dive, the dive must be terminated and appropriate surfacing procedures should be initiated immediately.
6. A diver should not dive for 18 hours before activating a dive computer to use it to control their diving.
7. Once the dive computer is in use, it must not be switched off until it indicates complete out gassing has occurred or 18 hours have elapsed, whichever comes first.
8. When using a dive computer, non emergency ascents are to be at a rate specified for the make and model of dive computer being used.
9. Whenever practical, divers using a dive computer should make a stop between 10 and 30 feet for 5 minutes, especially for dives below 60 fsw.
10. Multiple deep dives require special consideration.

## **APPENDIX 13**

Reverse Dive Profiles Workshop  
Michael A. Lang and Charles E. Lehner  
Co-Chairs  
Smithsonian Institution  
October 29 - 30, 1999

Co-Sponsors:  
Smithsonian Institution  
Divers Alert Network  
American Academy of Underwater Sciences  
Diving Equipment and Marketing Association  
Dive Training Magazine

### **Workshop Findings**

Historically neither the U.S. Navy nor the commercial sector have prohibited reverse dive profiles

Reverse dive profiles are being performed in recreational, scientific, commercial, and military diving

The prohibition of reverse dive profiles by recreational training organizations cannot be traced to any definite diving experience that indicates an increased risk of DCS

No convincing evidence was presented that reverse dive profiles within the no-decompression limits lead to a measurable increase in the risk of DCS

### **Workshop Conclusion**

We find no reason for the diving communities to prohibit reverse dive profiles for no-decompression dives less than 40 msw (130 fsw) and depth differentials less than 12 msw (40 fsw).

**APPENDIX 14**  
**AAUS 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 into water, an underwater diving activity utilizing compressed gas, an ascent/return to the surface, and a surface interval of greater than 10 minutes.

Dives will not be differentiated as openwater or confined water dives. But openwater and confined water dives will be logged and submitted for 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 divers home organization. Only a diver who has actually logged a dive during the reporting period is counted under this category.

Incident(s) occurring during the collection cycle. Only incidents occurring during, or resulting from, a dive where the diver is breathing a compressed gas will be submitted to 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 other than air.
- Mixed Gas: Dives where the bottom gas used for the dive is a combination of oxygen, nitrogen, and helium (or other "exotic" 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 keep up with 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 the monitoring his/her own depth, time, and diving profile.
- **Rebreathers:** Dives where the breathing gas is repeatedly recycled in the 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, and 191->. Depths are in feet seawater. 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 requiring the use of multiple-tethered 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 shall 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.