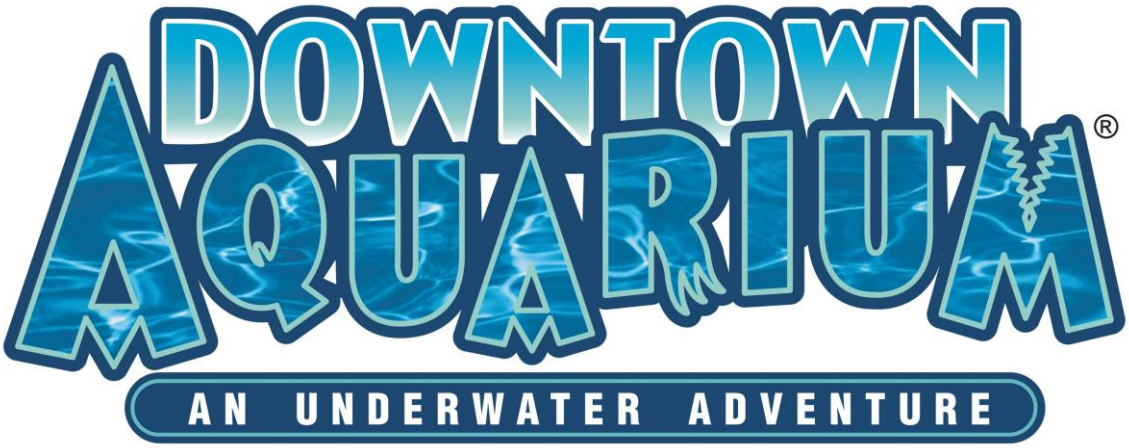

Scientific Diving Safety Manual

Denver, Colorado
Houston, Texas

Rev 7/16

CONTENTS

Revision History:
9/2012- Todd Hall
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Volume 1

Sections 1.00 through 6.00
Required For All Organizational Members

Section 1.00
Scientific Diving Standards

1.10 Purpose

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

This 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.

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.

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

Scientific Diving Definition

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

Scientific Diving Exemption

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

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

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

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

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

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

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

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

Classification of Diving Operation and Standards

All diving under the auspices of The Downtown Aquarium (DTAQ) for purposes other than scientific diving will be conducted under the accepted standards that are most applicable to the particular diving operation. The Downtown Aquarium Dive Control Board will have autonomous and absolute authority over deciding what classification a particular dive should be characterized as. The Dive Safety Officer or appointed qualified designee will be responsible for implementing and ensuring all applicable safety procedures and standards are being followed at all times regardless of the classification of a dive operation.

Review of Standards

As part of The Downtown Aquarium's annual report, any recommendations for modifications of these standards shall be submitted to the AAUS for consideration.

1.20 Operational Control

The Downtown Aquarium Auspices Defined

For the purposes of these standards the auspices of The Downtown Aquarium includes any scientific diving operation in which DTAQ is connected because of ownership of any equipment used, locations selected, or relationship with the individual(s) concerned. This includes all cases involving the operations of employees of The Downtown Aquarium or employees of auxiliary organizations, where such employees are acting within the scope of their employment, and the operations of other persons who are engaged in scientific diving with DTAQ or are diving as members of an organization recognized by DTAQ.

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

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

The Downtown Aquarium's Scientific Diving Standards and Safety Manual

The Downtown Aquarium develops and maintains this scientific diving safety manual that provides for the development and implementation of policies and procedures that will enable DTAQ to meet requirements of local environments and conditions as well as to comply with the AAUS scientific diving standards. The Downtown Aquarium's scientific diving manual includes, but is not limited to:

a) AAUS standards may be used as a set of minimal guidelines for the development of The Downtown Aquarium's scientific diving safety manual. Volume 1, Sections 1.00 through 6.00 and the Appendices are required for all manuals. Volume 2, Sections 7.00 through 9.00 are required only when the DTAQ conducts that diving activity. The Downtown Aquarium specific sections are placed in Volume 2.

b) Emergency evacuation and medical treatment procedures.

c) Criteria for diver training and certification.

d) Standards written or adopted by reference for each diving mode utilized which include the following:

1. Safety procedures for the diving operation.
2. Responsibilities of the dive team members.
3. Equipment use and maintenance procedures.
4. Emergency procedures.

Diving Safety Officer

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

a) Qualifications

1. Shall be appointed by the Director of Biology or designee, with the advice and counsel of the Diving Control Board.

2. Shall be trained as a scientific diver.

3. Shall be a full member as defined by AAUS.

4. Shall be an active underwater instructor from an internationally recognized certifying agency.

b) Duties and Responsibilities

1. Shall be an employee of the Downtown Aquarium and responsible, through the DCB, to the Director of Biology or designee, for the conduct of the scientific diving program of The Downtown Aquarium. The routine operational authority for this program, including the conduct of training and certification, approval of dive plans, maintenance of diving records, and ensuring compliance with this standard and all relevant regulations of The Downtown Aquarium, rests with the Diving Safety Officer.

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

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

4. Shall suspend diving operations considered to be unsafe or unwise.

c) The DTAQ Director of Biology, or designee may appoint a Corporate or Senior Dive Officer (SDO) to oversee dive operations at all locations to ensure consistency and compliance with the DTAQ dive safety manual and all other policies and procedures for dive operations. The SDO must be qualified as a DSO by AAUS standards.

Diving Control Board

a) The Diving Control Board (DCB) shall consist of a majority of active scientific divers. Voting members shall include the Diving Safety Officer(s), the Director of Biology, or designee, and should include other representatives of the diving program such as qualified divers and members selected by procedures established by The Downtown Aquarium. A chairperson and a secretary may be chosen from the membership of the board according to local procedure.

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

c) Shall approve and monitor diving projects.

d) Shall review and revise the diving safety manual.

e) Shall assure compliance with the diving safety manual.

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

g) Shall take disciplinary action for unsafe practices.

h) Shall assure adherence to the buddy system for scuba diving.

i) Shall act as the official representative of The Downtown Aquarium in matters concerning the scientific diving program.

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

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

l) Shall recommend changes in policy and amendments to AAUS and the membership organization's diving safety manual as the need arises.

m) Shall establish and/or approve training programs through which the applicants for certification can satisfy the requirements of The Downtown Aquarium's diving safety manual.

n) Shall suspend diving programs that are considered to be unsafe or unwise.

o) Shall establish criteria for equipment selection and use.

p) Shall recommend new equipment or techniques.

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

r) Shall ensure that The Downtown Aquarium's air station(s) meet air quality standards as described in Section 3.60.

s) Shall periodically review the Diving Safety Officer's performance and program.

t) Shall sit as a board of investigation to inquire into the nature and cause of diving accidents or violations of The Downtown Aquarium's diving safety manual.

Instructional Personnel

Qualifications - All personnel involved in diving instruction under the auspices of The Downtown Aquarium shall be qualified for the type of instruction being given.

Selection - Instructional personnel will be selected by the DSO, or designee, who will solicit the advice of the DCB in conducting preliminary screening of applicants for instructional positions.

Lead Diver

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

a) Coordination with other known activities in the vicinity that are likely to interfere with diving operations.

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

c) Planning dives in accordance with Section 2.20

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

e) Briefing dive team members on:

1. Dive objectives.
2. Unusual hazards or environmental conditions likely to affect the safety of the diving operation.
3. Modifications to diving or emergency procedures necessitated by the specific diving operation.
4. Suspending diving operations if in their opinion conditions are not safe.
5. Reporting to the DSO and DCB any physical problems or adverse physiological effects including symptoms of pressure-related injuries.

Reciprocity and Visiting Scientific Diver

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

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

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

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

Waiver of Requirements

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

1.30 Consequence of Violation of Regulations by Scientific Divers

Failure to comply with the regulations of The Downtown Aquarium‘s diving safety manual may be cause for the revocation or restriction of the diver’s scientific diving certificate by action of DTAQ’s Control Board.

1.40 Consequences of Violation of Regulations by Organizational Members

Failure to comply with the regulations of this standard may be cause for the revocation or restriction of The Downtown Aquarium‘s recognition by AAUS.

1.50 Record Maintenance

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

Availability of Records:

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

Records and documents required by this 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) Diving safety manual - 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.

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

2.10 Introduction

No person shall engage in scientific diving operations under the auspices of The Downtown Aquarium's scientific diving program unless they hold a current certification issued pursuant to the provisions of this standard.

2.20 Pre-Dive Procedures

Dive Plans

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

a) Divers qualifications, and the type of certificate or certification held by each diver.

b) Emergency plan (Appendix 7) with the following information:

1. Name, telephone number, and relationship of person to be contacted for each diver in the event of an emergency.
2. Nearest operational decompression chamber.
3. Nearest accessible hospital.
4. Available means of transport.

c) Approximate number of proposed dives.

d) Location(s) of proposed dives.

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

f) Decompression status and repetitive dive plans, if required.

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

h) Any hazardous conditions anticipated.

Pre-dive Safety Checks

Diver's Responsibility:

a) Scientific divers 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 unfavorable, or if they would be violating the precepts of their training, of this standard, or the organizational member's diving safety 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.

Equipment Evaluations

a) Divers shall ensure 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.

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

2.30 Diving Procedures

Solo Diving Prohibition

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

Refusal to Dive

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.

Safety - The ultimate responsibility for safety rests with the individual diver. It is the diver's responsibility and duty to refuse to dive if, in their judgment, conditions are unsafe or unfavorable, or if they would be violating the precepts of their training or the regulations in this standard.

Termination of the Dive

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

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

Emergencies and Deviations from Regulations

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

2.40 Post-Dive Procedures

Post-Dive Safety Checks

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

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

2.50 Emergency Procedures

The Downtown Aquarium Emergency Procedure follows the standards of care of the community and must include procedures for emergency care, recompression and evacuation for each dive location (Appendix 7).

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

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

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

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

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

2.70 Record Keeping Requirements

Personal Diving Log

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

a) Name of diver, buddy, and Lead Diver.

b) Date, time, and location.

c) Diving modes used.

d) General nature of diving activities.

e) Approximate surface and underwater conditions.

f) Maximum depths, bottom time, and surface interval time.

g) Diving tables or computers used.

h) Detailed report of any near or actual incidents.

Required Incident Reporting

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

Additional information must meet the following reporting requirements:

a) Organizational member shall record and report occupational injuries and illnesses 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 the organizational member, with the record of the dive, for a period of 5 years:

1. Complete AAUS Incident Report at http://www.aaus.org.
2. Written descriptive report to include:

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

c) The Downtown Aquarium shall investigate and document any incident of pressure-related injury and prepare a report that is to be forwarded to AAUS during the annual reporting cycle. This report must first be reviewed and released by the Downtown Aquarium's Diving Control Board.

SECTION 3.00
DIVING EQUIPMENT

3.10 General Policy

All equipment shall meet standards as determined by the SDO and the DCB. Equipment that is subjected to extreme usage under adverse conditions should require more frequent testing and maintenance.

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

3.20 Equipment

Regulators

a) Only those makes and models specifically approved by the SDO and the DCB shall be used.

b) Scuba regulators shall be inspected and tested prior to first use and every 12 months thereafter.

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

d) All inspections and repairs to life support equipment (ex. Regulators, full face masks, etc…) must be properly documented. If repairs or testing is contracted out the receipt of sale and a description of work performed from the contractor must be kept on file.

e) Only qualified and certified technicians may work on or repair life support equipment.

Breathing Masks and Helmets

Breathing masks and helmets shall have:

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

b) An exhaust valve.

c) A minimum ventilation rate capable of maintaining the diver at the depth to which they are diving.

Scuba Cylinders

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

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

Scuba cylinders must have an internal and external inspection at intervals not to exceed 12 months.

Scuba cylinder valves shall be functionally tested at intervals not to exceed 12 months.

Backpacks

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

Gauges

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

Flotation Devices

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

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

These devices shall be functionally inspected and tested at intervals not to exceed 12 months.

Timing Devices, Depth, and Pressure Gauges

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

Determination of Decompression Status: Dive Tables, Dive Computers

A set of diving tables, approved by the Diving Control Board, must be available at the dive location.

Dive computers may be utilized in place of diving tables, and must be approved by the Diving Control Board. Recommendations on dive computers are located in appendix 8

3.30 Auxiliary Equipment

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

3.40 Support Equipment

First aid supplies

An AED, first aid kit and emergency oxygen shall be available.

Diver's Flag

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

Compressor Systems – The Downtown Aquarium Controlled

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

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

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

c) All air compressor intakes shall be located away from areas containing exhaust or other contaminants.

Alternate Compressor Systems – i.e. Brownie's Third Lung Compressors

The following will be considered in design and location of Brownie's Third Lung or equivalent compressor systems

a) All air compressors (i.e. Brownie's) shall be located away from areas containing exhaust or other contaminants.

b) All air compressors (i.e. Brownie's) shall be located in a manner that protects the unit from any potential water contact.

c) All air compressors (i.e. Brownie's) must not be plugged into an overloaded circuit, as this can lead to a tripped breaker, interrupting the flow of air to the diver.

