Smithsonian
Scientific Diving Program

SCIENTIFIC DIVING SAFETY MANUAL

2022

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Revision History

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General Guidelines

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SECTION 1: GENERAL POLICY

1.1 Scientific Diving Standards

1.1.1 Purpose

The purpose of the Smithsonian Scientific Diving Safety Manual, here forward referred to as this *Manual*, is to ensure all scientific diving under the auspices of the Smithsonian Institution (SI) is conducted in a manner that will maximize the protection of scientific divers from accidental injury and/or illness. In addition, this *Manual* sets forth standards for training and certification that will allow a working reciprocity between the Smithsonian Scientific Diving Program (SDP), the American Academy of Underwater Sciences (AAUS) Organizational Members (OMs or OM), and other scientific diving programs or individuals with equivalent or greater standards who are members of a diving program, as approved by the Smithsonian Scientific Diving Control Board (SDCB) or designee.

Fulfillment of these purposes shall be consistent with the furtherance of safety and research, and facilitation of collaborative opportunities.

1.1.2 Scope

The requirements, standards, and guidelines of this *Manual* will apply at all diving sites and to all divers officially engaged in underwater diving activities under the auspices of, or in cooperation with, the SI. All Smithsonian employees, fellows, contractors, volunteers, and interns must have scientific diving activities specified in their official SI performance plan, registration, or contract.

1.1.3 Historical Perspective

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

In 1982, OSHA exempted scientific diving from commercial diving regulations (29CFR1910, Subpart T) under certain conditions that are outlined below. The final guidelines for the exemption became effective in 1985 (Federal Register, Vol. 50, No.6, p.1046).

1.1.4 Scientific Diving Definition

Scientific diving is defined (29CFR1910.402) as: *Diving performed solely as a necessary part of a scientific, research, or educational activity by employees whose sole purpose for diving is to perform scientific research tasks. Scientific diving does not include performing any tasks usually associated with commercial diving such as: Placing or removing heavy objects underwater; inspection of pipelines and similar objects; construction; demolition; cutting or welding; or the use of explosives.*

1.1.5 Scientific Diving Exemption

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

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

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

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

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

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

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

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

1.2 Operational Control

1.2.1 Authority

Smithsonian Directive 120 (SD 120) requires all SI units and organizations to comply with the regulations and procedures contained in this *Manual*.

This *Manual* shall:

1. ensure the Smithsonian Scientific Diving Program (SDP) remains in compliance with applicable OSHA regulations and the scientific diving exemption;

2. ensure the SDCB has, at a minimum, the necessary authority to fulfill its specific obligations under OSHA regulations;

3. ensure divers comply with SDP policy and procedures;

4. set forth minimal standards for the SDP including the fundamental regulations and procedures for safety in diving operations; and

5. establish the organizational structure for the conduct of this program including a framework for reciprocity with organizations or individual divers which adhere to these minimum standards for joint scientific diving projects.

1.2.2 Auspices and Responsibilities

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

As an OM of the AAUS, it is the SI's responsibility to adhere, at a minimum, to the AAUS Standards for Scientific Diving. The administration of the diving program will reside with the Central Diving Office (CDO).

1.2.3 The Under Secretary for Science and Research

The Under Secretary for Science and Research has the ultimate authority for the scientific diving program and its related activities.

Duties and Responsibilities

1. Provide administrative oversight of, and policy approval for, matters relating to the SDP and the SDCB.

2. Ensure effective and adequate support is provided for activities of the SDCB in the conduct of its official responsibilities, and for activities related to the administration of the SDP.

3. Review briefings from the DSO and Chair of the SDCB on SDP activities and provides guidance as needed.

4. Appoint a full-time Diving Safety Officer (DSO), based on the recommendation of the SDCB, who shall serve as an advisor to and member of the SDCB, and report directly to the Under Secretary for Science and Research or designee.

1.2.4 Smithsonian Scientific Diving Control Board

The SDCB must consist of a majority of active scientific divers. Voting members include the DSO and other representatives of the diving program selected by procedures established by the Under Secretary for Science and Research (OUSSR) as stated in the SD 120. A chairperson and a secretary may be chosen from the membership of the board.

The SDCB has autonomous and absolute authority over the SDP's diving operations. The SDCB may delegate operational oversight for portions of the program to the DSO. However, the SDCB may not abdicate responsibility for the safe conduct of the diving program.

Duties and Responsibilities

1. Establish additional standards, protocols, and operational procedures beyond the AAUS minimums to address specific needs and concerns of the SDP.

2. Approve and monitor diving projects.

3. Review and revise this *Manual* and the SD 120 as needed.

4. Ensure compliance with this *Manual* and the SD 120.

5. Approve the depth to which a diver has been authorized to dive.

6. Take disciplinary action for unsafe practices.

7. Ensure adherence to the buddy system for scientific diving.

8. Act as a board of appeal to consider diver-related problems.

9. Issue, reissue, or revoke diving authorizations.

10. Establish and/or approve training protocols or standards through which the applicants for authorization can satisfy the requirements of the SDP's diving safety manual.

11. Suspend diving operations considered unsafe or unwise.

12. Establish criteria for equipment selection and use in the Standardized Equipment Program (SEP).

13. Recommend new equipment or techniques for use within the SDP.

14. Establish and/or approve services to be used for the inspection and maintenance of equipment utilized for diving operations.

15. Ensure SDP air station(s) meet breathing gas quality standards as described in Section 3.6.

16. Review, at least yearly, both the activities of the DSO and the SDP, and submit reports thereon to the Under Secretary for Science and Research.

17. Meet at least annually, or upon specific request of the Under Secretary for Science and Research or any SDCB member, and record and distribute minutes of all meetings.

18. Investigate diving incidents within the SDP's diving program or violations of this *Manual*.

1.2.5 Scientific Diving Officer (Diving Safety Officer)

At the Smithsonian, the Scientific Diving Officer serves in the role traditionally referred to as Diving Safety Officer (DSO). For consistency with and ease of recognition by other scientific diving programs, this position will be referred to as the DSO throughout this manual. The DSO is selected by the Under Secretary for Science and Research and serves as a voting member of the SDCB and designated as one of the SDP Representatives to the AAUS. The DSO should have broad technical expertise and experience in research diving.

Qualifications

1. Be an active scuba instructor from an internationally recognized certifying agency.

2. Be appointed by the Under Secretary for Science and Research or designee, with the advice and counsel of the SDCB.

3. Qualify as a Full Voting Member of the AAUS as defined by AAUS Bylaws.

4. Attend an AAUS DSO Orientation within one year of accepting the position, unless previously served as a DSO for another current AAUS OM within the last year.

Duties and Responsibilities

1. Implements all policies and decisions prescribed by the SDCB.

2. Responsible to the Under Secretary for Science and Research for the management of the SDP.

3. Perform routine administrative and diving-related duties set forth in SD 120, and shall report directly to the Under Secretary for Science and Research or designee for the conduct of the SDP.

4. As delegated by the SDCB, the routine operational authority for this program rests with the DSO. This authority includes, but is not limited to:

   a) training and certifications;

   b) diver authorizations;

   c) authorization of dive plans (unless DSO is lead diver, then ADSO authorizes with consent of Chair of the SDCB);

   d) diving operations;

   e) maintenance of diving records; and

   f) ensuring compliance with SD 120 and this *Manual*.

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

6. Must be guided in the performance of the required duties by the advice of the SDCB, but operational responsibility for the conduct of the SDP will be retained by the DSO.

7. Must suspend diving operations determined unsafe or unwise.

1.2.6 Unit Diving Officer

The Unit Diving Officer (UDO) shall have full responsibility and accountability to the DSO in all operational, diving, and safety matters within their unit.

Qualifications

1. Be an active Dive Master from an internationally recognized certifying agency.

2. Be appointed by the Unit Director, with the advice and counsel of the DSO and the SDCB.

3. Attend an AAUS DSO Orientation within one year of accepting the position, unless previously served as a DO for another current AAUS OM within the last year.

Duties and Responsibilities

1. Maintain a current SI-Scientific Diver certification.

2. Oversee scientific diving activities conducted in their research unit or areas of responsibilities.

3. Ensure diving equipment used during diving activities is in accordance with Section 3.

4. Ensure a competent Lead Diver (LD) is in charge of operations at the dive site.

5. Ensure all diving is planned and conducted in compliance with all SI policies, requirements, and procedures established and set forth in this *Manual*.

6. Be responsible for maintaining diver and medical records of all SI Divers within their Unit and, as requested, make these records available in a timely manner to appropriate institutional requesters.

7. Be responsible for performing and/or documenting equipment maintenance for divers within their Unit through the SDP standardized equipment program.

8. Maintain appropriate certifications for duties performed, such as but not limited to, equipment maintenance.

9. Have the authority to suspend diving operations or divers whose diving activities they consider unsafe or unwise.

10. Report all diving related activities considered unsafe or unwise immediately to the DSO.

11. Ensure all dives within their Unit are logged with the SDP in a timely manner at the conclusion of the dive plan.

1.2.7 Smithsonian Units

Smithsonian Units which have employees, interns, fellows, volunteers, or contractors who are actively participating in diving as part of their official SI duties must adhere to requirements set forth in this *Manual*.

Duties and Responsibilities

1. If requested by the SDCB, appoint or employ, in consultation with the DSO, an active, appropriately trained, and experienced scientific diver to serve as the UDO for their respective unit.

2. Acknowledge UDO responsibilities and duties, including adhering to and enforcement of the SD 120 and this *Manual*, as an Element in the performance plan of the assigned UDO.

3. If requested by the SDCB, appoint an appropriately experienced scientific diver, in consultation with OUSSR and the Chair of the SDCB, to serve as the SDCB member for their respective unit.

4. Acknowledge the SDCB responsibilities and duties, including adhering to and enforcement of the SD 120 and this *Manual*, as an Element in the performance plan of their SDCB representative(s).

5. Ensure scientific diving activities are acknowledged in the performance plan for all active divers within their units, including adherence to the SD 120 and this *Manual*.

6. Ensure adequate resources are available for effective and compliant scientific diving activities to occur within their unit.