3.50 Equipment Maintenance

Record Keeping

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

a) Regulators

b) Submersible pressure gauges

c) Depth gauges

d) Scuba cylinders

A record of visual inspections and hydrostatic testing of all scuba bottles will be maintained along with the compressor logs. All scuba bottles will be visually inspected at intervals not to exceed 1 year. All scuba bottles will be subjected to hydrostatic testing at intervals not to exceed 5 years in length Any scuba bottle not passing either the visual or hydrostatic inspections will be destroyed and discarded.

e) Cylinder valves

f) Diving helmets

g) Submersible breathing masks

h) Compressors

i) Gas control panels

j) Air storage cylinders

k) Air filtration systems

l) Analytical instruments

m) Buoyancy control devices

n) Dry suits

Compressor Operation and Air Test Records

a) Gas analyses and air tests shall be performed on each Downtown Aquarium-controlled breathing air compressor at regular intervals of no more than 100 hours of operation or 6 months, whichever occurs first. The results of these tests shall be entered in a formal log and be maintained.

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

3.60 Air Quality Standards

Breathing air for scuba shall meet the following specifications as set forth by the Compressed Gas Association (CGA Pamphlet G-7.1). **CGA Grade E**	
Component	**Maximum**
Oxygen	20 - 22%/v
Carbon Monoxide	10 PPM/v
Carbon Dioxide	1000 PPM/v
Condensed Hydrocarbons	5 mg/m3
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.

Section 4.00
ENTRY LEVEL TRAINING REQUIREMENTS

4.10 General Policy

Training and certification as an entry-level diver is a prerequisite to AAUS Scientific Diver Training. In lieu of writing/promulgating AAUS specific standards for entry-level divers, AAUS references here, the standards for entry-level diver training as defined by the WRSTC and/or ISO. AAUS programs who wish to train entry-level divers may do so using one of the following options:

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

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

4.20 References

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

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

Section 5.00
SCIENTIFIC DIVER CERTIFICATION

5.10 Certification Types

Scientific Diver Certification

This is a permit to dive, usable only while it is current and for the purpose intended. Includes fulfillment of all requirements in Section 5.00. This certification is appropriate for reciprocity with other AAUS member organization dive programs. An individual holding this designation is also qualified as a Scientific Aquarium Scuba Diver.

Temporary Diver Permit

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

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

5.20 General Policy

DTAQ requires that no person shall engage in scientific diving unless that person is authorized by DTAQ pursuant to the provisions of this standard. Only a person diving under the auspices of DTAQ that subscribes to the practices of AAUS is eligible for a scientific diver certification.

5.30 Requirements For Scientific Diver Certification

Submission of documents and participation in aptitude examinations does not automatically result in certification. The applicant must convince the Diving Safety Officer and members of the DCB that they are sufficiently skilled and proficient to be certified. This skill will be acknowledged by the signature of the 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 DTAQ scientific diving privileges. Minimum documentation and examinations required are as follows:

Prerequisites

a) Application - Application for certification shall be made to the Diving Safety Officer on the form prescribed by DTAQ

b) Medical approval. Each applicant for diver certification shall submit a statement from a licensed physician, based on an approved medical examination, attesting to the applicant's fitness for diving (Section 6.00 and Appendices 1 through 4).

c) Scientific Diver-In-Training Permit - This permit signifies that a diver has completed and been certified as at least an open water diver through an internationally recognized certifying agency or scientific diving program, and has the knowledge skills and experience equivalent to that gained by successful completion of training as specified in Section 4.00.

Training

The diver must complete theoretical aspects and practical training as is relevant to the diving tasks he/she will be performing as described for his/her position. The minimum cumulative time of this training will be 100 hours.

Topics include, but are not limited to, data gathering techniques, behavior, installation of scientific apparatus, use of chemicals, site selection, site location and relocation, animal and plant identification, ecology, tagging,

photography, scientific dive planning, collecting methods, marine husbandry procedures, interpretive techniques, coordination with other agencies, appropriate governmental regulations, and small boat operation.

Practical training for Scientific Scuba Diver Certification shall include additional dives to ensure a cumulative total of at least 12 supervised ocean or open water dives in a variety of dive sites and diving conditions, for a cumulative bottom time of six hours. No more than three of these dives shall be made in one day.

Practical training for Scientific Aquarium Scuba Diver Certification shall include additional dives to ensure a cumulative total of at least 12 supervised Aquarium exhibit dives in a variety of dive sites/exhibits and diving conditions, for a cumulative bottom time of six hours. The appropriate exhibit training checklist must be completed in its entirety and checked off and dated by both trainer and trainee for proper validation of training completion. No more than three of these dives shall be made in one day.

Examinations

NAUI or PADI basic Open Water Exam or equivalent.

Scientific Diving Exam (Passing Score 90%)

Other written examinations appropriate for the certification type.

Other examinations as appropriate for facility specific scientific operations.

Examination of equipment.

Sheltered water check-out examination including emergency ascent techniques.

Open water or exhibit check-out dives as determined by the appropriate certification type.

5.40 Depth Certifications

Depth Certifications and Progression to Next Depth Level

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

a) Certification to 30 Foot Depth - Initial permit level, approved upon the successful completion of training listed in Section 4.00 and 5.30.

b) Certification to 60 Foot Depth - A diver holding a 30 foot certificate may be certified to a depth of 60 feet after successfully completing, under supervision, 12 logged training dives to depths between 31 and 60 feet, for a minimum total time of 4 hours.

c) Certification to 100 Foot Depth - A diver holding a 60 foot certificate may be certified to a depth of 100 feet after successfully completing, 4 dives to depths between 61 and 100 feet. The diver shall also demonstrate proficiency in the use of the appropriate Dive Tables.

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

e) Certification to 150 Foot Depth - A diver holding a 130 foot certificate may be certified to a depth of 150 feet after successfully completing, 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.

f) Certification to 190 Foot Depth - A diver holding a 150 foot certificate may be certified to a depth of 190 feet after successfully completing, 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.

5.50 Continuation of Certificate

Minimum Activity to Maintain Certification

During any 12-month period, each certified scientific diver must log a minimum of 12 dives. At least one dive must be logged near the maximum depth of the diver's certification during each 6-month period. Divers certified to 150 feet or deeper may satisfy these requirements with dives to 130 feet or over. Failure to meet these requirements may be cause for revocation or restriction of certification.

Re-qualification of Depth Certificate

Once the initial certification requirements of Section 5.30 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.

Medical Examination

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

Emergency Care Training.

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

a) Adult CPR (must be current).

b) Emergency oxygen administration (must be current)

c) First aid for diving accidents (must be current)

5.60 Revocation of Certification

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

5.70 Recertification

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

Section 6.00
MEDICAL STANDARDS

6.10 Medical Requirements

General

a) The Downtown Aquarium shall determine that divers have passed a current diving physical examination and have been declared by the examining physician to be fit to engage in diving activities as may be limited or restricted in the medical evaluation report.

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

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

Frequency of Medical Evaluations

Medical evaluation shall be completed:

a) Before a diver may begin diving, unless an equivalent initial medical evaluation has been given within the preceding 5 years (3 years if over the age of 40, 2 years if over the age of 60), the member organization has obtained the results of that examination, and those results have been reviewed and found satisfactory by the member organization.

b) 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.

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

Information Provided Examining Physician

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

Content of Medical Evaluations

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

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

b) Medical history (Appendix 3).

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

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

a) Abnormalities of the tympanic membrane, such as perforation, presence of a monomeric membrane, or inability to auto inflate the middle ears.

b) Vertigo including Meniere's Disease.

c) Stapedectomy or middle ear reconstructive surgery.

d) Recent ocular surgery.

e) Psychiatric disorders including claustrophobia, suicidal ideation, psychosis, anxiety states, untreated depression.

f) Substance abuse, including alcohol.

g) Episodic loss of consciousness.

h) History of seizure.

i) History of stroke or a fixed neurological deficit.

j) Recurring neurologic disorders, including transient ischemic attacks.

k) History of intracranial aneurysm, other vascular malformation or intracranial hemorrhage.

l) History of neurological decompression illness with residual deficit.

m) Head injury with sequelae.

n) Hematologic disorders including coagulopathies.

o) Evidence of coronary artery disease or high risk for coronary artery disease.

p) Atrial septal defects.

q) Significant valvular heart disease - isolated mitral valve prolapse is not disqualifying.

r) Significant cardiac rhythm or conduction abnormalities.

s) Implanted cardiac pacemakers and cardiac defibrillators (ICD).

t) Inadequate exercise tolerance.

u) Severe hypertension.

v) History of spontaneous or traumatic pneumothorax.

w) Asthma.

x) Chronic pulmonary disease, including radiographic evidence of pulmonary blebs, bullae or cysts.

y) Diabetes mellitus.

z) Pregnancy.

Laboratory Requirements for Diving Medical Evaluation and Intervals.

Initial examination under age 40:

a) Medical History

b) Complete Physical Exam, emphasis on neurological and otological components

c) Urinalysis

d) Any further tests deemed necessary by the physician.

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

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 risk factors using Multiple-Risk-Factor Assessment[1,2] (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) Chest X-ray

f) Urinalysis

g) Any further tests deemed necessary by the physician

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 risk factors using Multiple-Risk-Factor Assessment[1] (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

Physician's Written Report

a) After any medical examination relating to the individual's fitness to dive, the organizational member 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 will be reviewed by the DCB.

b) The organizational member shall make a copy of the physician's written report available to the individual.

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

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

Volume 2

Sections 7.00 through 10.00
Required Only When Conducting Described Diving Activities
and
Organizational Member Specific Sections

Section 7.00
NITROX DIVING GUIDELINES

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

7.10 Prerequisites

Eligibility

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

Documentation

Documentation for authorization to use nitrox should be made on forms specified by the Diving Control Board. If the diver has a recreational nitrox certification, the card must be available for inspection by the DSO of designee and a copy must be placed in the diver's file before any training begins.

7.20 Requirements for Authorization to Use Nitrox

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

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

Training

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

A recreational nitrox certification is an acceptable substitution for the written and oral examinations as long as the DSO or designee personally confirms the diver's proficiency of nitrox use and has the diver's nitrox card on file as documentation of training. The DSO or designee must still supervise two open water nitrox dives to confirm proficiency as specified in section 7.30.

Examinations

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

a) Written examinations covering the information presented in the classroom training session(s) (i.e., gas theory, oxygen toxicity, partial pressure determination, etc.);

b) Practical examinations covering the information presented in the practical training session(s) (i.e., gas analysis, documentation procedures, etc.);

c) Open water checkout dives, to appropriate depths, to demonstrate the application of theoretical and practical skills learned.

Minimum Activity to Maintain Authorization

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

7.30 Nitrox Training Guidelines

Training in these guidelines should be in addition to training for Diver-In-Training authorization (Section 5.00). It may be included as part of training to satisfy the Scientific Diver training requirements (Section 5.30). The DSO or designee may waive any of the Classroom Instruction, Practical Training or Examinations if the Diver in Training or Scientific Diver has a recreational nitrox certification and displays proficiency in the use of nitrox.

Classroom Instruction

Topics should include, but are not limited to: review of previous training; physical gas laws pertaining to nitrox; partial pressure calculations and limits; equivalent air depth (EAD) concept and calculations; oxygen physiology and oxygen toxicity; calculation of oxygen exposure and maximum safe operating depth (MOD); determination of decompression schedules (both by EAD method using approved air dive tables, and using approved nitrox dive tables); dive planning and emergency procedures; mixing procedures and calculations; gas analysis; personnel requirements; equipment marking and maintenance requirements; dive station requirements.

DCB may choose to limit standard nitrox diver training to procedures applicable to diving, and subsequently reserve training such as nitrox production methods, oxygen cleaning, and dive station topics to divers requiring specialized authorization in these areas.

Practical Training

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

a) Oxygen analysis of nitrox mixtures.

b) Determination of MOD, oxygen partial pressure exposure, and oxygen toxicity time limits, for various nitrox mixtures at various depths.

c) Determination of nitrogen-based dive limits status by EAD method using air dive tables, and/or using nitrox dive tables, as approved by the DCB.

d) Nitrox dive computer use may be included, as approved by the DCB.

Written Examination (based on classroom instruction and practical training)

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

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

b) Physical and physiological considerations of nitrox diving (ex.: O2 and CO2 toxicity).

c) Diving regulations and procedures as related to nitrox diving, either scuba or surface-supplied (depending on intended mode).

d) Given the proper information, calculation of:

   1. Equivalent air depth (EAD) for a given fO2 and actual depth;
   2. pO2 exposure for a given fO2 and depth;
   3. Optimal nitrox mixture for a given pO2 exposure limit and planned depth;
   4. Maximum operational depth (MOD) for a given mix and pO2 exposure limit;
   5. For nitrox production purposes, percentages/psi of oxygen present in a given mixture, and psi of each gas required to produce a fO2 by partial pressure mixing.

e) Dive table and dive computer selection and usage;

f) Nitrox production methods and considerations.

g) Oxygen analysis.

h) Nitrox operational guidelines (Section 7.40), dive planning, and dive station components.

Open water Dives

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

Surface-Supplied Training

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

7.40 Scientific Nitrox Diving Regulations

Dive Personnel Requirements

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

Scientific Diver - A Scientific Diver who has completed the requirements of Section 5.00 and the training and authorization sections of these guidelines, may be authorized by the DSO to use nitrox. Depth authorization to use nitrox should be the same as those specified in the diver's authorization, as described in Section. 5.40.

Lead Diver - On any dive during which nitrox will be used by any team member, the Lead Diver should be authorized to use nitrox, and hold appropriate authorizations required for the dive, as specified in AAUS Standards. Lead Diver authorization for nitrox dives by the DSO and/or DCB should occur as part of the dive plan approval process.

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

a) As part of the dive planning process, verify that all divers using nitrox on a dive are properly qualified and authorized;

b) 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.

c) The Lead Diver should also reduce the maximum allowable pO2 exposure limit for the dive team if on-site conditions so indicate (see Sec. 7.42.).

Dive Parameters

Oxygen Exposure Limits

a) The inspired oxygen partial pressure experienced at depth should not exceed 1.6 ATA. All dives performed using nitrox breathing mixtures should comply with the current *NOAA Diving Manual* "Oxygen Partial Pressure Limits for 'Normal' Exposures"

b) 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_2 exposure limits if conditions indicate.

c) If using the equivalent air depth (EAD) method the maximum depth of a dive should be based on the oxygen partial pressure for the specific nitrox breathing mix to be used.

Bottom Time Limits

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

b) Bottom time for a single dive should not exceed the NOAA maximum allowable "Single Exposure Limit" for a given oxygen partial pressure, as listed in the current NOAA Diving Manual.

Dive Tables and Gases

a) A set of DCB approved nitrox dive tables should be available at the dive site unless all nitrox divers are using nitrox compatible dive computers.

b) When using the equivalent air depth (EAD) method, dives should be conducted using air dive tables approved by the DCB.

c) 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

d) Breathing mixtures used while performing in-water decompression, or for bail-out purposes, should contain the same or greater oxygen content as that being used during the dive, within the confines of depth limitations and oxygen partial pressure limits set forth in Section 7.40 Dive Parameters.

Nitrox Dive Computers

a) Dive computers may be used to compute decompression status during nitrox dives. Manufacturers' guidelines and operations instructions should be followed.

b) Use of Nitrox dive computers should comply with dive computer guidelines included in the AAUS Standards.

c) Nitrox dive computer users should demonstrate a clear understanding of the display, operations, and manipulation of the unit being used for nitrox diving prior to using the computer, to the satisfaction of the DSO or designee.

d) If nitrox is used to increase the safety margin of an air-based dive computer, the MOD and oxygen exposure and time limits for the nitrox mixture being dived shall not be exceeded.

e) Dive computers capable of pO_2 limit and fO_2 adjustment should be checked by the diver prior to the start each dive to assure compatibility with the mix being used.

Repetitive Diving

a) Repetitive dives using nitrox mixtures should be performed in compliance with procedures required of the specific dive tables used or as directed by the diver's nitrox dive computer.

b) 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. If using a nitrox dive computer all NDL times must be followed on the repetitive dive.

c) 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.

d) When repetitive dives expose divers to different oxygen partial pressures from dive to dive, divers should account for accumulated oxygen exposure from previous dives when determining acceptable exposures for repetitive dives. Both acute (CNS) and chronic (pulmonary) oxygen toxicity concerns should be addressed.

Oxygen Parameters

a) Authorized Mixtures - Mixtures meeting the criteria outlined in Section 7.40 may be used for nitrox diving operations, upon approval of the DCB.

b) Purity - Oxygen used for mixing nitrox-breathing gas should meet the purity levels for "Medical Grade" (U.S.P.) or "Aviator Grade" standards.

c) In addition to the AAUS Air Purity Guidelines (Section 3.60), the following standard should be met for breathing air that is either:

    1. Placed in contact with oxygen concentrations greater than 40%.

2. Used in nitrox production by the partial pressure mixing method with gas mixtures containing greater than 40% oxygen as the enriching agent.

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

Gas Mixing and Analysis for Organizational Members

Personnel Requirements:

a) Individuals responsible for producing and/or analyzing nitrox mixtures should be knowledgeable and experienced in all aspects of the technique.

b) Only those individuals approved by the DSO and/or DCB should be responsible for mixing and/or analyzing nitrox mixtures.

Production Methods

It is the responsibility of the DCB to approve the specific nitrox production method used.

Analysis Verification by User

a) It is the responsibility of each diver to analyze prior to the dive the oxygen content of his/her scuba cylinder and acknowledge in writing the following information for each cylinder: fO2, MOD, cylinder pressure, date of analysis, and user's name.

b) Individual dive log reporting forms should report fO_2 of nitrox used, if different than 21%.

7.50 Nitrox Diving Equipment

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

- Labeled SCUBA Cylinders
- Oxygen Analyzers

Oxygen Cleaning and Maintenance Requirements

Requirement for Oxygen Service

1. All equipment, which during the dive or cylinder filling process is exposed to concentrations greater than 40% oxygen at pressures above 150 psi, should be cleaned and maintained for oxygen service.

2. Equipment used with oxygen or mixtures containing over 40% by volume oxygen shall be designed and maintained for oxygen service. Oxygen systems over 125 psig shall have slow-opening shut-off valves. This should include the following equipment: scuba cylinders, cylinder valves, scuba and other regulators, cylinder pressure gauges, hoses, diver support equipment, compressors, and fill station components and plumbing.

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" in some identifying manner that designates it from normal air cylinders.

b) Other markings, which identify the cylinder as containing gas mixes other than Air, may be used as the approval of the DCB.

c) A contents label should be affixed, to include the current fO_2, date of analysis, and MOD.

d) The cylinder should be labeled to indicate whether the cylinder is prepared for oxygen or nitrox mixtures containing greater than 40% oxygen.

Regulators

Regulators to be used with nitrox mixtures containing greater than 40% oxygen should be cleaned and maintained for oxygen service, and marked in an identifying manner.

Other Support Equipment

a) An oxygen analyzer is required which is capable of determining the oxygen content in the scuba cylinder. Two analyzers are recommended to reduce the likelihood of errors due to a faulty analyzer. The analyzer should be capable of reading a scale of 0 to 100% oxygen, within 1% accuracy.

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

Compressor system

a) Compressor/filtration system must produce oil-free air.

b) An oil-lubricated compressor placed in service for a nitrox system should be checked for oil and hydrocarbon contamination at least quarterly.

Fill Station Components

All components of a nitrox fill station that will contact nitrox mixtures containing greater than 40% oxygen should be cleaned and maintained for oxygen service. This includes cylinders, whips, gauges, valves, and connecting lines.

Section 8.00
AQUARIUM DIVE OPERATIONS

8.10 General Policy

Section 8.00 applies to scientific aquarium divers only.

Definition - A scientific aquarium diver is a scientific diver who is diving solely within an 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.

It is recognized that within scientific aquarium diving there are environments and equipment that fall outside the scope of those addressed in this standard. In those circumstances it is the responsibility of DTAQ's Dive Control Board to establish the requirements and protocol under which diving will be safely conducted.

Note: All of the standards set forth in other sections of this standard shall apply, except as otherwise provided in this section.

8.20 The Buddy System In Scientific Aquarium Diving

All scuba diving activities in the confined environment of an aquarium shall be conducted in accordance with the buddy system, whereby both divers, or a diver and a tender as provided below, are always in visual contact with one another, can always communicate with one another, and can always render prompt and effective assistance either in response to an emergency or to prevent an emergency.

A diver and tender comprise a buddy team in the confined environment of an aquarium only when the maximum depth does not exceed 30 feet, and there are no overhead obstructions or entanglement hazards for the diver, and the tender is equipped, ready and able to conduct or direct a prompt and effective in-water retrieval of the diver at all times during the dive.

8.30 Diving Equipment

Section 3.20 is modified to read as follows:

In an aquarium of a known maximum obtainable depth:

a) A depth indicator is not required, except that a repetitive diver shall use the same computer used on any prior dive.

b) Only one buddy must be equipped with a timing device.

c) The maximum obtainable depth of the aquarium shall be used as the diving depth.

8.40 Scientific Aquarium SCUBA Diver Certification

A Scientific Aquarium Diver is a certification enabling the qualified diver to participate in scientific diving in accordance with Section 8.00 as provided below.

For the safety of the animals and the diver, all practical dive training in exhibits must be supervised by the DSO or qualified delegate in accordance to DTAQ dive training procedures. As training proceeds, progress should be checked off on the dive training checklist appropriate to the dive location and the status of the diver being trained (staff, volunteer etc.). No person may dive a specific exhibit without supervision of the DSO, or qualified delegate, unless they have final signatures for that specific dive on the checklist. **All exhibit dive training is at the complete discretion of the acting Dive Safety Officer**, and he/ she may adapt dive training to the specific individual as needed or required.

Includes fulfillment of Required Topics 1-9 of Theoretical and Practical Training in Section 5.30 and successful completion of all appropriate exhibit dive training checklists with final sign off by the DSO, which will include at a minimum 12 supervised exhibit training dives with a cumulative bottom time of six hours and not more than three dives in one day. This certification is appropriate for diving primarily in DTAQ exhibit tanks.

Upgrading to Scientific Scuba Diver Certification will require approval of the DSO and fulfillment of the practical training requirements and shall include additional dives to ensure a cumulative total of at least 12 supervised ocean or open water dives in a variety of dive sites and diving conditions, for a cumulative bottom time of six hours. No more than three of these dives shall be made in one day.

8.50 Scientific Aquarium Diving Using Other Diving Technology

Surface Supplied Scientific Aquarium Diving

Definition: For purposes of scientific aquarium diving, surface supplied diving is described as a mode of diving using open circuit, surface supplied compressed gas which is provided to the diver at the dive location and may or may not include voice communication with the surface tender.

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

   Scientific aquarium divers using conventional scuba masks, full-face masks, or non-lockdown type helmets are exempt from this standard provided:

   1. There are no overhead obstructions or entanglements.
   2. The diver is proficient in performing a Controlled Emergency Swimming Ascent from at least as deep as the maximum depth of the aquarium.
   3. The diver is proficient in performing out of air emergency drills, including ascent and mask/helmet removal.
   4. Each surface supplied diver shall be hose-tended by a separate dive team member while in the water. Scientific aquarium divers are exempt from this standard, provided the tender is monitoring only one air source, there is mutual assistance between divers and there are no overhead obstructions or entanglements.

b) Divers using the surface supplied mode shall maintain communication with the surface tender.

c) The surface supplied breathing gas supply (volume and intermediate pressure) shall be sufficient to support all surface supplied divers in the water for the duration of the planned dive.

d) During surface supplied diving operations when only one diver is in the water, there must be a standby diver in attendance at the dive location. Scientific aquarium divers are exempt from this standard, provided the tender is equipped, ready and able to conduct a prompt and effective in-water retrieval of the diver at all times during the dive.

   1. When exhibits are only accessible by pulling down a trap door, that door must be left open during any dive operations.
   2. When exhibits are only accessible by a removable ladder, the ladder must be left in place during the entire duration of the dive.

e) Surface supplied equipment must be configured to allow retrieval of the diver by the surface tender without risk of interrupting air supply to the diver.

f) All surface supplied applications used for scientific aquarium diving shall have a non-return valve at the attachment point between helmet or mask hose, which shall close readily and positively.

Section 9.00
OTHER DIVING TECHNOLOGY

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

9.10 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.

9.11 Diver Requirements for Confined Space & Overhead Environments

Diving in Confined Spaces and/or Overhead Environments can be more stressful than open water diving. For this reason, divers must follow stricter guidelines for safety. All persons diving in exhibits with limited mobility or surface access must be approved by DSO.

All confined space and overhead environment divers:

a) Must be fully trained and qualified for the tasks they are performing.

b) Must be comfortable diving in an enclosed environment with many different species of aquatic life.

c) Must exhibit excellent buoyancy control with both hookah and open circuit scuba devices.

d) Must show competency in problem solving underwater. The surface is not an option.

e) Must maintain constant orientation of exit (being disoriented /lost) and of self (banging tanks against acrylic/ structure/ animal during dive).

f) Must perform controlled entries and exits as not to injure self, other employees, and animals.

g) Must exhibit excellent control of gear pre, during, and post dive. This includes transporting cylinders to and away from dive site, and streamlining hoses etc... While underwater.

h) Must have primary and secondary light source when working in a dark environment.

i) Must effectively communicate with buddy/ tender via 2-way underwater communications system or other communication method approved by the DCB.

j) Must be proficient with wearing and the use of safety harnesses with connected tether line.

k) Must be continuously line tended.