1.2.8 Lead Diver

For each dive, one individual shall be designated the LD who shall be at the dive location during the diving operation.

Duties and Responsibilities

1. Ensure dives are conducted in compliance with Section 2.

2. Ensure diving equipment used during diving activities is compliance with Section 3.

3. Ensure dive plans are submitted to the UDO for review and approval at least 6 weeks prior to intended dive date.

4. Prohibit any diver from diving who, in the LD's opinion, exhibits problems of a physical or psychological nature that may compromise the safety of a diver or the dive team.

5. Ensure all dive team members possess current authorization and are qualified for the type of diving operation.

6. Coordinate with other known activities in the vicinity that are likely to interfere with diving operations.

7. Ensure emergency procedures are established and clearly understood by all personnel, and readily available at the dive site before diving begins.

8. Ensure safety and emergency equipment is in working order and at the dive site.

9. Conduct pre- and post-dive safety briefings.

10. Check first aid equipment, including O2 kit, to ensure appropriate supplies are functional and available at the dive site.

11. Ensure all divers are monitored after each dive for signs or symptoms of decompression sickness or other diving-related maladies.

12. Suspend diving operations when unusual hazards or environmental conditions adversely affect the safety of the diving operation.

13. Report all diving-related accidents and incidents to the UDO and the DSO.

14. Ensure all diver-worn equipment is properly configured in accordance with the standards outlined in this *Manual*.

15. Obtain concurrence from the vessel captain and ensure all vessel pre-dive checklists have been completed prior to initiating diving operations when applicable.

16. Suspend diving operations if, in their opinion, conditions are not safe.

17. Report modifications to diving or emergency procedures necessitated by the specific diving operation to the UDO.

18. Report to the DSO, through the UDO, any physical problems or adverse physiological effects including symptoms of pressure-related injuries.

19. Ensure all dives associated with the dive plan are logged with the SDP in a timely manner at the conclusion of the dive plan.

1.2.9 Diver

Responsibility and Refusal to Dive

The ultimate responsibility for safety rests with the individual diver. It is the diver's responsibility and duty to refuse to dive, without fear of penalty, if in the diver's judgment, conditions are unsafe or unfavorable, or in violation of the precepts of regulations in this *Manual*.

1. No dive team member will be required to be exposed to hyperbaric conditions against their will.

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

Qualifications

Each SI Diver shall be a certified and current Scientific Diver or Diver-in-Training as defined in Section 4 of this *Manual*. Divers not part of the SDP but diving with the SDP or on SI projects, must meet the SDP Minimum Standards defined in Section 4.2.1 of this *Manual*.

Duties and Responsibilities

1. Adhere to the standards contained within this *Manual* when conducting dives.

2. Refuse to dive when, in their judgment, conditions are unsafe and/or actions would be in violation of the precepts of training or the requirements in this *Manual*.

3. Submit a completed Scientific Diver Application through DecoStop.

4. Obtain a Scientific Diver medical certification (Section 5).

5. Maintain good physical condition and a high level of diving proficiency commensurate with the frequency, scope, and type of diving activity being undertaken.

6. Provide proof of Diving Emergency Care training (Section 4.4.5).

7. Ensure diving equipment used is maintained in a safe operating condition including, but not limited to, the annual scuba equipment inspection and maintenance completed by an appropriately certified equipment technician.

8. Maintain accountability for SI-issued equipment.

9. Report to the LD any physical or psychological changes that may adversely impact their or their buddy's fitness to dive.

10. Adhere to the buddy system. Actively monitor buddy status, including, but not limited to cylinder pressure, and intervene to the maximum extent practicable to ensure the safety of the dive team.

11. Terminate diving activity immediately when a physical or psychological problem develops that can compromise the safety of the diver or dive team and immediately reports this to the LD.

12. Obtain authorization to dive by the DSO through a submitted SDP dive plan prior to engaging in any activities.

13. Ensure all dive logs associated with the dive plan are logged with the SDP at the conclusion of the dive plan.

1.2.10 Dive Buddy Responsibility

The dive buddy system is based upon mutual assistance with the intent to avoid an emergency. Dive Buddies should at all times maintain continuous contact and be able to:

1. provide their buddy with assistance;

2. observe their buddy for signs of distress;

3. periodically check the integrity of their buddy's dive gear; and

4. provide immediate assistance if emergency help is needed.

1.2.11 Reciprocity and Visiting Scientific Diver

Two or more organizations with established reciprocity engaged jointly in diving activities, or engaged jointly in the use of diving resources, must designate one of the participating SDCBs to govern the joint dive project. However, responsibility for individual divers ultimately resides with their home organization.

1. A Scientific Diver from one organization must apply for permission to dive under the auspices of another organization by submitting to the DSO of the host organization a document containing all the information listed in Appendix 6 AAUS Standards for Scientific Diving Manual, signed by the DSO or designee of the home DCB.

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

3. If the SDP denies a visiting Scientific Diver permission to dive, the SDCB must notify the visiting Scientific Diver and their DCB with an explanation of all reasons for the denial.

1.2.12 Waiver of Requirements

The SDCB may grant a waiver for specific requirements of training, examinations, depth authorizations, and minimum activity to maintain authorizations. Medical standards set forth in this *Manual* may not be waived.

1.3 Consequence of Violation of Regulations by Scientific Divers

Failure to comply with the regulations of the OM's diving safety manual may be cause for the restriction, suspension or revocation of the diver's scientific diving authorization (Section 4.5).

1.4 Record Maintenance

The SDP must maintain consistent records for its diving program and for each participant. These records include but are not limited to: diving safety manual; equipment inspection, testing, and maintenance records; dive plans; medical approval to dive; diver training records; diver authorization(s); individual dive log(s); dive incident reports; reports of disciplinary actions by the SDCB; and other pertinent information deemed necessary by the DSO or the SDCB.

1.4.1 Availability of Records

Medical records must be available to an attending physician of a diver or former diver when released in writing by the diver. Records and documents required by this *Manual* must be retained by the SDP for the following period:

1. Diving safety manual – Current document only.

2. Equipment inspection, testing, and maintenance records – Minimum current entry or tag.

3. Records of Dive – minimum of 1 year, except 5 years where there has been an incident of pressure-related injury.

4. Medical approval to dive – Minimum of 1 year past the expiration of the current document

except 5 years where there has been an incident of pressure-related injury.

5. Diver training records – Minimum of 1 year beyond the life of the diver's program participation.

6. Diver authorization(s) – Minimum of 1 year beyond the life of the diver's program participation.

7. Pressure-related injury assessment - 5 years.

8. Reports of disciplinary actions by the SDCB – Minimum of 1 year beyond the life of the diver's program participation.

SECTION 2: DIVING REGULATIONS

2.1 Introduction

No person shall engage in scientific diving operations under the auspices of the SI unless authorized pursuant to the provisions of this *Manual*.

2.2 Pre-Dive Procedures

2.2.1 Dive Plans

Before conducting any diving operations under the auspices of the SI, a dive plan for the proposed dives must be authorized by the DSO. Dives should be planned around the competency of the least experienced diver. The dive plan shall be submitted 6 weeks in advance through the UDO to the DSO for authorization. The UDO shall submit the completed dive plan 2 weeks in advance to the DSO.

For complicated, irregular, or unusual dive plans, especially but not limited to, any diving activity that is in exception to this *Manual*, the DSO should consult with the Chair of the SDCB to review the plans and recommendations before authorization. The DSO and Chair of the SDCB are expected to consult with appropriate members of the SDCB and/or external advisers before authorization. This review process, consultation, and recommendations should be documented in the SDP records.

When the DSO is the Lead Diver, the dive plan must be authorized by the ADSO with consent of Chair of the SDCB.

The dive plan should include the following:

1. Diving Mode(s) and Gas(es)

2. Divers' authorizations

3. Approximate number of proposed dives

4. Location(s) of proposed dive(s)

5. Estimated depth(s) and bottom time(s) anticipated
6. Decompression status and repetitive dive plans, if required
7. Proposed work, equipment, and boats to be employed
8. Any hazardous conditions anticipated
9. Emergency Action Plan (Appendix 2)
10. In-water details of the dive plan including:
    a) Dive Buddy assignments and tasks;
    b) Goals and objectives;
    c) Maximum depth(s) and bottom time;
    d) Gas management plan;
    e) Entry, exit, descent and ascent procedures;
    f) Perceived environmental and operational hazards and mitigations; and
    g) Emergency and diver recall procedures.

2.2.2 Shipboard Scientific Diving Safety

All scientific diving activities carried out from Smithsonian research vessels shall conform to this manual, the R/V cruise manual, and those of the UNOLS (University-National Oceanographic Laboratory System). The on-board Diving Supervisor shall be designated by the DSO for each cruise.

The LD shall obtain concurrence from the vessel Captain and Chief Engineer (when applicable) and ensure all vessel pre-dive checklists have been completed prior to initiating diving operations. This will include, but not limited to, lockout tagout procedures for the vessel's propulsion system, sanitation system, galvanic protection system, and all systems discharging to or taking suction from sea. Systems deemed essential for the operation of the vessel will be identified and divers briefed to their location so they can maintain a safe distance from active intake and discharge ports.

2.2.3 Pre-dive Safety Checks

Prior to commencing the dive, the divers must:

1. ensure every team member is healthy, fit, and trained for the type of dive that is being attempted;
2. conduct a functional check of their diving equipment in the presence of the dive buddy or tender to ensure the equipment is functioning properly and suitable for the type of diving operation being conducted;
3. have the capability of achieving and maintaining positive buoyancy at the surface; and
4. evaluate environmental conditions of the dive site.

2.2.4 Pre-dive Briefings

Before conducting any diving operations under the auspices of the SI, the dive team members must be briefed on:

1. dive Buddy assignments and tasks;
2. dive objectives;
3. maximum depth(s) and bottom time;
4. turn around pressure and required surfacing pressure;
5. entry, exit, descent and ascent procedures;
6. perceived environmental and operational hazards and mitigations; and
7. emergency and diver recall procedures.

2.3 Diving Procedures

2.3.1 Solo Diving Prohibition

All diving activities must adhere to the buddy system. Solo diving is prohibited.

2.3.2 Decompression Management

On any given dive, both divers in the buddy pair must follow the most conservative dive profile and dive computer.

A safety stop at 15-20 feet for 3-5 minutes should be performed during the ascent phase of any dive that exceeds 30 feet (9.14m).

2.3.3 Termination of the Dive

Any dive must be terminated while there is still sufficient cylinder pressure to permit the diver to safely reach the surface, including decompression time, or to safely reach an additional air source at the decompression station. At no time shall the diver return to the surface with less than 500 psi remaining in the cylinder.

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

2.3.4 Emergencies and Deviations from Regulations

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

2.4 Post-Dive Procedures

2.4.1 Post-Dive Safety Checks

After the completion of a dive, each diver must report any physical problems, symptoms of decompression sickness, or equipment malfunctions to the LD who will notify the UDO. The UDO will notify the DSO who, when warranted, will notify the SDCB.

While considered a specialty and not allowed without prior authorization and training, should a diver find themselves diving outside the no-decompression limits, the diver should remain awake for at least one hour after diving and in the company of a dive team member who is prepared to activate the Emergency Action Plan, if necessary. Divers should report the decompression dive, and any repercussions, to their UDO immediately who will then notify the DSO.

2.5 Emergency Procedures

Each dive plan will include emergency procedures and implementation criteria for emergency care, recompression, evacuation, and incident reporting. This information will be included in the SI Dive Plan and a copy will be kept at the dive site.

2.6 Flying or Ascending to Altitude After Diving

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

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

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

4. Before ascending to altitude above 1000 feet (304 meters): Divers should follow the appropriate guideline for preflight surface intervals unless the decompression procedure used has accounted for the increase in elevation.

2.7 Record Keeping Requirements

2.7.1 Personal Diving Log

Authorized dives must be logged with the SI-issued dive computer. These logs will be submitted through the SDP dive log upload system. The dive log must include at least the following:

1. Name of diver and buddy
2. Date, time, and location
3. Dive plan authorization number
4. Diving modes used
5. General nature of diving activities
6. Maximum depth and dive time
7. Detailed report of any near or actual incidents

2.7.2 Required Near-Miss Reporting

All diving related near-misses occurring while performing official SI duties shall be reported to the UDO, who will then forward the report to the DSO.

2.7.3 Required Incident Reporting

All diving related incidents occurring while performing official SI duties shall be reported to the UDO, who will then forward the report to the DSO. Incidents requiring recompression treatment, or resulting in moderate or serious injury or death, must be reported to the SDCB, the Under Secretary for Science and Research, and the AAUS in a timely manner. The SDCB must record and report occupational injuries and illnesses in accordance with the applicable requirements established by OSHA. SDCB must investigate and document any incident of pressure-related injury and prepare a report to be forwarded to AAUS during the annual reporting cycle.

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

1. Name, address, phone numbers of the principal parties involved
2. Summary of experience of divers involved
3. Location, description of dive site, and description of conditions that led up to incident
4. The circumstances of the incident and the extent of any injuries or illnesses
5. Narrative of events from each individual directly involved
6. Description of symptoms, including depth and time of onset

7. Description and results of treatment
8. Disposition of case
9. Recommendations to avoid repetition of incident

All diving incidents will be reported to the AAUS. This report must first be reviewed and released by the SDCB and at a minimum contain:

1. A complete AAUS Incident Report
2. Summary of experience of divers involved
3. Description of dive site
4. Description of conditions that led up to incident
5. The circumstances of the incident
6. The extent of any injuries or illnesses
7. Description of symptoms, including depth and time of onset
8. Description and results of treatment
9. Disposition of case
10. Recommendations to avoid repetition of incident

SECTION 3: DIVING EQUIPMENT

3.1 General Policy

All equipment must meet standards as determined by the DSO and the SDCB. All equipment must be regularly examined by the person using it and serviced according to manufacturer recommendations. Equipment subjected to extreme usage under adverse conditions requires more frequent testing and maintenance.

3.2 Equipment

The SDP operates a Standardized Equipment Program (SEP) which provides specifications for BCDs, alternate air sources, and regulators. In addition, the SDP provides:

1. Diving equipment for SDP Scientific Diving course
2. SDP required dive computers

Diving equipment maintenance and quality control is provided by the Unit.

3.2.1 Required Equipment

Each SI Diver shall dive with the following equipment:

1. Mask, fins, and snorkel
2. Regulator (first and second stage)
3. Redundant second stage regulator on the primary cylinder(s) for air sharing
4. Scuba cylinder
5. Submersible pressure gauge
6. Dive computer (SDP issued)
7. Buoyancy Compensation Device (BCD) with attached inflator
8. Dive knife or cutting device sharp enough to cut through monofilament line
9. Surface Marker Buoy when in open water
10. Compass when in open water
11. Weight system capable of quick release
12. Appropriate thermal insulation
13. Whistle or other sound-producing device

3.2.2 Regulators and Gauges

Scuba regulators and gauges must be inspected and serviced annually, then tested by the SI Diver prior to each use. Standard open circuit (OC) regulator configuration is:

1. first stage;
2. primary 2nd stage or Full Face Mask;
3. alternate Air 2nd stage;
4. submersible Pressure Gauge (SPG); and
5. inflator hose for a BCD.

3.2.3 Dive Computers for Determination of Dive Time, Depth and Decompression Status

3.2.3.1 SI Diver Primary Dive Computer

All SI Divers will be issued an SDP dive computer to be used as the diver's primary source for dive depth, dive time, and no decompression status, and will be held responsible for the following:

1. Each SI Diver must dive with their own SI-issued dive computer;

2. SI Divers must use the same SI-issued dive computer on all repetitive dives and/or multiple days of diving;

3. SI Divers will be held accountable to the data recorded on the SDP-issued dive computer;

4. If dive tables are being used for dive planning, a set of tables must be available at the dive location;

5. In the instance of a dive computer failure, the diver must remain out of the water to offgas for 24 hours before changing to a back-up computer, unless the back-up computer has been on every dive with that diver during the current repetitive dive sequence.

3.2.3.2 Exception for Aquarium or other manmade structure

In an aquarium or other manmade structure of a known maximum obtainable depth:

1. A depth indicator is not required, except when a diver's decompression status must be taken into consideration on repetitive dives.

2. Only one buddy must be equipped with a timing device.

3. The maximum obtainable depth of the aquarium must be used as the diving depth.

3.2.4 Scuba Cylinders

Scuba cylinders must:

1. be designed, constructed, and maintained in accordance with the applicable provisions of the Unfired Pressure Vessel Safety Orders;

2. be hydrostatically tested in accordance with DOT standards;

3. have an internal and external inspection at intervals not to exceed 12-months; and

4. have valves functionally tested at intervals not to exceed 12-months.

3.2.5 Buoyancy Compensation Devices (BCD)

1. Divers must have the capability of achieving and maintaining neutral buoyancy underwater and positive buoyancy at the surface;

2. BCDs, dry suits, or other variable volume buoyancy compensation devices must be equipped with an exhaust valve;

3. These devices must be functionally inspected and tested at intervals not to exceed 12-months; and

4. BCDs, dry suits, or other variable volume buoyancy compensation devices must not be used as a lifting device in lieu of lift bags.

3.2.6 Specialty Equipment

The use of the following specialty equipment requires approval by the DSO and additional training through an internationally recognized agency or the SDP:

1. Full Face Mask

2. Dry suit

3. Tether

4. Independent Reserve Breathing Gas

5. Hookah

6. Diving Helmet

7. Twin Cylinders

3.3 Auxiliary Equipment

3.1.1 Handheld Underwater Power Tools

1. Power tools and equipment used underwater must be specifically approved for this purpose and the diver must be trained in their use.

2. Tools and equipment supplied with power from the surface must be de-energized before being placed into or retrieved from the water.

3. Handheld power tools must not be supplied with power from the dive location until

requested by the diver.

3.4 Support Equipment

3.4.1 Dive Site Requirements

The following must be available at the dive site:

3.4.1.1 First Aid Kit

A first aid kit must be:

a) Approved under CFR 160.041 or have equivalent contents and instructions;

b) Stored in a suitable, watertight container that is marked “First-Aid Kit”;

c) Easily visible and readily available;

d) Appropriate for the diving location; and

e) Stocked to the appropriate capacity for the number of participants.

3.4.1.2 Oxygen Kit

An emergency oxygen kit must be:

a) Equipped with a regulator with hose and demand valve;

b) Filled with medical or aviator grade oxygen and have sufficient quantity of oxygen to supply one diver for the time required to transport them to a higher level of care; and

c) Capable of delivering oxygen simultaneously to two patients.

3.4.1.3 Diver’s Flag

When operating in areas capable of supporting marine traffic, a red and white “diver down” sport diving flag, appropriately sized for meeting local legal requirements, shall be displayed at the dive location in a manner which allows all-round visibility, and shall be illuminated during night diving operations.

3.4.1.4 Communications

An operational, two-way surface communication system (e.g., VHF radio, cell phone) will be available at the dive location to obtain emergency assistance.

3.4.4 Compressor Systems

1. Compressors shall be operated and maintained following manufacturer's specifications.

2. Persons operating breathing air compressors must receive training in the proper operating procedures.

3. 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 must have a check valve on the inlet side, a pressure gauge, a relief valve, and a drain valve.

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

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

3.4.5 Compressor Air Testing

Gas analyses and air tests to the standard outlined in 3.6.1 must be performed on each breathing gas compressor at regular intervals of no more than 100 hours of operation or 6-months, whichever occurs first.

3.4.6 Oxygen Systems

1. Equipment used with oxygen or mixtures containing over forty percent (40%) by volume oxygen must be designed, dedicated and maintained for oxygen service according to the highest prevailing standards for such use.

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

3. Oxygen systems over 125 psig must have slow-opening shut-off valves.

3.5 Equipment Maintenance Record Keeping

3.5.1 Compressors

A log must be maintained showing operation, repair, overhaul, filter maintenance and temperature adjustment for each compressor as well as training verification of air compressor operators.