9.20 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.

All hookah supplied breathing apparatuses must have means to control intermediate pressure to the diver from the originating air source.

9.30 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. Surface supplied divers shall comply with all scuba diving procedures in this manual (except Sec. 2.31). Surface supplied diving shall not be conducted at depths greater than 190 fsw (58 msw).

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

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

c) Divers using the surface supplied mode shall maintain voice communication with the surface tender.

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

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

9.40 Drysuit Diving

Due to the risk of an uncontrolled ascent, all divers using a dry suit under the auspice of The Downtown Aquarium must be Drysuit certified by a recognized SCUBA agency and must have a copy of the Drysuit certification card in their personnel file.

Before a diver is allowed to use The Downtown Aquarium controlled dry suits the diver must:

a) Have a copy of their Drysuit certification card from a recognized scuba agency in their personnel file.

b) Display proficiency for Dive Safety Officer in care, setup, tear down and general knowledge of dry suits.

c) Display proficiency for Dive Safety Officer in use of Drysuit on a dive in an open water setting or an aquarium exhibit as appropriate.

d) Additional dry suit training or testing may be required in the form of written exam or in-water training as deemed necessary by the Dive Safety Officer.

9.50 Contaminated Water Diving

Contaminated water can include biological or chemical contaminants.

a) All contaminated water dive plans must be reviewed and approved by the DSO or designated representative prior to the actual dive.

b) All contaminated water divers must be fully trained for the job they are performing.

c) All contaminated water divers must be Drysuit certified by a recognized SCUBA agency and must have a copy of the certification card in their file.

d) All contaminated water divers must avoid personal contact with the contaminated water, most critically with open wounds and sores, the mouth and eyes.

e) Any diver contact with the contaminated water should be immediately reported to the DSO or appointed representative.

f) All contaminated water equipment and any other objects that have come in contact with contaminated water must be fully disinfected and dried completely between uses.

9.51 Decontamination procedures:

a) After egress from contaminated water but before the diver has removed any equipment the diver must thoroughly be sprayed down with a suitable disinfectant.

b) Any suitable disinfectant used must be allowed the appropriate contact time as directed by the manufacturer.

c) After the appropriate contact time has elapsed, the diver should be thoroughly rinsed with fresh water in an appropriate area that will minimize the possibilities of cross contamination.

d) All disinfected and rinsed HAZMAT equipment should be hung up appropriately and allowed to dry before the next use.

9.52 Contaminated Water Dive Training Requirements

All training requirements for contaminated water diving must be successfully completed and properly documented by both trainee and trainer before a diver can dive in contaminated water without direct supervision by the DSO or designated representative.

Divers in Training for contaminated water dives must:

a) Be satisfactorily trained in the use of dry suits and have proof of dry suit certification card on file as per section 9.4 in this manual.

b) Be fully trained on use of full face mask by DSO.

c) Be fully trained on specific characteristics of a Contaminated Water Dry Suit by DSO.

d) Must be fully trained on pre-dive equipment checks before entering the water.

e) Must by fully trained on contaminated water decontamination procedures post dive.

f) Must show proficiency in using all necessary contaminated water equipment in non-contaminated water for DSO before final approval to dive without direct supervision by DSO. Diver in training must use all necessary equipment as if on a real contaminated water dive.

g) Must be fully trained on procedures should the diver have direct contact with the contaminated water source.

9.53 Contaminated Water Equipment

All contaminated water dives must be conducted using the proper equipment which includes but is not limited to:

a) Contaminated water specific Drysuit with smooth external surface for ease of disinfection.

b) Dry glove/ cuff system and enclosed boot.

c) Latex or other material dry hood.

d) Full Face Mask with positive pressure second stage regulator.

9.60 Mixed Gas Blending

The Downtown Aquarium has the equipment necessary for blending mixed gasses for dives that require nitrox. Only qualified and certified individuals approved by the Dive Safety Officer will be allowed to use the blending equipment.

The following requirements must be followed:

a) All persons blending mixed gasses (blenders) must be properly trained and approved by the Dive Safety Officer or qualified designee.

b) All blenders must hold a valid gas blending certification card from a recognized Technical Diving Certification Agency and have a copy on file at The Downtown Aquarium.

c) All blending equipment must be safe for 100% oxygen service.

d) All blenders must notify Dive Safety Officer or qualified designee before stating a blending operation.

e) All blenders must follow all facility safety standards as well as all recognized standards for handling pure oxygen.

f) All blended cylinders must be properly labeled, analyzed, recorded and stored for use.

g) All blending equipment must be stored properly when not in use to ensure contamination does not happen. All hoses should be capped at both ends and all blending equipment should be stored in a cool dry place when not in use.

Section 10.00
REBREATHERS

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

a) Training and/or experience verification requirements for authorization

b) Equipment requirements

c) Operational requirements and additional safety protocols to be used

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

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

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

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

10.10 Definitions and General Information

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

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

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

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

Oxygen Rebreathers

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

Semi-Closed Circuit Rebreathers

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

differ between SCR models, but the mechanism usually provides a semi-constant fraction of oxygen (FO2) in the breathing loop at all depths, similar to open-circuit SCUBA.

Closed-Circuit Mixed Gas Rebreathers

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

10.20 Prerequisites

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

Training Prerequisites

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

b) Completion of a minimum of 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 or designated representative.

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.

Training

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

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

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

a) In particular, causes, signs and symptoms, first aid, treatment and prevention of the following must be covered:

    1. Hyperoxia (CNS and Pulmonary Oxygen Toxicity)
    2. Middle Ear Oxygen Absorption Syndrome (oxygen ear)
    3. Hyperoxia-induced myopia

4. Hypoxia
5. Hypercapnia
6. Inert gas narcosis
7. Decompression sickness

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

1. System design and operation, including:
2. Counterlung(s)
3. CO_2 scrubber
4. CO_2 absorbent material types, activity characteristics, storage, handling and disposal
5. Oxygen control system design, automatic and manual
6. Diluent control system, automatic and manual (if any)
7. Pre-dive set-up and testing
8. Post-dive break-down and maintenance
9. Oxygen exposure management
10. Decompression management and applicable decompression tracking methods
11. Dive operations planning
12. Problem recognition and management, including system failures leading to hypoxia, hyperoxia, hypercapnia, flooded loop, and caustic cocktail
13. Emergency protocols and bailout procedures

Practical Training (with model of rebreather to be used)

a) A minimum number of hours of underwater time.

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

* Dives should not exceed 20 fsw.

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

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

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:

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

Written Evaluation

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

Supervised Rebreather Dives

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

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

Dives at this level may be targeted to activities associated with the planned science diving application. See

the following table for number and cumulative water time for different rebreather types.

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.

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

Extended Range, Required Decompression and Helium-Based Inert Gas

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

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

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

Training shall be in accordance with standards for required-decompression and mixed gas diving, as applicable to rebreather systems, starting at the130 fsw level.

Maintenance of Proficiency

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

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

10.30 Equipment Requirements

General Requirements

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

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

the DCB supporting documentation to this effect.

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

If the DCB or designated representative has any concern to the legitimacy or reliability of a specific rebreather prior to approval, the manufacturer should supply the DCB with supporting documentation detailing the methods of specification determination by a recognized third-party testing agency, including unmanned and manned testing. Test data should be from a recognized, independent test facility.

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

These should include:

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_2 absorbent durations, as a function of depth, exercise level, breathing gas, and water temperature
g) Method, range and precision of inspired PPO_2 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

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

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

Minimum Equipment

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

Oxygen Rebreathers

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

Semi-Closed Circuit Rebreathers.

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

Closed Circuit Mixed-gas Rebreathers.

a) CCR shall incorporate a minimum of three independent oxygen sensors.

b) A minimum of two independent displays of oxygen sensor readings shall be available to the diver.

c) Two independent power supplies in the rebreather design are desirable. If only one is present, a secondary system to monitor oxygen levels without power from the primary battery must be incorporated.

d) CCR shall be equipped with manual diluent and oxygen addition valves, to enable the diver to maintain safe oxygen levels in the event of failure of the primary power supply or automatic gas addition systems.

e) Redundancies in onboard electronics, power supplies, and life support systems are highly desirable.

10.40 Operational Requirements

General Requirements

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

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

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

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

Dive Plan

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

a) Information about the specific rebreather model to be used

b) Make, model, and type of rebreather system

c) Type of CO_2 absorbent material

d) Composition and volume(s) of supply gases

e) Complete description of alternate bailout procedures to be employed, including manual rebreather operation and open-circuit procedures

f) Other specific details as requested by DCB

Buddy Qualifications

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

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

Oxygen Exposures

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 ata. 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.

Decompression Management

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

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

a) Oxygen rebreathers: Not applicable.

b) SCR (presumed constant FO_2):

1. Use of any method approved for open-circuit scuba diving breathing air, above the maximum operational depth of the supply gas.
2. Use of open-circuit nitrox dive tables based upon expected inspired FO_2. In this case, contingency air dive tables may be necessary for active-addition SCR's in the event that exertion level is higher than expected.
3. Equivalent air depth correction to open-circuit air dive tables, based upon expected inspired FO_2 for planned exertion level, gas supply rate, and gas composition. In this case, contingency air dive tables may be necessary for active-addition SCR's in the event that exertion level is higher than expected.

c) CCR (constant PPO_2):

1. Integrated constant PPO_2 dive computer.
2. Non-integrated constant PPO_2 dive computer.
3. Constant PPO_2 dive tables.
4. Open-circuit (constant FO_2) nitrox dive computer, set to inspired FO_2 predicted using PPO_2 set point at the maximum planned dive depth.
5. Equivalent air depth (EAD) correction to standard open-circuit air dive tables, based on the inspired FO_2 predicted using the PPO_2 set point at the maximum planned dive depth.
6. Air dive computer, or air dive tables used above the maximum operating depth (MOD) of air for the PPO_2 set point selected.

Maintenance Logs, CO2 Scrubber Logs, Battery Logs, and Pre-And Post-Dive Checklists

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

a) Gas supply cylinders full

b) Composition of all supply and bail-out gases analyzed and documented

c) Oxygen sensors calibrated

d) Carbon dioxide canister properly packed

e) Remaining duration of canister life verified

f) Breathing loop assembled

g) Positive and negative pressure leak checks

h) Automatic volume addition system working

i) Automatic oxygen addition systems working

j) 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)

k) Other procedures specific to the model of rebreather used

l) Documentation of ALL components assembled

m) Complete pre-dive system check performed

n) Final operational verification immediately before to entering the water:

1. PO_2 in the rebreather is not hypoxic

2. Oxygen addition system is functioning;

3. Volumetric addition is functioning

4. Bail-out life support is functioning

Alternate Life Support System

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

a) Open-circuit bailout cylinders or sets of cylinders, either carried or pre-positioned

b) Redundant rebreather

c) Pre-positioned life support equipment with topside support

CO2 Absorbent Material

a) CO_2 absorption canister shall be filled in accordance with the manufacturer's specifications.