3.5.2 Dive support equipment

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

1. Regulators
2. Alternative breathing sources
3. Gauges (SPG, Depth Gauges, Timers, and Dive Computers)
4. BCDs
5. Dry suits
6. Scuba cylinders and valves
7. Full Face Masks
8. Compressors, air filtration systems, gas control panels, and storage banks
9. Surface supplied equipment
10. Rebreather systems
11. Additional equipment categories as determined by the SDCB

3.6 Breathing Gas Quality Standards

3.6.1 Breathing Gas

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

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

(2) 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.

3.6.2 Breathing Gas in Remote Operations

The quality of the breathing gas utilized by our divers is critical in safeguarding their safety. Every effort shall be made to locate a source which conducts testing of all compressors supplying breathing gas. These tests are required at intervals of 100 hours of operation or 6-months, whichever occurs first, using CGA Grade E as the standard. Lead Divers will attain a copy of this test and submit it to the UDO to be included in the record of the dive plan.

As true for all aspects of diving, the diver is ultimately responsible for their own safety. This carries over to the breathing gas utilized. The procedures outlined below are intended to provide prudent steps to help ensure breathing gas quality. Even when a valid breathing gas test is available, this does not alleviate the responsibility of diver in doing their part to check and use their judgement when determining if the breathing gas is acceptable.

As is standard practice in setting up a Scuba unit prior to diving, the diver should smell and breath the breathing gas being delivered by the regulator and refuse to use any breathing gas with a detectable odor or taste.

1. Any tank which has breathing gas with detectable odor or taste needs to be chemically cleaned prior to use.

2. The cause of this contaminant is most likely the compressor and therefore and alternate source for breathing gas should be found.

3.6.2.1 The SDP Breathing Gas Questionnaire

Found in DecoStop, this questionnaire provides information to help validate the maintenance and usage of a facility intended for use to supply dive cylinders and/or breathing gas. The Lead Diver will send this questionnaire to the proposed source for completion and then submit it to the UDO to be evaluated and included with the dive plan. Responses from the SDP Breathing Gas Compressor Questionnaire will be retained on file and updated as needed. This data, as well as endorsements from reputable sources (AAUS OM's or International Collaborators) will be taken into consideration when approving dive plans and/or determination of further actions which may need to be taken.

3.6.2.2 Operational Requirements

3.6.2.2.1 Breathing Gas Quality Test Available

For remote site operations where the testing of a breathing gas source **is** available, the following protocol will be followed:

1. SDP Breathing Gas Questionnaire submission and review.

2. First time using the supplier, Lead Diver will be required to bring a CO and O2 analyzer to test the breathing gas upon arrival and periodically throughout the dive operations. This becomes a recommendation when supplier has been used in the past without incident or concerns raised.

a) At a minimum, an analysis using the CO and O2 analyzers will be made of the breathing gas of one tank from each fill cycle of the compressor.

b) Only tanks for which the oxygen level is between 20-22% (air) or 23-40% (nitrox) and a CO count of less than 10 ppm/v can be used.

c) For breathing gas which does not meet the CO and O2 standards outlined in b., the options are as follows:

i. Find another breathing gas source which meets the above standard.

ii. Use an inline filter when filling each tank (if taken).

iii. Do not dive.

3.6.2.2.2 Breathing Gas Quality Test Not Available

For remote site operations where the testing of a breathing gas source is not available, the following protocol will be followed:

1. SDP Breathing Gas Questionnaire submission and review.

2. If time permits, a breathing gas test kit will be sent to the location so breathing gas testing can be conducted.

   a) The actual analysis can occur quickly with shipping time being the greatest time factor in this process. It is advised to allow up to 6 weeks depending on the location.

   b) CDO has breathing gas test kits available which can be sent upon request.

   c) If a successful test results are attained, follow protocol outlined above in 3.6.2.2.1 (2)

3. If time does not permit for a test kit to be sent, with the approval of the SDCB or designee, the following protocol will be followed:

   a) Lead Diver must bring a CO and O2 analyzer to test the breathing gas being utilized by the dive team and follow the same protocols outlined in Section 3.6.2.2.1 (2) a, b, & c only.

b) Lead Diver must bring an inline filter to be utilized by the dive team if the breathing gas fails the CO or O2 analysis and another source breathing gas cannot be found. Should this occur:

   i. the inline filter will be used in the filling of every tank;

   ii. the breathing gas coming out of the filter must initially and subsequently be checked for acceptable CO and O2 levels; and

   iii. if the breathing gas does not fall within acceptable levels, then diving will not be conducted.

In all cases where a breathing gas test cannot be verified, final approval for the use of a facility to supply breathing gas will be made by the SDCB or designee as part of the dive plan approval process.

SECTION 4: SCIENTIFIC DIVER CERTIFICATION AND AUTHORIZATIONS

Set forth below are the SDCB standards for the SI Scientific Diver certification as well as requirements to receive and maintain authorization to dive with the SI. No person shall engage in scientific diving activities under the auspices of the SDP unless the diver completes all requirements outlined below and receives an authorized dive plan issued by the DSO.

Submission of documents and participation in aptitude examinations does not automatically result in certification. Any applicant who does not appear to possess the necessary judgment to make safe decisions under diving conditions may be denied SI scientific diving privileges.

Training requirements for diving specialties are found under Sections 6.00 -12.00 Specialty Guidelines.

4.1 Scientific Diver Certification Training

4.1.1 Eligibility

The Smithsonian Scientific Diving Course is a mechanism by which SI employees, fellows, interns, contractors, or volunteers obtain the required training and experience (classroom, pool, and open water) to become a certified SI Scientific Diver to dive with the Smithsonian Institution. The applicant must have an identifiable need for the use of scuba diving to conduct research or educational activities under the auspices of the Smithsonian Institution and this language will be included in the diver's performance plan or contract. The signature of the candidate's supervisor or sponsoring principal investigator acknowledges this need.

4.1.2 Prerequisites

4.1.2.1 Administrative

The applicant must complete and submit all required diver application, administrative, medical, and legal documentation through their UDO.

4.1.2.2 Medical Examination

The candidate must be medically qualified for diving as described in Section 5 of this *Manual* before the individual will be allowed participation in any diving activities or the swim test. SDP medical standards may not be waived.

4.1.2.3 Swimming/Watermanship Evaluation

The candidate must demonstrate the following in the presence of the DSO or designee:

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

All tests are to be performed without swim aids. However, the candidate may use weights to achieve neutral buoyancy.

4.1.2.4 Entry Level Diver Certification

The SDP Scientific Diver Course provides entry level diver training in compliance with the Recreational Scuba Training Council/World Recreational Scuba Training Council (RSTC/WRSTC) and/or ISO entry-level diver standards. Entry level diver training is a prerequisite to scientific diver training and therefore no part of entry level training may be counted in any way toward scientific diver training.

4.1.3 Instructional Personnel Qualifications

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

4.1.4 Course Requirements

The candidate must successfully complete prerequisites, theoretical aspects, practical training, and examinations for a minimum cumulative time of 100-hours and a minimum of 12 open water dives for a minimum cumulative bottom time of 6 hours. One of these dives must be a check-out dive with the DSO, UDO, or designee. Formats for meeting the 100-hour training requirements include the SDP developed formalized training course.

The SDP has developed a Minimum Standard (Section 4.2.1) all divers must meet to dive with the SI. Upon completion of the SDP course, candidates will continue to dive as a Diver-in-Training (DIT) until the Minimum Standard is met. These additional dives will be conducted under the supervision of a DSO approved SI Diver and will provide the opportunity to obtain on-the-job training specific to the principles and activities appropriate to the intended area of

scientific study. The SI Scientific Diver Certification will be awarded upon successful completion of the 100-hour formalized training course, plus additional job specific science dives, for a minimum of 25 scientific dives.

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

Submission of documents and participation in aptitude examinations does not automatically result in certification. To be certified, the applicant must demonstrate to the SDCB, through the DSO, sufficient skills and proficiency, and possess the necessary judgement for their safety and/or that of the dive team. Scientific Diver Certification is only active when required authorizations are in place and current.

4.1.5 Theoretical Training / Knowledge Development

Required Topics:	**Suggested Topics:**
Diving Emergency Care Training 1. Cardiopulmonary Resuscitation (CPR) 2. AED 3. Standard or Basic First Aid 4. Recognition of DCS and AGE 5. Accident Management 6. Field Neurological Exam 7. Oxygen Administration	Specific Dive Modes (methods of gas delivery) 1. Open Circuit 2. Hookah 3. Surface Supplied diving 4. Rebreathers (closed and/or semi-closed)
Dive Rescue To include procedures relevant to OM specific protocols. (See water skills below)	Specialized Breathing Gas 1. Nitrox 2. Mixed Gas
Scientific Method	Small Boat Operation
Data Gathering Techniques (Only items specific to area of study required) 1. Transects and Quadrats 2. Mapping 3. Coring 4. Photography 5. Tagging 6. Collecting 7. Animal Handling 8. Archaeology 9. Common Biota 10. Organism Identification 11. Behavior 12. Ecology 13. Site Selection, Location, and Re-location 14. Specialized Data Gathering Equipment	Specialized Environments and Conditions 1. Blue Water Diving 2. Altitude 3. Ice and Polar Diving (Cold Water Diving) 4. Zero Visibility Diving 5. Polluted Water Diving 6. Saturation Diving 7. Decompression Diving 8. Overhead Environments 9. Aquarium Diving 10. Night Diving 11. Kelp Diving 12. Strong Current Diving 13. Potential Entanglement/Entrapment 14. Live boating

Navigation HazMat Training 1. HP Cylinders	HazMat Training 1. Chemical Hygiene, Laboratory Safety (Use of Chemicals)
Decompression Management Tools 1. Dive Tables 2. Dive Computers 3. PC Based Software	Specialized Diving Equipment 1. Full face mask 2. Dry Suit 3. Communications 4. Dive Propulsion Vehicle (DPV) 5. SMBs/Lift Bags 6. Line Reels
AAUS Scientific Diving Regulations and History 1. Scientific Dive Planning 2. Coordination with other Agencies 3. Appropriate Governmental Regulations	
SDP Policy, Procedures, and Best Practices	
Hazards of breath-hold diving and ascents	
Dive Physics (Beyond entry level scuba)	Other Topics and Techniques as Determined by the SDCB
Dive Physiology (Beyond entry level scuba)	
Dive Environments	
Decompression Theory and its Application	