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

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

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

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

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

Unit Disinfections

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

10.50 Oxygen Rebreathers

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

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

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

10.60 Semi-Closed Circuit Rebreathers

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

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

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

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

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

10.70 Closed-Circuit Rebreathers

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

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

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

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

Appendices

APPENDIX 1
DIVING MEDICAL EXAM OVERVIEW FOR THE EXAMINING PHYSICIAN

TO THE EXAMINING PHYSICIAN:

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

_____ _____

Diving Safety Officer Date

_____ _____

Printed Name Phone Number

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

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

CONDITIONS WHICH MAY DISQUALIFY CANDIDATES FROM DIVING

1. Abnormalities of the tympanic membrane, such as perforation, presence of a monomeric membrane, or inability to autoinflate the middle ears. [5 ,7, 8, 9]
2. Vertigo, including Meniere's Disease. [13]
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

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

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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

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

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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 <u>REQUIRED</u>:

DURING ALL INITIAL AND PERIODIC RE-EXAMS (UNDER AGE 40):

Medical history
Complete physical exam, with emphasis on neurological and otological components
Urinalysis
Any further tests deemed necessary by the physician

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

Chest x-ray (Required only during first exam over age 40)
Resting EKG
Assessment of coronary artery disease using Multiple-Risk-Factor Assessment[1]
(age, lipid profile, blood pressure, diabetic screening, smoking)
Note: Exercise stress testing may be indicated based on Multiple-Risk-Factor Assessment[2]

PHYSICIAN'S STATEMENT:

_____ 01 Diver **<u>IS</u>** medically qualified to dive for: _____2 years (over age 60)
_____3 years (age 40-59)
_____5 years (under age 40)

_____ 02 Diver **<u>IS NOT</u>** medically qualified to dive:_____Permanently_____Temporarily.

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

_____ **MD or DO** _____

Signature Date

_____

Name (Print or Type)

_____

Address

_____ _____

Telephone Number E-Mail Address

My familiarity with applicant is: _____This exam only _____Regular physician for _____years

My familiarity with diving medicine is: _____

APPENDIX 2b

The Downtown Aquarium MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING REPORT

APPLICANT'S RELEASE OF MEDICAL INFORMATION FORM

Name of Applicant (Print or Type)_____
I authorize the release of this information and all medical information subsequently acquired in association with my diving to the _____ Diving Safety Officer and Diving Control Board or their designee at (place) _____ on (date) _____
Signature of Applicant _____
Date_____

REFERENCES

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

[2] Gibbons RJ, et al. ACC/AHA Guidelines for exercise testing. A report of the American College of Cardiology/American Heart Association Task Force on practice guidelines (Committee on Exercise Testing). J Am Coll Cardiol. 1997; 30: 260-311.
http://www.acc.org/clinical/guidelines/exercise/exercise.pdf

APPENDIX 3
DIVING MEDICAL HISTORY FORM

(To Be Completed By Applicant-Diver)

Name _____ Sex ____Age ___ Wt.___ Ht. _____

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

TO THE APPLICANT:

Scuba diving 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	
18			Wear glasses or contact lenses	
19			Bleeding disorders	
20			Alcoholism	
21			Any problems related to diving	
22			Nervous tension or emotional problems	

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

	Yes	No	Please indicate whether or not the following apply to you	Comments
59			Low blood pressure	
60			Recurrent or persistent swelling of the legs	
61			Pounding, rapid heartbeat or palpitations	
62			Easily fatigued or short of breath	
63			Abnormal EKG	
64			Joint problems, dislocations or arthritis	
65			Back trouble or back injuries	
66			Ruptured or slipped disk	
67			Limiting physical handicaps	
68			Muscle cramps	
69			Varicose veins	
70			Amputations	
71			Head injury causing unconsciousness	
72			Paralysis	
73			Have you ever had an adverse reaction to medication?	
74			Do you smoke?	
75			Have you ever had any other medical problems not listed? If so, please list or describe below;	
76			Is there a family history of high cholesterol?	
77			Is there a family history of heart disease or stroke?	
78			Is there a family history of diabetes?	
79			Is there a family history of asthma?	
80			Date of last tetanus shot? Vaccination dates?	

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

_____

_____

_____

_____

_____

_____

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

Signature Date

APPENDIX 4
RECOMMENDED PHYSICIANS WITH EXPERTISE IN DIVING MEDICINE

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: _____

   Address: _____

   _____

   Telephone: _____

2. Name: _____

   Address: _____

   _____

   Telephone: _____

3. Name: _____

   Address: _____

   _____

   Telephone: _____

4. Name: _____

   Address: _____

   _____

   Telephone: _____

5. Name: _____

   Address: _____

   _____

   Telephone: _____

APPENDIX 5

DEFINITION OF TERMS

Air sharing - Sharing of an air supply between divers.

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

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

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

Buddy Diver - Second member of the dive team.

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

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

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

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

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

Cylinder - A pressure vessel for the storage of gases.

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

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

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

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

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

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

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

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

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

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

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

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

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

EAD - Equivalent Air Depth (see below).

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

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

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

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

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

FFW – Feet or freshwater, or equivalent static head.

FSW - Feet of seawater, or equivalent static head.

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

Hyperbaric Chamber - See decompression chamber.

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

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

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

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

Mixed Gas - MG

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

MOD - Maximum Operating Depth, usually determined as the depth at which the pO_2 for a given gas mixture reaches a predetermined maximum.

MSW - Meters of seawater or equivalent static head.

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

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

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

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

Oxygen Clean - All combustible contaminants have been removed.

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

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

Oxygen Toxicity Unit - OTU

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

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

Pressure Vessel - See cylinder.

pN_2 - Inspired partial pressure of nitrogen, usually expressed in units of atmospheres absolute.

pO_2 - Inspired partial pressure of oxygen, usually expressed in units of atmospheres absolute.

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

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

Recompression Chamber - see decompression chamber.

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

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

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

Surface Supplied Diving - Surface Supplied: Dives where the breathing gas is supplied from the surface by means of a pressurized umbilical hose. The umbilical generally consists of a

gas supply hose, strength member, pneumofathometer hose, and communication line. The umbilical supplies a helmet or full-face mask. The diver may rely on the tender at the surface to keep up with the divers' depth, time and diving profile.

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

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

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

APPENDIX 6

The Downtown Aquarium/ 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 ***The Downtown Aquarium*** Diving Safety Manual, and has demonstrated competency in the indicated areas. The Downtown Aquarium 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 The Downtown Aquarium (*Houston/ Denver) *Circle one.

_____
(Date)
_____ Original diving authorization
_____ Written scientific diving examination
_____ Last diving medical examination Medical examination expiration date_____
_____ Most recent checkout dive
_____ Scuba regulator/equipment service/test
_____ CPR training (Agency) _____ CPR Exp.
_____
_____ Oxygen administration (Agency) _____ 02 Exp. _____
_____ First aid for diving _____ F.A. Exp. _____
_____ Date of last dive _____ Depth
Number of dives completed within previous 12 months?_____ Depth
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 DIVING EMERGENCY MANAGEMENT PROCEDURES

Introduction

A diving accident victim could be any person who has been breathing air underwater regardless of depth. It is essential that emergency procedures are pre-planned and that medical treatment is initiated as soon as possible. The Downtown Aquarium has developed procedures for diving emergencies including evacuation and medical treatment for each dive location. General procedures for any emergency are outlined below.

General Procedures

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

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

List of Emergency Contact Numbers Appropriate For Dive Location

Available Procedures

- Emergency care
- Recompression
- Evacuation

Emergency Plan Content

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

APPENDIX 8

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 his/her own unit.
4. On any given dive, both divers in the buddy pair must follow the most conservative dive computer.
5. If the dive computer fails at any time during the dive, the dive must be terminated and appropriate surfacing procedures should be initiated immediately.
6. A diver should not dive for 18 hours before activating a dive computer to use it to control their diving.
7. Once the dive computer is in use, it must not be switched off until it indicates complete out gassing has occurred or 18 hours have elapsed, whichever comes first.
8. When using a dive computer, non emergency ascents are to be at a rate specified for the make and model of dive computer being used.
10. Whenever practical, divers using a dive computer should make a stop between 10 and 30 feet for 5 minutes, especially for dives below 60 fsw.
11. Multiple deep dives require special consideration.

APPENDIX 9

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.

APPENDIX 10
POTENTIALLY DANGEROUS ANIMALS AT DTAQ

Some of the animals at The Downtown Aquarium are potentially dangerous. They have teeth, sharp spines and some are large and powerful. All animals must be handled with caution for the safety of both the animal, and the diver. Animals, dangerous or not, should only be handled by trained staff members. The following is a representative list of potentially dangerous animals and is in no way inferred to be a complete list.

VENOMOUS ANIMALS

Any facility with venomous animals on display or in quarantine must have emergency response protocols in place in the event of invenomation. All dive operations involving venomous animals must be handled with extreme caution and any available safety equipment must be properly used. All divers and tenders must be familiar with emergency invenomation response protocols for an effective response in the event of an emergency. *Note- It is the responsibility of the Facility Curator to add any venomous animals not included on this list.*
Some Venomous Animals typically on display are listed below:

SCORPION/ STONE FISH

Scorpionfish are some of the most toxic fish possibly kept on exhibit. They can be life threatening and any victims of suspected invenomation from a Scorpionfish should seek immediate care from a physician. Wounds from these spines are very painful, and the seriousness of the invenomation varies from person to person. Severe allergic reactions can occur from the injury as well as infection. All invenomation should be treated seriously and immediately.

LIONFISH

Lionfish have venomous spines at the end of their dorsal fins. . Wounds from these spines are very painful, and the seriousness of the invenomation varies from person to person. Severe allergic reactions can occur from the injury as well as infection. All invenomation should be treated seriously and immediately by removing all jewelry and any other item worn that could cause constriction if swelling occurs. The affected area of the sting should be immersed in water as hot as the victim can withstand and victim should be monitored for an allergic reaction while EMS is in route.

RABBITFISH

Rabbitfish have venomous spines at the end of their fins. Wounds from these spines are very painful, and the seriousness of the invenomation varies from person to person. Severe allergic reactions can occur from the injury as well as infection. All invenomation should be treated seriously and immediately by removing all jewelry and any other item worn that could cause constriction if swelling occurs. The affected area of the sting should be immersed in water as hot as the victim can withstand and victim should be monitored for an allergic reaction while EMS is in route.

CORAL CATFISH

These fish have a complex toxin that can cause intense pain to a person that has been injured by the venomous spines. Severe allergic reactions can occur from the injury as well as infection.

STINGRAYS

Stingrays have a sharp barb that protrudes from the tail anywhere from the base to the end of the tail, depending on species. The barb is also equipped with a toxin. Generally, stingrays only sting as a defensive behavior if stepped on, but caution should be taken at all times while interacting with these animals, above and below water. Be aware of what is under you as you descend into an exhibit. Severe allergic reactions can occur from the injury as well as infection. All invenomation should be treated seriously and immediately by removing all jewelry and any other item worn that could cause constriction if swelling occurs. The affected area of the sting should be immersed in water as hot as the victim can withstand and victim should be monitored for an allergic reaction while EMS is in route.

ANEMONES

Certain species of anemones can be potentially harmful. Each facility curator should identify the characteristics of each anemone in their facility to know if it is potentially toxic to humans.

URCHINS

Certain species of urchin can be potentially harmful. Each facility curator should identify the characteristics of each urchin in their facility to know if it is potentially toxic to humans.

NON-VENOMOUS ANIMALS

SHARKS

All sharks are wild animals despite their perceived disposition or docile behavior. All sharks have teeth and powerful jaws whatever size they are. Precautions MUST be taken while working with this group of animals. Excessive handling should be avoided. Protective equipment should be worn when feeding or handling this group of animals. Suggested safety equipment includes feeding poles, feeding tongs, proper transport equipment, Kevlar and chain mail suits, sleeves, or gloves.

If there is an incident involving a shark bite, all divers should signal to their safety or buddy diver and immediately leave the water. First aid should be administered and the wound treated by a physician. Wetsuits on the affected diver should ONLY be removed by the attending emergency personnel.

MORAY EELS

Morays are normally not aggressive, but they can be dangerous under certain circumstances. They normally reside in cracks or holes in the reef structure. The eels may come out to swim around. If they do this, try and avoid contact with the eel. Divers needs to take care not to place a hand into any crack or hole.

Moray eels are not poisonous, unless eaten. However, their mouth is full of sharp teeth. If bitten by an eel the teeth can cause massive tissue damage. The bacteria found in the mouth of a Moray will lead to a serious infection unless a physician properly cares for the wound. If bitten by a Moray, the diver should signal to their safety or buddy diver and immediately leave the water. First aid should be administered and the wound treated by a physician

BARRACUDA

Barracuda are extremely fast and powerful predators of the reef. They have extremely large teeth and are very unpredictable. Divers should use all provided safe guards and act cautiously around barracudas due to the amount of tissue damage that they can cause if they strike.

If there is an incident involving a barracuda bite, all divers should signal to their safety or buddy diver and immediately leave the water. First aid should be administered and the wound treated by a physician. Wetsuits on the affected diver should ONLY be removed by the attending emergency personnel.

PUFFERFISH

Pufferfish have powerful jaws and sharp teeth. They are known to associate divers with food and will bite at divers if they feel they are being ignored. Keep an eye on this fish while in the water.

TRIGGERFISH

Triggerfish are not venomous, but they do have a powerful jaws and sharp teeth. They are known to be territorial and will bite at intruders to get them to leave their territory.

FILEFISH

Filefish are not venomous, but they do have a powerful jaws and sharp teeth. They are known to be territorial and will bite at intruders to get them to leave their territory.

GROUPER

Grouper have several sets of teeth, placed in the mouth to act as raspers or holding teeth. These fish gulp down prey using the raspers to prevent the smaller fish from escaping. The teeth are not used to slash or tear, but could do a lot of damage to the hand of a diver. Care should be taken when putting your hands near the groupers mouth, especially during a feeding.

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APPENDIX 11

The Downtown Aquarium Animal Removal Policies

Any time that an animal must be removed from an exhibit using SCUBA or Hookah systems, a DSO and DCB approved plan must be developed and discussed with all staff and volunteer participants. Any questions that should arise will be addressed before the dive takes place, and should an unplanned problem arise before the completion of the dive, ALL divers will surface to discuss and clarify the situation. Serious consideration should be given to the safety of the animal being captured, the divers, and the effect the action will have on other animals in the exhibit.

Should an animal need to be culled, the DSO will complete the task using the appropriate equipment. Should a spear gun be used, the following procedures will be followed:

a. All divers involved in dive operations with a speargun must be properly trained for the job they are performing.

b. No more than two divers (including the Dive Safety Officer) will be allowed in the water during the time that the spear gun is being used. Depending on the display and the conditions, the Dive Safety Officer may enter the water alone with visual contact being maintained by personnel with radios, and a topside diver who is prepared to enter the water to assist if necessary.

c. The gun will always be kept on "safe" until ready to shoot

d. Always look beyond the fish to see what else might be in the way (another diver, another fish, or the acrylic windows). Think carefully about it before you shoot.

e. Be careful to only spear the fish that is intended for removal and remove the fish from the water as quickly as possible so that a necropsy may be performed.

f. Never shoot a fish that is so large that the spear will not kill or incapacitate it immediately. Other methods can be used to remove large animals if necessary.

g. Make the shot count. Do not cause unnecessary trauma to the animal by injuring it and being forced to shoot again.

h. Always ascend to a shallower depth if the fish is fighting and remember to breathe slow and deep. NEVER hold your breath.

i. Always pull the trigger after you breathe in

j. Remember to ascend slowly to the surface after finishing your dive.

APPENDIX 12
DIVE PLANNING FORM (SPECIAL PROJECTS)

This form is to be filled out and submitted to the Dive Safety Officer at least two days prior to the diving activities. Projects are not permitted to proceed without approval from the DSO and DCB. Please use this form to plan the activities, staffing and emergency procedures. This form should be filed for reference for a period of 1 year or in the case of a dive accident the record must be kept for 5 years. **Note: All participants must be approved staff of DTAQ or approved by the DSO and DCB in the case of utilizing outside assistance by contracted divers or divers under the reciprocity of another AAUS institution.*

Project Details:
Project Supervisor: _____
Topside Diving Supervisor (if necessary): _____
Proposed date of dive activity: _____
Dive team leaders (if necessary): _____
Location of Dive Activity: _____
Number of divers involved:_____
Staff Names: _____Other Divers Name/Affiliation: _____
Staff Names: _____Other Divers Name/Affiliation: _____
Staff Names: _____Other Divers Name/Affiliation: _____
Staff Names: _____Other Divers Name/Affiliation: _____
Staff Names: _____Other Divers Name/Affiliation: _____
Staff Names: _____Other Divers Name/Affiliation: _____
Staff Names: _____Other Divers Name/Affiliation: _____
Estimated start time of project: _____ Estimated end time of project: _____
Project Type: *CIRCLE ONE*- SCIENTIFIC/ COMMERCIAL/ RECREATIONAL

Safety Manual and Standards Used: *CIRCLE ONE*-
DTAQ Dive Safety Manual/ OSHA Commercial Diving Standards/ RSTC Agency:_____/ OTHER_____
Description:

Dive Services Support:
Dive Officer required**: yes / no**
Special / Extra Equipment needed: _____
_____

Estimated number of SCUBA tanks required: _____

Emergency Planning:
Nearest working phone location and extension: _____
Emergency services number: __**911**_____
First Aid in place: yes / no Location of closest kit: _____
Oxygen bottles full: yes / no Location of closest O2 bottle: _____
Potential emergency situations with proposed project:

Emergency plan for listed emergencies:

I understand that all scuba diving conducted under the auspices of The Downtown Aquarium must comply with the current DTAQ Dive Manual, OSHA Standards for Commercial Diving or RSTC diving standards or other applicable safety manual as appropriate for the type of dive operation being conducted. I understand further that the DSO and DCB must approve ALL persons as appropriate involved in the diving operations described above.

Project Supervisor- Signed: _____ Date: _____

DSO Approval- Signed: _____ Date: _____

APPENDIX 13
OSHA COMMERCIAL DIVING STANDARDS

The following document sets the operational standards for all dive operations under the auspice of The Downtown Aquarium for all dives determined to be commercial in nature only. Scientific or Recreational dives will follow the corresponding standards for each of those different types of dive operation. The Dive Safety Officer or designee will determine which dives are to be considered commercial. All the commercial diving operational standards must be followed when conducting dive operations using the following standards. Any deviation from the standards below should be immediately reported to management. These standards can be located at www.osha.gov.

1910.401(a)
Scope.
1910.401(a)(1)
This subpart (standard) applies to every place of employment within the waters of the United States, or within any State, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, American Samoa, Guam, the Trust Territory of the Pacific Islands, Wake Island, Johnston Island, the Canal Zone, or within the Outer Continental Shelf lands as defined in the Outer Continental Shelf Lands Act (67 Stat. 462, 43 U.S.C. 1331), where diving and related support operations are performed.
1910.401(a)(2)
This standard applies to diving and related support operations conducted in connection with all types of work and employments, including general industry, construction, ship repairing, shipbuilding, shipbreaking and longshoring. However, this standard does not apply to any diving operation:
1910.401(a)(2)(i)
Performed solely for instructional purposes, using open-circuit, compressed-air SCUBA and conducted within the no-decompression limits;
1910.401(a)(2)(ii)
Performed solely for search, rescue, or related public safety purposes by or under the control of a governmental agency; or
1910.401(a)(2)(iii)
Governed by 45 CFR Part 46 (Protection of Human Subjects, U.S. Department of Health and Human Services) or equivalent rules or regulations established by another federal agency, which regulate research, development, or related purposes involving human subjects.
1910.401(a)(2)(iv)
Defined as scientific diving and which is under the direction and control of a diving program containing at least the following elements:
1910.401(a)(2)(iv)(A)
Diving safety manual which includes at a minimum: Procedures covering all diving operations specific to the program; procedures for emergency care, including recompression and evacuation; and criteria for diver training and certification.
1910.401(a)(2)(iv)(B)
Diving control (safety) board, with the majority of its members being active 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.
1910.401(a)(3)
Alternative requirements for recreational diving instructors and diving guides. Employers of recreational diving instructors and diving guides are not required to comply with the decompression-chamber requirements specified by paragraphs (b)(2) and (c)(3)(iii) of § 1910.423 and paragraph (b)(1) of § 1910.426 when they meet all of the following conditions:
1910.401(a)(3)(i)
The instructor or guide is engaging solely in recreational diving instruction or dive-guiding operations;
1910.401(a)(3)(ii)
The instructor or guide is diving within the no-decompression limits in these operations;
1910.401(a)(3)(iii)
The instructor or guide is using a nitrox breathing-gas mixture consisting of a high percentage of oxygen (more than 22% by volume) mixed with nitrogen;
1910.401(a)(3)(iv)
The instructor or guide is using an open-circuit, semi-closed-circuit, or closed-circuit self-contained underwater breathing apparatus (SCUBA); and
1910.401(a)(3)(v)
The employer of the instructor or guide is complying with all requirements of Appendix C of this subpart.
1910.401(b)

Application in emergencies. An employer may deviate from the requirements of this standard to the extent necessary to prevent or minimize a situation which is likely to cause death, serious physical harm, or major environmental damage, provided that the employer:

1910.401(b)(1)

Notifies the Area Director, Occupational Safety and Health Administration within 48 hours of the onset of the emergency situation indicating the nature of the emergency and extent of the deviation from the prescribed regulations; and

1910.401(b)(2)

Upon request from the Area Director, submits such information in writing.

1910.401(c)

Employer obligation. The employer shall be responsible for compliance with:

1910.401(c)(1)

All provisions of this standard of general applicability; and

1910.401(c)(2)

All requirements pertaining to specific diving modes to the extent diving operations in such modes are conducted.

As used in this standard, the listed terms are defined as follows:

1910.402

Definitions

Acfm: Actual cubic feet per minute.

ASME Code or equivalent: ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code, Section VIII, or an equivalent code which the employer can demonstrate to be equally effective.

ATA: Atmosphere absolute.

Bell: An enclosed compartment, pressurized (closed bell) or unpressurized (open bell), which allows the diver to be transported to and from the underwater work area and which may be used as a temporary refuge during diving operations.

Bottom time: The total elapsed time measured in minutes from the time when the diver leaves the surface in descent to the time that the diver begins ascent.

Bursting pressure: The pressure at which a pressure containment device would fail structurally.

Cylinder: A pressure vessel for the storage of gases.

Decompression chamber: A pressure vessel for human occupancy such as a surface decompression chamber, closed bell, or deep diving system used to decompress divers and to treat decompression sickness.

Decompression sickness: A condition with a variety of symptoms which may result from gas or bubbles in the tissues of divers after pressure reduction.

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

Dive-guiding operations means leading groups of sports divers, who use an open-circuit, semi-closed-circuit, or closed-circuit self-contained underwater breathing apparatus, to local undersea diving locations for recreational purposes.

Dive location: A surface or vessel from which a diving operation is conducted.

Dive-location reserve breathing gas: A supply system of air or mixed-gas (as appropriate) at the dive location which is independent of the primary supply system and sufficient to support divers during the planned decompression.

Dive team: Divers and support employees involved in a diving operation, including the designated person-in-charge.

Diver: An employee working in water using underwater apparatus which supplies compressed breathing gas at the ambient pressure.

Diver-carried reserve breathing gas: A diver-carried 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 a standby diver.

Diving mode: A type of diving requiring specific equipment, procedures and techniques (SCUBA, surface-supplied air, or mixed gas).

Fsw: Feet of seawater (or equivalent static pressure head).

Heavy gear: Diver-worn deep-sea dress including helmet, breastplate, dry suit, and weighted shoes.

Hyperbaric conditions: Pressure conditions in excess of surface pressure.

Inwater stage: A suspended underwater platform which supports a diver in the water.

Liveboating: The practice of supporting a surfaced-supplied air or mixed gas diver from a vessel which is underway.

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

No-decompression limits: The depth-time limits of the "no-decompression limits and repetitive dive group designation table for no-decompression air dives", U.S. Navy Diving Manual or equivalent limits which the employer can demonstrate to be equally effective.

Psi(g): Pounds per square inch (gauge).

Recreational diving instruction means training diving students in the use of recreational diving procedures and the safe operation of diving equipment, including an open-circuit, semi-closed-circuit, or closed-circuit self-contained underwater breathing apparatus, during dives.

Scientific diving means diving performed solely as a necessary part of a scientific, research, or educational activity by employees whose sole purpose for diving is to perform scientific research tasks. Scientific diving does not include performing any tasks usually associated with commercial diving such as: Placing or removing heavy objects underwater; inspection of pipelines and similar objects; construction; demolition; cutting or welding; or the use of explosives.

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 available to assist a diver in the water.

Surface-supplied air diving: A diving mode in which the diver in the water is supplied from the dive location with

compressed air for breathing.
Treatment table: A depth-time and breathing gas profile designed to treat decompression sickness.
Umbilical: The composite hose bundle between a dive location and a diver or bell, or between a diver and a bell, which supplies the 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.
Volume tank: A pressure vessel connected to the outlet of a compressor and used as an air reservoir.
Working pressure: The maximum pressure to which a pressure containment device may be exposed under standard operating conditions.