4.1.6 Practical Training / Skill Development

Confined Water	At the completion of training, the trainee must satisfy the DSO or SDCB approved designee of their ability to perform the following, as a minimum, in a pool or in sheltered water: 1. Enter water fully equipped for diving 2. Clear fully flooded face mask 3. Demonstrate air sharing and ascent using an alternate air source, as both donor and recipient, with and without a face mask 4. Demonstrate buddy breathing as both donor and recipient, with and without a face mask 5. Demonstrate understanding of underwater signs and signals 6. Demonstrate ability to remove and replace equipment while submerged 7. Demonstrate acceptable watermanship skills for anticipated scientific diving conditions

Open Water Skills	The trainee must satisfy the DSO, or SDCB approved designee, of their ability to perform at least the following in open water: 1. Surface dive to a depth of 10 feet (3 meters) without scuba[a] 2. Enter and exit water while wearing scuba gear[a, b] 3. Kick on the surface 400 yards (366 meters) while wearing scuba gear, but not breathing from the scuba unit[a] 4. Demonstrate proficiency in air sharing ascent as both donor and receiver[a] 5. Demonstrate a buddy check[b] 6. Demonstrate the ability to ascend at a rate not to exceed 30 feet/min[c] 7. Demonstrate the ability to perform a safety stop for 3-5 mins at 15 feet[c] 8. Demonstrate the ability to maneuver efficiently in the environment, at and below the surface[a, b] 9. Complete a simulated emergency swimming ascent[a] 10. Demonstrate clearing of mask and regulator while submerged[a] 11. Underwater communications[b] 12. Demonstrate ability to achieve and maintain neutral buoyancy while submerged[a] 13. Demonstrate techniques of self-rescue and buddy rescue[a] 14. Navigate underwater[c] 15. Plan and execute a dive[c] 16. Demonstrate judgment adequate for safe scientific diving[a, b] [a]Checkout dive element [b]Evaluated on all dives [c]Evaluated at some point during the training cycle
	Rescue Skills: 1. Rescue from depth and transport 25 yards (23 meters), as a diver, a passive simulated victim of an accident: surface diver, establish buoyancy, stabilize victim 2. Demonstrate simulated in-water mouth-to-mouth resuscitation 3. Removal of victim from water to shore or boat 4. Stressed and panicked diver scenarios 5. *Rescue of a Submerged Unresponsive Compressed-Gas Diver* – Appendix 3
	Following the initial checkout dive, the eleven dives (minimum) may be conducted over a variety of depth ranges as specified by the SDCB. Depth progression must proceed shallower to deeper, after acceptable skills and judgement have been demonstrated at each depth and are not to exceed 100 feet (30 m) during the initial 12 dive cycle.
	The candidate will receive DIT status after successfully completing a minimum of one checkout dive and at least eleven additional open water dives, for a cumulative time of 6 hours.
	The remaining dives required following the course, for a total of 25 training dives, must be supervised by an active Scientific Diver holding the necessary depth authorization and experience in the type of diving planned, and with the knowledge and permission of the DSO.

4.1.7 Examinations

Equipment	The trainee will be subject to examination/review of: 1. Personal diving equipment 2. Task specific equipment 3. Function and manipulation of decompression computer to be employed by the diver (if applicable)
Written Exams	The trainee must pass SDP written examinations which demonstrate knowledge of at least the following: 1. Function, care, use, and maintenance of diving equipment 2. Advanced physics and physiology of diving 3. Diving regulations 4. Applicable diving environments 5. Emergency procedures, including buoyant ascent and ascent by air sharing 6. Currently accepted decompression theory and procedures 7. Proper use of dive tables 8. Hazards of breath-hold diving and ascents 9. Planning and supervision of diving operations 10. Navigation 11. Diving hazards & mitigations 12. Cause, symptoms, treatment, and prevention of the following: near drowning, air embolism, hypercapnia, squeezes, oxygen toxicity, nitrogen narcosis, exhaustion and panic, respiratory fatigue, motion sickness, decompression sickness, hypothermia, and hypoxia/anoxia 13. Applicable theoretical training and knowledge development from the Required and Suggested Topics (above) 14. Dive Computer theory and use

Authorization requirements for diving specialties are found under Sections 6.00 -12.00 Specialty Guidelines.

4.2 Diver Authorization

Only a person diving under the auspices of an OM who subscribes to the practices of AAUS is eligible for a scientific diver certification.

4.2.1 SDP Minimum Standard

All divers conducting dives with the SDP are required to be certified as a Scientific Diver through the SDP or an OM of AAUS in accordance with this *Manual* and will be required to have conducted at least 25 open water dives or possess equivalent training and operational experience as determined by the DSO. Divers must abide by the policies outlined in this *Manual*, including Diving Emergency Care Training, Diving Medical Clearance, and the Standardized Equipment Program.

Should an SI Diver not meet required certification qualifications as described above, the diver may be authorized to dive under Diver-In-Training status as described in Section 4.2.2.1.

4.2.2 Smithsonian Diver (SI Diver)

This category is for all divers who are associated with the Smithsonian through employment, academic appointment, contract, or as a volunteer, and wish to conduct dives in support of Smithsonian research or educational activities.

4.2.2.1 Diver-In-Training (DIT) Authorization

This authorization signifies a diver has met the qualifications below and has the knowledge, skills, and experience necessary to commence and continue training to become a scientific diver under supervision, as approved by the DSO. It allows for divers to continue their training or begin their work prior to attaining the qualifications of a Smithsonian Scientific Diver. This authorization is intended to be temporary, not a substitute for Scientific Diver Certification.

Eligibility

Smithsonian personnel (including but not limited to: Volunteers, Fellows, Interns, Contractors, as well as Employees) who require the use of scientific diving for research or educational activities.

Qualifications

1. Scientific Diving Course participation/completion with less than 25 open water dives; or
2. Dive Rescue and Advanced Open Water Diver from an internationally recognized recreational certification and a minimum of 25 open water dives.
3. All must successfully complete:
    a. SDP swim test
    b. SDP check-out dive
    c. SDP written exams

Limitations

Divers must abide by the limitations outlined in this *Manual* and shall be supervised at all times. Initial depth limitations will be set to 30 feet in accordance with Section 4.3.

4.2.2.2 Scientific Diver Authorization

Signifies a diver has completed all requirements in Section 4.1 and is certified by the DSO to engage in scientific diving without supervision, as approved by the SDCB through the DSO.

Eligibility

For all those who are associated with the Smithsonian (including but not limited to: Volunteers, Fellows, Interns, Contractors, as well as Employees) who require the use of scientific diving for research and educational activities.

Qualifications

1. A minimum of 25 open water dives
2. Scientific Diver certification
3. SDP swim test completion
4. SDP check-out dive
5. SDP written exams

Limitations

Divers must abide by the limitations outlined in this *Manual*. Unless otherwise authorized by the DSO, initial depth authorization will be set to 30 feet in accordance with Section 4.3.

4.2.2.3 Temporary Diver Authorization

This authorization recognizes the situation where a highly qualified diver who could significantly contribute to a Smithsonian dive project but is not classified by one of the other categories.

Only a diver not under the auspices of an AAUS OM may be granted a Temporary Diver Authorization. The individual in question must demonstrate proficiency in diving and can contribute measurably to a planned dive. A Temporary Diver Authorization constitutes a waiver of selected requirements of Section 4 and is valid only for a limited time, as approved by the SDCB. A Temporary Diver Authorization must be restricted to the planned diving operation and must comply with all other policies, regulations, and standards of this *Manual*, including medical requirements. This authorization is not to be utilized as a repeated mechanism to circumvent existing standards set forth in this *Manual*.

Eligibility

Must be current and active diver who does not belong to a scientific diving program currently having, or the potential to establish, Reciprocity with the SDP.

Qualifications

1. A minimum of 25 open water dives
2. Scientific Diver certification or equivalent as determined by the DSO (minimum Rescue and Advanced Open Water Diver internationally recognized recreational certifications)
3. SDP swim test completion
4. SDP check-out dive
5. SDP written exam

Limitations

Divers must abide by the limitations outlined in this *Manual*. Authorization shall be restricted to the planned diving operation for the duration of the dive plan and shall comply with all policies, regulations and standards of this *Manual*. Initial depth limitations will be set to 30 feet in accordance with Section 4.3. Deeper depth limits may be requested via the SI Unit Diving Officer and granted at the discretion of the DSO.

4.2.3 Visiting Diver

This category for all divers who are not part of the SDP and wish to conduct dives with Smithsonian Divers, dive at Smithsonian facilities, or otherwise utilize Smithsonian auspices (Section 1.2.2) for their diving activities.

4.2.3.1 Reciprocity Diver Authorization

This authorization is issued by the DSO for a certified scientific diver from an organization that operates under scientific diving regulations that meet or exceed those of the American Academy of Underwater Sciences (AAUS).

Eligibility

Diver must be part of a Scientific Diving Program which has established reciprocity with the SDP either as being an Organization Member of the AAUS or through a direct request to the Central Diving Office via the Diving Officer for the Unit in which the diving will occur. Diver's status and eligibility will be verified through a signed Letter of Reciprocity (LOR) from the Diving Safety Officer of the scientific diving program in which the diver belongs. Verification of meeting the qualifications listed below will be the responsibility of the diver's Diving Safety Officer and will be specifically addressed in the LOR. The LOR, at a minimum, will address the elements listed in Appendix 6 of the AAUS Standards for Scientific Diving.

Qualifications

1. A minimum of 25 open water dives
2. Scientific Diver certification or equivalent as determined by the DSO
3. Swim test completion
4. SDP Check-out dive (at the discretion of the DSO)
5. Written exam

Limitations

Divers must abide by the limitations outlined in this *Manual*. Divers depth limit will be in accordance to those of the LOR or as determined by the DSO. The reciprocity authorization, if granted, is for the duration of the dive plan for which it was requested.

4.2.3.2 Non-Reciprocity Diver Authorization

This authorization is issued by the DSO to a visiting diver under the auspices of their home institution which may not meet AAUS standards but has, at a minimum, a dive program which meets the OSHA Scientific Diving Exemption requirements. This certified scientific diver, or diver who meets SDP minimum qualifications as stated below, will operate under scientific diving regulations that meet or exceed those of the American Academy of Underwater Sciences (AAUS).

Eligibility

Diver must establish authorization with the SDP through a direct request to the Central Diving Office via the Diving Officer for the Unit in which the diving will occur. Diver's status and eligibility will be verified via direct documentation. The documentation, at a minimum, will address the elements listed in Appendix 6 of the AAUS Standards for Scientific Diving.

Qualifications

1. A minimum of 25 open water dives
2. Scientific Diver certification or equivalent as determined by the DSO (minimum Rescue and Advanced Open Water Diver internationally recognized recreational certifications)
3. Swim test completion
4. Check-out dive
5. Written exam

Limitations

Divers must abide by the limitations outlined in this *Manual.* Divers depth limit will be set at 30 feet or as determined by the DSO. This non-reciprocity authorization, if granted, is for the duration of the dive plan for which it was requested.

4.3 Depth Authorizations

Indicates the maximum depth in which a diver can conduct science and, with appropriate experience and DSO approval, may supervise other divers holding a lesser depth authorization. A scientific diver requires a valid depth authorization, approved by the DSO, to be considered active.

4.3.1 Progression to Next Depth Limit

A diver may be authorized by the DSO to the next depth limit, providing there is a research need, after successfully completing the requirements for that limit. Depth authorizations may be exceeded by one level when accompanied and supervised by a dive buddy holding a depth authorization greater or equal to the intended depth. Dives must be planned and executed with the permission of the DSO. A DSO approved UDO or designee documented check-out dive for all depth authorizations beyond 60 feet is required before a depth increase will be authorized.

4.3.2 Depth Limits

1. Authorization to 30 Foot Depth - Initial science diver depth authorization, approved upon the successful completion of training listed in Section 4.1. Cumulative minimum supervised dives: 12.

2. Authorization to 60 Foot Depth - A diver holding a 30-foot authorization may be authorized to a depth of 60 feet after successfully completing and logging 12 supervised dives (post completion of dive course) near the maximum depth of 60 feet under supervision of a diver authorized by the DSO, for a minimum total time of 4 hours. Cumulative minimum supervised dives: 24.

3. Authorization to 100 Foot Depth - A diver holding a 60-foot authorization may be authorized to a depth of 100 feet after successfully completing and logging 6 supervised dives near the maximum depth of 100 feet under supervision of a dive buddy authorized by the DSO. The diver must demonstrate knowledge of the impacts the advanced hyperbaric environment has upon air management, tissue absorption, heat loss, and mental acuity. Divers will demonstrate the ability to properly plan and work at these depths while maintaining appropriate situational awareness through a series of tests administered by the DSO or designee during supervised dives. Even though decompression diving requires a specialized certification, divers will be trained on how to properly manage a decompression obligation to include, but not limited to, the use of their dive computer and dive tables. Cumulative minimum supervised dives: 30.

Dives deeper than 100 feet, as well as authorizations awarded to 130 feet or deeper, will require the approval of the SDCB.

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

5. Authorization to 150 Foot Depth - A diver holding a 130-foot authorization may be authorized to a depth of 150 feet after successfully completing and logging 6 supervised dives near the maximum depth of 150 feet under supervision of the DSO or designee. The diver must also demonstrate knowledge of the special problems of deep diving and of special safety requirements. Cumulative minimum supervised dives: 42.

Use of alternate inert gas mixtures to limit narcosis is recommended for depths greater than 150 feet (Section 9).

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

Diving on air is not permitted beyond a depth of 190 feet. Dives beyond 190 feet require the use of mixed gas (Section 9).

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

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

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

4.4 Maintaining Active Status

4.4.1 Minimum Activity to Maintain Authorizations

Each scientific diver must log a minimum of 12 scientific, scientific training, or proficiency dives within the 12-month period prior to an intended dive. At least one dive must be logged near the maximum depth of the diver's authorization during each 6-month period. Divers authorized to 150 feet or deeper may satisfy these requirements with dives to 130 feet or deeper.

4.4.2 Failure to meet Minimum Activity

Failure to meet minimum activity requirements will result in revocation, restriction, or reduction of depth authorization of diver's authorization.

4.4.3 Requalification of Authorization

Once the initial requirements of Section 4 are met, divers whose do not meet minimum activity requirements (4.4.1) may be requalified by satisfactorily performing a check-out dive with the DSO or approved designee. Should a long duration occur between diving activities, additional training or work-up dives may be required as specified by the DSO.

4.4.4 Medical Examination

All scientific divers must pass a medical examination, cleared by the DMO, as specified in Section 5. This medical examination requirement cannot be waived for any diver.

4.4.5 Emergency Care Training

SI Divers must hold current DAN DFA Pro certification or equivalent from an internationally recognized agency to be completed every two years, as well as annual hands-on practical training to include the following:

1. Adult CPR and AED
2. Emergency oxygen administration
3. First aid for diving accidents
4. Field Neurological exam

4.5 Violation of Regulations

All dive operations must be immediately suspended whenever there is concern the activities could result in dangerous consequences such as unacceptable risk to human life or property and/or constitutes a scientific diving policy violation.

Violations of regulations set forth in this *Manual*, or demonstration of poor judgement, may be considered cause for restriction, suspension, or revocation. All outcomes, actions, written statements and requests, as identified in this section, shall be documented and included in the diver's file.

4.5.1 Violation Reporting Process

Should a violation occur:

1. Lead Diver (LD) must suspend diving activity and immediately notify the UDO of the situation;
2. UDO must immediately suspend any further diving activities of divers in violation and notify the DSO;
3. DSO will discuss the situation with the UDO and, if warranted, immediately notify the SDCB and the diver's immediate supervisor;
4. SDCB will review, evaluate, make findings, and where appropriate, require corrective actions in all diving policy violations submitted. Findings and corrective actions shall be:
    a) Approved by at least a two-thirds vote of the SDCB.
    b) Submitted in written form to the Under Secretary for Science and Research within twenty-one calendar days after the matter is received by the SDCB for consideration.

4.5.2 Restriction/Suspension of Authorization

Authorizations associated with an individual's scientific diver certification may be restricted or suspended for cause by the DSO.

1. Restriction or suspension of authorizations may be rescinded by the DSO.
2. All actions will be reported to and reviewed by the SDCB.

4.5.3 Revocation of Certification

An individual's scientific diver certification can be revoked for cause by the SDCB.

1. The SDCB or designee must inform the diver in writing of the reason(s) for revocation.

2. The diver will be given the opportunity to present their case in writing to the SDCB for reconsideration.

3. Following revocation, the diver may be reauthorized after complying with all conditions imposed by the SDCB.

4.5.4 Diver Appeals

SI Divers have the right to appeal if adversely affected by a finding or if remedial action is required by the SDCB. The appeal procedures are as follows:

1. All appeals must be submitted in writing to the DSO within ten working days of the SDCB action or decision.

2. The DSO, through SDCB, will render a final written decision within ten working days after receipt of the appeal.

3. If needed, a further appeal can be made to the Under Secretary for Science and Research who will consult with the DSO, Chair of the SDCB and a DSO from another AAUS OM of equivalent size and complexity of the SDP and render a final decision.

SECTION 5: MEDICAL STANDARDS

5.1 Medical Requirements

All medical evaluations required by this *Manual* must be performed by, or under the direction of, a Medical Doctor (MD) or a Doctor of Osteopathy (DO), preferably one trained in diving/undersea medicine, with final clearance being provided by the SI Diving Medical Officer (DMO) or designee.

The diver should be free of any chronic disabling disease and any conditions listed in contained in *Conditions Which May Disqualify Candidates from Diving* described under Appendix 1 of the *AAUS Standards for Scientific Diving*, unless otherwise cleared to dive by the DMO. The DSO shall verify that scientific divers have passed a current diving medical evaluation and have been certified as medically fit to engage in diving activities.

5.2 Frequency of Medical Evaluations

Medical evaluation must be completed:		
Before Age 40	After age 40 Before Age 60	After Age 60
Before a diver may begin diving, unless an equivalent initial medical evaluation has been given within the preceding 5 years	Before a diver may begin diving, unless an equivalent initial medical evaluation has been given within the preceding 3 years	Before a diver may begin diving, unless an equivalent initial medical evaluation has been given within the preceding 2 years
At 5-year intervals	At 3-year intervals	At 2-year intervals
A previously medically cleared diver must be granted medical clearance by the DMO, from direct examination or based on information from the healthcare provider, prior to returning to diving when experiencing any of the following: 1. Major injury or illness; 2. Condition requiring chronic medication; or 3. Conditions listed in Appendix 1 of the AAUS *Standards for Scientific Diving.*		

5.3 Information Provided to Examining Physician

The SI Diver must submit the SDP *Diving Medical Exam Packet*, completed and signed by the diver, to the examining physician. The examining physician will follow instructions provided and, once the exam is complete, submit the entire packet, along with any additional information deemed necessary, to the SI Diving Medical Officer (DMO) at the SI Occupational Health Services (OHS).

The SDP *Diving Medical Exam Packet* is available to download within DecoStop.

5.4 Content of Medical Evaluations

Medical examinations conducted initially and at the intervals specified in Section 5.2 must consist of the following:

1. The Medical Evaluation Checklist and Clearance to Dive (Form SDP-001)
2. Report of Medical History (SDP-002)
3. Report of Physical Examination (SDP-003)

5.5 Physician's Written Report

1. The *SDP Diving Medical Exam Packet,* and any additional information deemed necessary, will be forwarded to the DMO for review.
2. Final determination for fitness for diving will be made by the SI DMO.
3. Once the *Medical Evaluation Checklist and Clearance to Dive* (Form SDP-001) has been received by the UDO from the DMO, the diver's records and authorizations will be updated accordingly.
4. A copy of any physician's written reports will be made available to the individual upon request.