1910.410(a)
General.
1910.410(a)(1)
Each dive team member shall have the experience or training necessary to perform assigned tasks in a safe and healthful manner.
1910.410(a)(2)
Each dive team member shall have experience or training in the following:
1910.410(a)(2)(i)
The use of tools, equipment and systems relevant to assigned tasks;
1910.410(a)(2)(ii)
Techniques of the assigned diving mode: and
1910.410(a)(2)(iii)
Diving operations and emergency procedures.
1910.410(a)(3)
All dive team members shall be trained in cardiopulmonary resuscitation and first aid (American Red Cross standard course or equivalent).
1910.410(a)(4)
Dive team members who are exposed to or control the exposure of others to hyperbaric conditions shall be trained in diving-related physics and physiology.
1910.410(b)
Assignments.
1910.410(b)(1)
Each dive team member shall be assigned tasks in accordance with the employee's experience or training, except that limited additional tasks may be assigned to an employee undergoing training provided that these tasks are performed under the direct supervision of an experienced dive team member.
1910.410(b)(2)
The employer shall not require a dive team member to be exposed to hyperbaric conditions against the employee's will, except when necessary to complete decompression or treatment procedures.
1910.410(b)(3)
The employer shall not permit a dive team member to dive or be otherwise exposed to hyperbaric conditions for the duration of any temporary physical impairment or condition which is known to the employer and is likely to affect adversely the safety or health of a dive team member.
1910.410(c)
Designated person-in-charge.
1910.410(c)(1)
The employer or an employee designated by the employer shall be at the dive location in charge of all aspects of the diving operation affecting the safety and health of dive team members.
1910.410(c)(2)
The designated person-in-charge shall have experience and training in the conduct of the assigned diving operation.
1910.420(a)
General. The employer shall develop and maintain a safe practices manual which shall be made available at the dive location to each dive team member.
1910.420(b)
Contents.
1910.420(b)(1)
The safe practices manual shall contain a copy of this standard and the employer's policies for implementing the requirements of this standard.
1910.420(b)(2)
For each diving mode engaged in, the safe practices manual shall include:
1910.420(b)(2)(i)
Safety procedures and checklists for diving operations;
1910.420(b)(2)(ii)
Assignments and responsibilities of the dive team members;
1910.420(b)(2)(iii)
Equipment procedures and checklists; and
1910.420(b)(2)(iv)
Emergency procedures for fire, equipment failure, adverse environmental conditions, and medical illness and injury.
1910.421(a)

General. The employer shall comply with the following requirements prior to each diving operation, unless otherwise specified.
1910.421(b)
Emergency aid. A list shall be kept at the dive location of the telephone or call numbers of the following:
1910.421(b)(1)
An operational decompression chamber (if not at the dive location);
1910.421(b)(2)
Accessible hospitals;
1910.421(b)(3)
Available physicians;
1910.421(b)(4)
Available means of transportation; and
1910.421(b)(5)
The nearest U.S. Coast Guard Rescue Coordination Center.
1910.421(c)
First aid supplies.
1910.421(c)(1)
A first aid kit appropriate for the diving operation and approved by a physician shall be available at the dive location.
1910.421(c)(2)
When used in a decompression chamber or bell, the first aid kit shall be suitable for use under hyperbaric conditions.
1910.421(c)(3)
In addition to any other first aid supplies, an American Red Cross standard first aid handbook or equivalent, and a bag-type manual resuscitator with transparent mask and tubing shall be available at the dive location.
1910.421(d)
Planning and assessment. Planning of a diving operation shall include an assessment of the safety and health aspects of the following:
1910.421(d)(1)
Diving mode;
1910.421(d)(2)
Surface and underwater conditions and hazards;
1910.421(d)(3)
Breathing gas supply (including reserves);
1910.421(d)(4)
Thermal protection;
1910.421(d)(5)
Diving equipment and systems;
1910.421(d)(6)
Dive team assignments and physical fitness of dive team members (including any impairment known to the employer);
1910.421(d)(7)
Repetitive dive designation or residual inert gas status of dive team members;
1910.421(d)(8)
Decompression and treatment procedures (including altitude corrections); and
1910.421(d)(9)
Emergency procedures.
1910.421(e)
Hazardous activities. To minimize hazards to the dive team, diving operations shall be coordinated with other activities in the vicinity which are likely to interfere with the diving operation.
1910.421(f)
Employee briefing.
1910.421(f)(1)
Dive team members shall be briefed on:
1910.421(f)(1)(i)
The tasks to be undertaken;
1910.421(f)(1)(ii)
Safety procedures for the diving mode;
1910.421(f)(1)(iii)
Any unusual hazards or environmental conditions likely to affect the safety of the diving operation; and
1910.421(f)(1)(iv)
Any modifications to operating procedures necessitated by the specific diving operation.
1910.421(f)(2)
Prior to making individual dive team member assignments, the employer shall inquire into the dive team member's current state of physical fitness, and indicate to the dive team member the procedure for reporting physical problems or adverse physiological effects during and after the dive.
1910.421(g)
Equipment inspection. The breathing gas supply system including reserve breathing gas supplies, masks, helmets, thermal protection, and bell handling mechanism (when appropriate) shall be inspected prior to each dive.
1910.421(h)

Warning signal. When diving from surfaces other than vessels in areas capable of supporting marine traffic, a rigid replica of the international code flag "A" at least one meter in height shall be displayed at the dive location in a manner which allows all-round visibility, and shall be illuminated during night diving operations.
1910.422(a)
General. The employer shall comply with the following requirements which are applicable to each diving operation unless otherwise specified.
1910.422(b)
Water entry and exit.
1910.422(b)(1)
A means capable of supporting the diver shall be provided for entering and exiting the water.
1910.422(b)(2)
The means provided for exiting the water shall extend below the water surface.
1910.422(b)(3)
A means shall be provided to assist an injured diver from the water or into a bell.
1910.422(c)
Communications.
1910.422(c)(1)
An operational two-way voice communication system shall be used between:
1910.422(c)(1)(i)
Each surface-supplied air or mixed-gas diver and a dive team member at the dive location or bell (when provided or required); and
1910.422(c)(1)(ii)
The bell and the dive location.
1910.422(c)(2)
An operational, two-way communication system shall be available at the dive location to obtain emergency assistance.
1910.422(d)
Decompression tables. Decompression, repetitive, and no-decompression tables (as appropriate) shall be at the dive location.
1910.422(e)
Dive profiles. A depth-time profile, including when appropriate any breathing gas changes, shall be maintained for each diver during the dive including decompression.
1910.422(f)
Hand-held power tools and equipment.
1910.422(f)(1)
Hand-held electrical tools and equipment shall be de-energized before being placed into or retrieved from the water.
1910.422(f)(2)
Hand-held power tools shall not be supplied with power from the dive location until requested by the diver.
1910.422(g)
Welding and burning.
1910.422(g)(1)
A current supply switch to interrupt the current flow to the welding or burning electrode shall be:
1910.422(g)(1)(i)
Tended by a dive team member in voice communication with the diver performing the welding or burning; and
1910.422(g)(1)(ii)
Kept in the open position except when the diver is welding or burning.
1910.422(g)(2)
The welding machine frame shall be grounded.
1910.422(g)(3)
Welding and burning cables, electrode holders, and connections shall be capable of carrying the maximum current required by the work, and shall be properly insulated.
1910.422(g)(4)
Insulated gloves shall be provided to divers performing welding and burning operations.
1910.422(g)(5)
Prior to welding or burning on closed compartments, structures or pipes, which contain a flammable vapor or in which a flammable vapor may be generated by the work, they shall be vented, flooded, or purged with a mixture of gases which will not support combustion.
1910.422(h)
Explosives.
1910.422(h)(1)
Employers shall transport, store, and use explosives in accordance with this section and the applicable provisions of 1910.109 and 1926.912 of Title 29 of the Code of Federal Regulations.
1910.422(h)(2)
Electrical continuity of explosive circuits shall not be tested until the diver is out of the water.
1910.422(h)(3)
Explosives shall not be detonated while the diver is in the water.
1910.422(i)
Termination of dive. The working interval of a dive shall be terminated when:
1910.422(i)(1)

A diver requests termination;
1910.422(i)(2)
A diver fails to respond correctly to communications or signals from a dive team member;
1910.422(i)(3)
Communications are lost and cannot be quickly re-established between the diver and a dive team member at the dive location, and between the designated person-in-charge and the person controlling the vessel in liveboating operations; or
1910.422(i)(4)
A diver begins to use diver-carried reserve breathing gas or the dive-location reserve breathing gas.
1910.423(a)
General. The employer shall comply with the following requirements which are applicable after each diving operation, unless otherwise specified.
1910.423(b)
Precautions.
1910.423(b)(1)
After the completion of any dive, the employer shall:
1910.423(b)(1)(i)
Check the physical condition of the diver;
1910.423(b)(1)(ii)
Instruct the diver to report any physical problems or adverse physiological effects including symptoms of decompression sickness;
1910.423(b)(1)(iii)
Advise the diver of the location of a decompression chamber which is ready for use; and
1910.423(b)(1)(iv)
Alert the diver to the potential hazards of flying after diving.
1910.423(b)(2)
For any dive outside the no-decompression limits, deeper than 100 fsw or using mixed gas as a breathing mixture, the employer shall instruct the diver to remain awake and in the vicinity of the decompression chamber which is at the dive location for at least one hour after the dive (including decompression or treatment as appropriate).
1910.423(c)
Recompression capability.
1910.423(c)(1)
A decompression chamber capable of recompressing the diver at the surface to a minimum of 165 fsw (6 ATA) shall be available at the dive location for:
1910.423(c)(1)(i)
Surface-supplied air diving to depths deeper than 100 fsw and shallower than 220 fsw;
1910.423(c)(1)(ii)
Mixed gas diving shallower than 300 fsw; or
1910.423(c)(1)(iii)
Diving outside the no-decompression limits shallower than 300 fsw.
1910.423(c)(2)
A decompression chamber capable of recompressing the diver at the surface to the maximum depth of the dive shall be available at the dive location for dives deeper than 300 fsw.
1910.423(c)(3)
The decompression chamber shall be:
1910.423(c)(3)(i)
Dual-lock;
1910.423(c)(3)(ii)
Multiplace; and
1910.423(c)(3)(iii)
Located within 5 minutes of the dive location.
1910.423(c)(4)
The decompression chamber shall be equipped with:
1910.423(c)(4)(i)
A pressure gauge for each pressurized compartment designed for human occupancy;
1910.423(c)(4)(ii)
A built-in-breathing-system with a minimum of one mask per occupant;
1910.423(c)(4)(iii)
A two-way voice communication system between occupants and a dive team member at the dive location;
1910.423(c)(4)(iv)
A viewport; and
1910.423(c)(4)(v)
Illumination capability to light the interior.
1910.423(c)(5)
Treatment tables, treatment gas appropriate to the diving mode, and sufficient gas to conduct treatment shall be available at the dive location.
1910.423(c)(6)
A dive team member shall be available at the dive location during and for at least one hour after the dive to operate the decompression chamber (when required or provided).

1910.423(d)
Record of dive.
1910.423(d)(1)
The following information shall be recorded and maintained for each diving operation:
1910.423(d)(1)(i)
Names of dive team members including designated person-in-charge;
1910.423(d)(1)(ii)
Date, time, and location;
1910.423(d)(1)(iii)
Diving modes used;
1910.423(d)(1)(iv)
General nature of work performed;
1910.423(d)(1)(v)
Approximate underwater and surface conditions (visibility, water temperature and current); and
1910.423(d)(1)(vi)
Maximum depth and bottom time for each diver.
1910.423(d)(2)
For each dive outside the no-decompression limits, deeper than 100 fsw or using mixed gas, the following additional information shall be recorded and maintained:
1910.423(d)(2)(i)
Depth-time and breathing gas profiles;
1910.423(d)(2)(ii)
Decompression table designation (including modification); and
1910.423(d)(2)(iii)
Elapsed time since last pressure exposure if less than 24 hours or repetitive dive designation for each diver.
1910.423(d)(3)
For each dive in which decompression sickness is suspected or symptoms are evident, the following additional information shall be recorded and maintained:
1910.423(d)(3)(i)
Description of decompression sickness symptoms (including depth and time of onset); and
1910.423(d)(3)(ii)
Description and results of treatment.
1910.423(e)
Decompression procedure assessment. The employer shall:
1910.423(e)(1)
Investigate and evaluate each incident of decompression sickness based on the recorded information, consideration of the past performance of decompression table used, and individual susceptibility;
1910.423(e)(2)
Take appropriate corrective action to reduce the probability of recurrence of decompression sickness; and
1910.423(e)(3)
Prepare a written evaluation of the decompression procedure assessment, including any corrective action taken, within 45 days of the incident of decompression sickness.
1910.424(a)
General. Employers engaged in SCUBA diving shall comply with the following requirements, unless otherwise specified.
1910.424(b)
Limits. SCUBA diving shall not be conducted:
1910.424(b)(1)
At depths deeper than 130 fsw;
1910.424(b)(2)
At depths deeper than 100 fsw or outside the no-decompression limits unless a decompression chamber is ready for use;
1910.424(b)(3)
Against currents exceeding one (1) knot unless line-tended; or
1910.424(b)(4)
In enclosed or physically confining spaces unless line-tended.
1910.424(c)
Procedures.
1910.424(c)(1)
A standby diver shall be available while a diver is in the water.
1910.424(c)(2)
A diver shall be line-tended from the surface, or accompanied by another diver in the water in continuous visual contact during the diving operations.
1910.424(c)(3)
A diver shall be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.
1910.424(c)(4)
A diver-carried reserve breathing gas supply shall be provided for each diver consisting of:
1910.424(c)(4)(i)
A manual reserve (J valve); or