Specialty Guidelines

Sections 6 through 12

Required Only When Conducting Described Diving Activities
Prior Authorization is mandatory

SECTION 6: NITROX CERTIFICATION AND AUTHORIZATION

This section describes the minimum requirements for authorization and use of nitrox for scientific diving. Application for authorization to use nitrox must be made to the DSO. Authorizations will be considered once diver provides proof of training in compliance with section 6.1 or equivalent. Submission of documents and participation in aptitude examinations does not automatically result in authorization to use nitrox. The applicant must convince the SDCB through the DSO that they are sufficiently knowledgeable, skilled and proficient in the theory and use of nitrox for diving.

6.1 Training

Training for use of nitrox will be conducted under the auspices and standards of an internationally recognized diver training agency.

6.1.1 Prerequisites

Diver must hold a Scientific Diver Certification or be an active participant in the SI Scientific Dive Course.

6.1.2 Practical Evaluation

Must include:

1. Oxygen analysis of nitrox mixtures;
2. Determination of Maximum Operating Depth (MOD), oxygen partial pressure exposure (pO_2), and oxygen toxicity time limits, for various nitrox mixtures at various depths;
3. Determination of nitrogen-based dive limit status by Equivalent Air Depth (EAD) method using air dive tables, NOAA nitrox dive tables, and dive computers;
4. Nitrox dive computer use; and
5. A minimum of two supervised open water dives using nitrox is required for authorization.

6.1.3 Written Evaluation

Must include:

1. Function, care, use, and maintenance of equipment cleaned for nitrox use.
2. Physical and physiological considerations of nitrox diving (e.g. O_2 and CO_2 toxicity)
3. Diving regulations, procedures/operations, and dive planning as related to nitrox diving
4. Equipment marking and maintenance requirements
5. Dive table and dive computer usage
6. Calculation of MOD and pO_2

6.2 Minimum Activity to Maintain Authorization

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

6.3 Operational Requirements

6.3.1 Oxygen Exposure Limits

1. The inspired oxygen partial pressure experienced at depth should not exceed 1.4 atmospheres absolute (ATA).

2. The maximum allowable exposure limit should be reduced in cases where cold or strenuous dive conditions, or extended exposure times are expected.

6.3.2 Calculation of No-Decompression Status

1. NOAA nitrox dive tables should be available at the dive site.

2. Dive computers may be used to compute decompression status during nitrox dives.

3. Dive computers with properly set pO_2 limit and fraction of oxygen (fO_2) should be checked by the diver prior to the start each dive and verified by the Lead Diver (LD) to ensure conformity with the mix being used.

6.3.3 Gas Mixture Requirements

1. Only nitrox mixtures and mixing methods approved by the DSO may be used.

2. SDP personnel mixing nitrox must be qualified and approved by the DSO for the method(s) used.

3. Oxygen used for mixing nitrox should meet the purity levels for "Medical Grade" (U.S.P.) or "Aviator Grade" standards.

4. In addition to the Breathing Gas Quality Standards outlined in Section 3.6, any air that may come in contact with oxygen concentrations greater than 40% (e.g. during mixing), must also have a hydrocarbon contaminant no greater than .01 mg/m^3.

5. For site operations using compressors not controlled by the SDP where this is not verifiable, the SDP breathing gas quality protocol (Section 3.6.2) must be followed to mitigate risk to the diver.

6.3.4 Analysis Verification by User

1. Prior to the dive, it is the responsibility of each diver to analyze the oxygen content of his/her scuba cylinder and acknowledge in writing the following information for each cylinder: fO_2, MOD, cylinder pressure, date of analysis, and user's name.

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

3. The above should be verified by the LD.

6.4 Nitrox Diving Equipment

6.4.1 Required Equipment

All of the designated equipment and stated requirements regarding scuba equipment required in this *Manual* apply to nitrox operations. Additional minimal equipment necessary for nitrox

diving operations includes:

1. Dedicated oxygen-clean "NITROX"-labeled scuba cylinders must be used
2. Oxygen Analyzers
3. Oxygen compatible equipment as applicable
4. Dive computers adjusted for fO_2 and PO_2 limit.

6.4.2 Requirement for Oxygen Service

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

6.4.3 Compressor system

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

SECTION 7: SURFACE SUPPLIED DIVING TECHNOLOGIES

Surface supplied diving technologies include any diving mode in which a diver at depth is supplied with breathing gas from the surface. For the purpose of this manual, the two breathing gas delivery modes addressed are via an umbilical with required strength member, pneumofathometer hose, and communication line, etc. (Surface Supplied Diving) and via a simple pressurized hose (Hookah).

7.1 Prerequisites

All surface supplied and hookah divers must be certified scientific divers or divers in training and have completed system specific training as authorized by the SDCB.

7.2 Surface Supplied Diving

Currently the SDP does not conduct or allow Surface Supplied Diving. Request for addition of Surface Supplied Diving to the SDP can be made to the SDCB via the UDO.

7.3 Hookah

7.3.1 Hookah Definition

Hookah is an open circuit diving mode comprised of a remote gas supply, a long hose, and a standard scuba second stage or full face mask. Hookah is generally used in shallow water (30 feet or less), though the configuration has been used to supply breathing gas from a diving bell, habitat, or submersible/submarine.

7.3.2 Equipment Requirements

1. All hookah system elements will be designed for the system being used and meet manufacturer specifications.

2. Gas supplied to the hookah diver must meet the breathing gas quality standards outlined in section 3.6.

3. Hookah supply systems must be capable of supplying all divers breathing from the system with sufficient gas for comfortable breathing for the planned depth and workload.

4. Hookah system second stage should be capable of being attached to the diver in a way to avoid pulling stress on the second stage mouthpiece and affords easy release if the diver must jettison the regulator and hose.

5. An independent reserve breathing gas supplied will be carried by each hookah diver:

    a) when the diver does not have direct access to the surface; or

    b) At depths or distance from alternate breathing gas source determined by the SDCB.

7.3.3 Operational Requirements

1. Hookah diving must not be conducted beyond depths or distance from alternate breathing gas source as determined by the SDCB.

2. A diver's independent reserve breathing gas supply, if worn, must contain sufficient volume to allow the diver(s) to exit to the surface or alternate breathing gas source.

3. Hookah divers not supported by diving bell, or underwater habitat must not be exposed to dives that require staged decompression.

4. The SDCB is responsible for developing additional operational protocols.

7.3.4 Hookah Diving in Aquariums

1. In an aquarium habitat where the maximum depth is known and planned for, a depth gauge is not required.

2. The maximum obtainable depth of the aquarium may be used as the maximum diving depth.

3. A hookah configured diver may operate without an in-water buddy in an aquarium provided the diver is tended from the surface; has visual, line pull, or voice communication with the tender; the diver carries an independent reserve breathing gas source containing sufficient volume to allow the diver to exit to the surface or alternate breathing gas source; and under other operational conditions as determined by the SDCB.

SECTION 8: STAGED DECOMPRESSION DIVING

Decompression diving is defined as any diving during which the diver cannot perform a direct return to the surface without performing a mandatory decompression stop to allow the release of inert gas from the diver's body. The following procedures must be observed when conducting dives requiring planned decompression stops.

Staged decompression diving is currently not standardly authorized by the SDP. Special consideration will be made on a case by case bases should a scientific need arise, and operational conditions warrant the use of this mode of diving. Request for this mode of diving will be made to the SCDB via the Unit Diving Officer. For consideration, the standards outlined in this section must be adhered to.

8.1 Experience and Training Requirements

8.1.1 Prerequisites

1. Scientific Diver qualification (Section 4).

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

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

4. Nitrox authorization (Section 6).

8.1.2 Training Requirements

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

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

2. At least one training session shall be conducted in a pool or sheltered water setting, to cover equipment handling and familiarization, swimming and buoyancy control, to estimate gas consumption rates, and to practice contingency situations and emergency procedures.

3. At least 6 open-water training dives simulating/requiring decompression must be conducted, emphasizing planning and execution of required decompression dives for no more than 15min total decompression time according with the dive tables, dive computers, and/or PC software.

4. Progression to greater depths must be by 6-dive increments at depth intervals as specified in Section 4.3.

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

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

    a) Buoyancy control

    b) Proper ascent rate

    c) Proper depth control

    d) Equipment manipulation

    e) Stage/decompression bottle use as pertinent to planned diving operation

    f) Buddy skills

    g) Gas management

    h) Time management

    i) Task loading

    j) Emergency skills

    k) Safety drills

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

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

8.2 Equipment Requirements

1. Valve and regulator systems for primary (bottom) gas supplies must be configured in a redundant manner that allows continuous breathing gas delivery in the event of failure of any one component of the regulator/valve system.

2. Bottom cylinders and Deco Stage cylinders must have enough volume and configuration adequate for planned diving operations.

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

4. During decompression on high-oxygen concentration mixtures, divers must closely monitor one another for signs of acute oxygen toxicity. Decompression stage bottle mixture may be between 22% to 100% O2.

5. Minimum dive equipment should include:

    a) Diver location devices adequate for the planned diving operations and environment.

    b) Compass

    c) Redundancy in the following components are required:

        i. Decompression Schedules

        ii. Dive Timing Devices

        iii. Depth gauges

        iv. Buoyancy Control Devices

        v. Cutting devices

        vi. Lift bags and line reels

8.3 Operational Requirements

1. The maximum pO_2 to be used for planning required decompression dives is 1.6 for open circuit. It is recommended that a pO_2 of less than 1.4 be used during bottom exposure.

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

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

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

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

6. Use of additional nitrox and/or high-oxygen fraction decompression gases to decrease decompression obligations is required.

7. Use of alternate inert gas mixtures to limit narcosis for decompression diving is required for depths greater than 150 feet.

8. The maximum depth for required decompression using air as the bottom gas is 150 feet.

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

10. Mission specific workup dives are recommended.

SECTION 9: MIXED GAS DIVING

Mixed gas diving is defined as dives conducted while breathing gas mixtures containing proportions greater than 1% by volume of an inert gas other than nitrogen.

Mixed gas diving is currently not authorized by the SDP. Special consideration will be made on a case by case bases should a scientific need arise, and operational conditions warrant the use of this mode of diving. Request for this mode of diving will be made to the SCDB via the Unit Diving Officer.