1910.424(c)(4)(ii)
An independent reserve cylinder with a separate regulator or connected to the underwater breathing apparatus.
1910.424(c)(5)
The valve of the reserve breathing gas supply shall be in the closed position prior to the dive.
1910.425(a)
General. Employers engaged in surface-supplied air diving shall comply with the following requirements, unless otherwise specified.
1910.425(b)
Limits.
1910.425(b)(1)
Surface-supplied air diving shall not be conducted at depths deeper than 190 fsw, except that dives with bottom times of 30 minutes or less may be conducted to depths of 220 fsw.
1910.425(b)(2)
A decompression chamber shall be ready for use at the dive location for any dive outside the no-decompression limits or deeper than 100 fsw.
1910.425(b)(3)
A bell shall be used for dives with an inwater decompression time greater than 120 minutes, except when heavy gear is worn or diving is conducted in physically confining spaces.
1910.425(c)
Procedures.
1910.425(c)(1)
Each diver shall be continuously tended while in the water.
1910.425(c)(2)
A diver shall be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.
1910.425(c)(3)
Each diving operation shall have a primary breathing gas supply sufficient to support divers for the duration of the planned dive including decompression.
1910.425(c)(4)
For dives deeper than 100 fsw or outside the no-decompression limits:
1910.425(c)(4)(i)
A separate dive team member shall tend each diver in the water;
1910.425(c)(4)(ii)
A standby diver shall be available while a diver is in the water;
1910.425(c)(4)(iii)
A diver-carried reserve breathing gas supply shall be provided for each diver except when heavy gear is worn; and
1910.425(c)(4)(iv)
A dive-location reserve breathing gas supply shall be provided.
1910.425(c)(5)
For heavy-gear diving deeper than 100 fsw or outside the no-decompression limits:
1910.425(c)(5)(i)
An extra breathing gas hose capable of supplying breathing gas to the diver in the water shall be available to the standby diver.
1910.425(c)(5)(ii)
An inwater stage shall be provided to divers in the water.
1910.425(c)(6)
Except when heavy gear is worn or where physical space does not permit, a diver-carried reserve breathing gas supply shall be provided whenever the diver is prevented by the configuration of the dive area from ascending directly to the surface.
1910.426(a)
General. Employers engaged in mixed-gas diving shall comply with the following requirements, unless otherwise specified.
1910.426(b)
Limits. Mixed-gas diving shall be conducted only when:
1910.426(b)(1)
A decompression chamber is ready for use at the dive location; and
1910.426(b)(1)(i)
A bell is used at depths greater than 220 fsw or when the dive involves inwater decompression time of greater than 120 minutes, except when heavy gear is worn or when diving in physically confining spaces; or
1910.426(b)(1)(ii)
A closed bell is used at depths greater than 300 fsw, except when diving is conducted in physically confining spaces.
1910.426(c)
Procedures.
1910.426(c)(1)
A separate dive team member shall tend each diver in the water.
1910.426(c)(2)
A standby diver shall be available while a diver is in the water.
1910.426(c)(3)

A diver shall be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.
1910.426(c)(4)
Each diving operation shall have a primary breathing gas supply sufficient to support divers for the duration of the planned dive including decompression.
1910.426(c)(5)
Each diving operation shall have a dive-location reserve breathing gas supply.
1910.426(c)(6)
When heavy gear is worn:
1910.426(c)(6)(i)
An extra breathing gas hose capable of supplying breathing gas to the diver in the water shall be available to the standby diver; and
1910.426(c)(6)(ii)
An inwater stage shall be provided to divers in the water.
1910.426(c)(7)
An inwater stage shall be provided for divers without access to a bell for dives deeper than 100 fsw or outside the no-decompression limits.
1910.426(c)(8)
When a closed bell is used, one dive team member in the bell shall be available and tend the diver in the water.
1910.426(c)(9)
Except when heavy gear is worn or where physical space does not permit, a diver-carried reserve breathing gas supply shall be provided for each diver:
1910.426(c)(9)(i)
Diving deeper than 100 fsw or outside the no-decompression limits; or
1910.426(c)(9)(ii)
Prevented by the configuration of the dive area from directly ascending to the surface.
1910.427(a)
General. Employers engaged in diving operations involving liveboating shall comply with the following requirements.
1910.427(b)
Limits. Diving operations involving liveboating shall not be conducted:
1910.427(b)(1)
With an inwater decompression time of greater than 120 minutes;
1910.427(b)(2)
Using surface-supplied air at depths deeper than 190 fsw, except that dives with bottom times of 30 minutes or less may be conducted to depths of 220 fsw;
1910.427(b)(3)
Using mixed gas at depths greater than 220 fsw;
1910.427(b)(4)
In rough seas which significantly impede diver mobility or work function; or
1910.427(b)(5)
In other than daylight hours.
1910.427(c)
Procedures.
1910.427(c)(1)
The propeller of the vessel shall be stopped before the diver enters or exits the water.
1910.427(c)(2)
A device shall be used which minimizes the possibility of entanglement of the diver's hose in the propeller of the vessel.
1910.427(c)(3)
Two-way voice communication between the designated person-in-charge and the person controlling the vessel shall be available while the diver is in the water.
1910.427(c)(4)
A standby diver shall be available while a diver is in the water.
1910.427(c)(5)
A diver-carried reserve breathing gas supply shall be carried by each diver engaged in liveboating operations.
1910.430
General.
1910.430(a)(1)
All employers shall comply with the following requirements, unless otherwise specified.
1910.430(a)(2)
Each equipment modification, repair, test, calibration or maintenance service shall be recorded by means of a tagging or logging system, and include the date and nature of work performed, and the name or initials of the person performing the work.
1910.430(b)
Air compressor system.
1910.430(b)(1)
Compressors used to supply air to the diver shall be equipped with a volume tank with a check valve on the inlet side, a pressure gauge, a relief valve, and a drain valve.
1910.430(b)(2)

Air compressor intakes shall be located away from areas containing exhaust or other contaminants.
1910.430(b)(3)
Respirable air supplied to a diver shall not contain:
1910.430(b)(3)(i)
A level of carbon monoxide (CO) greater than 20 p/m;
1910.430(b)(3)(ii)
A level of carbon dioxide (CO(2)) greater than 1,000 p/m;
1910.430(b)(3)(iii)
A level of oil mist greater than 5 milligrams per cubic meter; or
1910.430(b)(3)(iv)
A noxious or pronounced odor.
1910.430(b)(4)
The output of air compressor systems shall be tested for air purity every 6 months by means of samples taken at the connection to the distribution system, except that non-oil lubricated compressors need not be tested for oil mist.
1910.430(c)
Breathing gas supply hoses.
1910.430(c)(1)
Breathing gas supply hoses shall:
1910.430(c)(1)(i)
Have a working pressure at least equal to the working pressure of the total breathing gas system;
1910.430(c)(1)(ii)
Have a rated bursting pressure at least equal to 4 times the working pressure;
1910.430(c)(1)(iii)
Be tested at least annually to 1.5 times their working pressure; and
1910.430(c)(1)(iv)
Have their open ends taped, capped or plugged when not in use.
1910.430(c)(2)
Breathing gas supply hose connectors shall:
1910.430(c)(2)(i)
Be made of corrosion-resistant materials;
1910.430(c)(2)(ii)
Have a working pressure at least equal to the working pressure of the hose to which they are attached; and
1910.430(c)(2)(iii)
Be resistant to accidental disengagement.
1910.430(c)(3)
Umbilicals shall:
1910.430(c)(3)(i)
Be marked in 10-ft. increments to 100 feet beginning at the diver's end, and in 50 ft. increments thereafter;
1910.430(c)(3)(ii)
Be made of kink-resistant materials; and
1910.430(c)(3)(iii)
Have a working pressure greater than the pressure equivalent to the maximum depth of the dive (relative to the supply source) plus 100 psi.
1910.430(d)
Buoyancy control.
1910.430(d)(1)
Helmets or masks connected directly to the dry suit or other buoyancy-changing equipment shall be equipped with an exhaust valve.
1910.430(d)(2)
A dry suit or other buoyancy-changing equipment not directly connected to the helmet or mask shall be equipped with an exhaust valve.
1910.430(d)(3)
When used for SCUBA diving, a buoyancy compensator shall have an inflation source separate from the breathing gas supply.
1910.430(d)(4)
An inflatable flotation device capable of maintaining the diver at the surface in a face-up position, having a manually activated inflation source independent of the breathing supply, an oral inflation device, and an exhaust valve shall be used for SCUBA diving.
1910.430(e)
Compressed gas cylinders. Compressed gas cylinders shall:
1910.430(e)(1)
Be designed, constructed and maintained in accordance with the applicable provisions of 29 CFR 1910.101 and 1910.169 through 1910.171.
1910.430(e)(2)
Be stored in a ventilated area and protected from excessive heat;
1910.430(e)(3)
Be secured from falling; and
1910.430(e)(4)

Have shut-off valves recessed into the cylinder or protected by a cap, except when in use or manifolded, or when used for SCUBA diving.

1910.430(f)

Decompression chambers.

1910.430(f)(1)

Each decompression chamber manufactured after the effective date of this standard, shall be built and maintained in accordance with the ASME Code or equivalent.

1910.430(f)(2)

Each decompression chamber manufactured prior to the effective date of this standard shall be maintained in conformity with the code requirements to which it was built, or equivalent.

1910.430(f)(3)

Each decompression chamber shall be equipped with:

1910.430(f)(3)(i)

Means to maintain the atmosphere below a level of 25 percent oxygen by volume;

1910.430(f)(3)(ii)

Mufflers on intake and exhaust lines, which shall be regularly inspected and maintained;

1910.430(f)(3)(iii)

Suction guards on exhaust line openings; and

1910.430(f)(3)(iv)

A means for extinguishing fire, and shall be maintained to minimize sources of ignition and combustible material.

1910.430(g)

Gauges and timekeeping devices.

1910.430(g)(1)

Gauges indicating diver depth which can be read at the dive location shall be used for all dives except SCUBA.

1910.430(g)(2)

Each depth gauge shall be deadweight tested or calibrated against a master reference gauge every 6 months, and when there is a discrepancy greater than two percent (2 percent) of full scale between any two equivalent gauges.

1910.430(g)(3)

A cylinder pressure gauge capable of being monitored by the diver during the dive shall be worn by each SCUBA diver.

1910.430(g)(4)

A timekeeping device shall be available at each dive location.

1910.430(h)

Masks and helmets.

1910.430(h)(1)

Surface-supplied air and mixed-gas masks and helmets shall have:

1910.430(h)(1)(i)

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

1910.430(h)(1)(ii)

An exhaust valve.

1910.430(h)(2)

Surface-supplied air masks and helmets shall have a minimum ventilation rate capability of 4.5 acfm at any depth at which they are operated or the capability of maintaining the diver's inspired carbon dioxide partial pressure below 0.02 ATA when the diver is producing carbon dioxide at the rate of 1.6 standard liters per minute.

1910.430(i)

Oxygen safety.

1910.430(i)(1)

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

1910.430(i)(2)

Components (except umbilicals) exposed to oxygen or mixtures containing over forty percent (40%) by volume oxygen shall be cleaned of flammable materials before use.

1910.430(i)(3)

Oxygen systems over 125 psig and compressed air systems over 500 psig shall have slow-opening shut-off valves.

1910.430(j)

Weights and harnesses.

1910.430(j)(1)

Except when heavy gear is worn, divers shall be equipped with a weight belt or assembly capable of quick release.

1910.430(j)(2)

Except when heavy gear is worn or in SCUBA diving, each diver shall wear a safety harness with:

1910.430(j)(2)(i)

A positive buckling device;

1910.430(j)(2)(ii)

An attachment point for the umbilical to prevent strain on the mask or helmet; and

1910.430(j)(2)(iii)

A lifting point to distribute the pull force of the line over the diver's body.

1910.440(a)(1)

[Reserved]

1910.440(a)(2)
The employer shall record the occurrence of any diving-related injury or illness which requires any dive team member to be hospitalized for 24 hours or more, specifying the circumstances of the incident and the extent of any injuries or illnesses.
1910.440(b)
Availability of records.
1910.440(b)(1)
Upon the request of the Assistant Secretary of Labor for Occupational Safety and Health, or the Director, National Institute for Occupational Safety and Health, Department of Health and Human Services of their designees, the employer shall make available for inspection and copying any record or document required by this standard.
1910.440(b)(2)
Records and documents required by this standard shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.1020 (a)-(e) and (g)-
1910.440(b)(2)(i)
Safe practices manuals (1910.420), depth-time profiles (1910.422), recordings of dives (1910.423), decompression procedure assessment evaluations (1910.423), and records of hospitalizations (1910.440) shall be provided in the same manner as employee exposure records or analyses using exposure or medical records. Equipment inspections and testing records which pertain to employees (1910.430) shall also be provided upon request to employees and their designated representatives.
1910.440(b)(3)
Records and documents required by this standard shall be retained by the employer for the following period:
1910.440(b)(3)(i)
[Reserved]
1910.440(b)(3)(ii)
Safe practices manual (1910.420) - current document only;
1910.440(b)(3)(iii)
Depth-time profile (1910.422) - until completion of the recording of dive, or until completion of decompression procedure assessment where there has been an incident of decompression sickness;
1910.440(b)(3)(iv)
Recording of dive (1910.423) - 1 year, except 5 years where there has been an incident of decompression sickness;
1910.440(b)(3)(v)
Decompression procedure assessment evaluations (1910.423) - 5 years;
1910.440(b)(3)(vi)
Equipment inspections and testing records (1910.430) - current entry or tag, or until equipment is withdrawn from service;
1910.440(b)(3)(vii)
Records of hospitalizations (1910.440) - 5 years.
1910.440(b)(4)
The employer shall comply with any additional requirements set forth at 29 CFR 1910.1020,