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

9.1 Minimum Experience and Training Requirements

9.1.1 Prerequisites

1. Nitrox authorization (Section 6).

2. If the intended use entails required decompression stops, divers will be previously authorized in stage decompression diving (Section 8).

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

9.1.2 Training

Divers must be certified by an internationally recognized training agency approved the by SDCB.

9.1.2.1 Practical Training

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

2. A minimum of 6 open water training dives.

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

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

5. Planned operational depth for initial training dives must not exceed 200 feet.

6. Diving operations beyond 200 feet requires additional training dives.

9.2 Equipment and Gas Quality Requirements

1. Equipment and techniques must meet minimum standards of the approved certifying agency and must meet other pertinent requirements set forth elsewhere in this *Manual*.

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

9.3 Operational Requirements

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

2. The maximum pO_2 to be used for planning required open circuit decompression dives is 1.6. It is recommended that a pO_2 of less than 1.4 be used during bottom exposure.

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

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

5. Mission specific workup dives are recommended.

SECTION 10: SPECIALIZED DIVING ENVIRONMENTS

The types of diving listed below require specialized equipment, procedures, training and must be approved by the DSO. Divers must comply with all scuba diving procedures in this *Manual* unless specified.

10.1 Blue Water Diving

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

10.2 Ice and Polar Diving

Divers planning to dive under ice or in polar conditions should refer to the USAP Antarctic Dive Guide (https://www.usap.gov/scienceSupport/documents/Antarctic_Dive_Guide.pdf) or “PESH-POL Standards for the Conduct of Scientific Diving”, National Science Foundation, Division of Polar Programs.

Dry suit use requires additional training (Sec 3.2.6).

10.3 Overhead Environments

This section covers any diving environment where the diver cannot easily reach the surface in the event of equipment failure or a compromised breathing supply due to an overhead physical obstruction. (This does not include ship husbandry diving.) Overhead environments include water filled caverns, caves, flooded mines and ice diving, as well as portions of sunken shipwrecks and other manmade structures.

1. A dive team shall be considered to be overhead obstruction diving if at any time during the dive they find themselves in a position where they cannot complete a direct, unobstructed vertical ascent to the surface, e.g., rock formations, ice, or manmade structures.

2. Overhead obstruction diving shall not be conducted at depths greater than 100 feet.

3. Dive teams shall perform a safety drill prior to commencing overhead obstruction diving operations that includes locating and rescuing a trapped diver.

4. Each team within the overhead obstruction zone shall utilize a continuous guideline appropriate for the environment leading to a point from which an uninterrupted vertical ascent to the surface may be made.

10.3.1 Equipment Requirements

1. Equipment used for scuba in an overhead environment is based on the concept of redundancy.

2. In addition to standard scuba diving equipment, the following equipment is required when diving in an overhead environment:

   a) A diver-carried, independent reserve breathing gas supply with separate scuba regulator and sufficient gas volume to allow the diver to safely return to the surface;

   b) A slate and pencil; and

   c) Redundant underwater lights, knives, and line reels as deemed appropriate by the DSO.

10.3.2 Specific Environments

1. Ice diving is a specialized overhead environment addressed in Section 10.2.

2. For cavern, cave, or flooded mine diving see Section 12.

3. For sunken shipwrecks and other manmade structures, divers should refer to the NOAA Diving Manual (Section 17.18, 6th ed) for further information.

10.3.3 Training and Proficiency

1. The requirement for overhead obstruction dive training will be left to the discretion of the DSO.

2. Dive experience in lieu of training may be approved by the DSO.

3. When diving of this type is not performed on a routine basis, ‘work-up’ dives shall be completed prior to the dive mission.

10.4 Aquarium Diving

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

It is recognized that within scientific aquarium diving there are environments and equipment that fall outside the scope of those addressed in this *Manual*. In those circumstances, SDP Aquarium diving will meet the standards of the Association of Zoos & Aquarium (AZA).

10.4.1 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.

10.4.2 Annual Safety Drills

Scientific Aquarium Divers are required to have annual rescue skills training in accordance with the Association of Zoos and Aquariums (AZA) standards to maintain Scientific Diver Active Status. To fulfill the AZA accreditation requirement, the National Zoo Unit Diving Officer will conduct annual live-action emergency safety drills.

10.5 Night Diving

Is defined as diving during the periods from one hour after sunset to one hour before sunrise.

1. Divers must have lights for visual illumination.
2. Light sticks attached to diver's cylinder must be used to provide continual illumination for each diver.
3. Safety stops should be illuminated on the descent line.
4. Redundant dive lights are required.
5. Dive flag shall be illuminated at night.
6. Pre-dive brief should include night dive hand signals.
7. An effective way to recall divers in case of emergency.

Divers should refer to the NOAA Diving Manual (Section 17.19, 6th ed) for further information.

10.6 Diving at Altitude

Is defined as all dives where the surface is 1000 feet or more above sea level. This specialty requires certification by an internationally recognized agency.

10.7 Deep Diving

Is defined as depths beyond 60 feet. Additional training and an DSO approved check-out dive are required to obtain certifications to these depths.

10.8 Low/Zero Visibility Diving

Is defined as when visual contact with the dive buddy can no longer be maintained. Alternate buddy systems, such as tethered or buddy lines, should be implemented. Divers should refer to the NOAA Diving Manual (Section 17.26, 6th ed) for further information.

10.9 Contaminated Water Diving

Is defined as water which contains any chemical, biological, or radioactive substance which poses a chronic or acute health risk to exposed personnel. This specialty requires additional training to include exposure protection, decontamination procedures as well as dry suit and full face mask use. Because of the wide variability in contaminants, potential exposure levels and other variables, dive operation requirements will be based on specifics of the dive site contamination which should be identified in the SDP dive plan. Divers should refer to the NOAA Diving Manual (Section 18, 6th ed) for further information.

SECTION 11: REBREATHERS

Rebreathers are currently not authorized for use by the SDP. Special consideration will be made on a case by case bases should a scientific need arise, and operational conditions warrant the use of this specialized equipment. In such case, divers must abide by the standards outlined in the AAUS Standards for Scientific Diving Manual.

SECTION 12: SCIENTIFIC CAVE AND CAVERN DIVING

12.1 General

This section defines specific considerations regarding the following issues for Scientific Cavern and Cave diving. Only divers certified by the National Speleological Society Cave Diving Section (NSS/CDS), the National Association for Cave Diving (NACD), International Association of Nitrox and Technical Divers (IANTD), Technical Diving International (TDI), or other equivalent agencies reviewed by the SDCB, will be considered for authorization to conduct planned diving operations in caverns, or caves.

All scientific cave or cavern dives under the auspices of the SDP must receive prior approval by the SDCB and authorization by the DSO. Equipment and techniques must meet minimum standards of the approved certifying agency.

Divers must demonstrate they possesses the proper attitude, judgment, and discipline to safely conduct cave and cavern diving in the context of planned operations and the understanding that any cave/cavern dive may be called at any time for any reason or even for no articulable reason whatsoever by any member of the dive team.

For cavern or cave dives that involve staged decompression, rebreathers, and/or mixed gas diving, all requirements for each of the relevant diving techniques, modes, or gases must be met.

Application of this standard is in addition to pertinent requirements of all other sections of this *Manual*. If a conflict exists between this section and other sections in this *Manual*, the information set forth in this section only takes precedence when the scientific diving being conducted takes place wholly or partly within an underwater cave or cavern environment.

12.2 Definition

A dive team must be considered to be cave or cavern diving if at any time during the dive they find themselves in a position where they cannot complete a direct, unobstructed ascent to the surface because of rock formations. In addition to blocking direct access to surfacing, underwater caves have additional environmental hazards including but not limited to:

1. The absence of natural light.

2. Current or flow that vary in strength and direction. Of particular note is a condition known as siphoning. Siphoning caves have flow or current directed into the cave. This can cause poor visibility as a result of mud and silt being drawn into the cave entrance.

3. The presences of silt, sand, mud, clay, etc. that can cause visibility to be reduced to nothing in a very short time.

4. Restrictions – Any passage through which two divers cannot easily pass side by side while sharing air make air sharing difficult.

5. Cave-Ins – Cave-Ins are a normal part of cave evolution. However, experiencing a cave-in during diving operations is extremely unlikely.

12.3 Prerequisites

Prerequisites	Cavern: OC or Rebreather	Cave	Rebreather Cave
Active scientific diver status, with depth qualification sufficient for proposed training location(s)	X	X	X
Completion of a minimum of 25 dives.	X		
Cavern Diver Authorization		X	X

12.4 Training

Training	Cavern: OC or Rebreather	Cave OC	Rebreather Cave
Key: X = include, R = Review, IA = If Applicable, OC = Open Circuit			
Trainers must be qualified for the type of instruction to be provided. Training must be conducted by agencies or instructors approved by the DCB or their designee	X	X	X
Academic			
Policy for diving overhead environments	X	X	X
Environment and environmental hazards	X	X	X
Accident analysis	X	X	X
Psychological considerations	X	X	X

Required equipment and equipment configuration			
Single cylinder with H or Y Valve	IA	IA	
Doubles with Isolation Manifold	IA	IA	
Side Mount		IA	IA
No Mount		IA	IA
Stage Cylinder(s)		IA	IA
Off-board Bailout	IA		X
Communications	X	X	X
Diving techniques			
Body control	X	X	X
Navigation and guidelines	X	X	X
Entry and Exit Protocols (Right of Way)	X	R	R
Use of line arrows and cookies	X	X	X
Line Systems Applicable to the Area and/or Cave System	X	R	R
Line Jumps		X	X
Circuits		X	X
Dive planning			
Rule of Sixths	X	R	R
Rule of Thirds	X	R	R
Gas Matching	IA	X	X
Decompression Theory	R	R	R
Dive Tables	R	R	R
Mixed Mode Diving	IA	IA	IA
Cave geology	X	R	R
Cave hydrology	X	R	R
Cave biology	X	X	X
Emergency procedures	X	X	X
Practical Training and Evaluation			
Land Drills			
Line Reel Use	X	R	R
Techniques and Considerations for Laying a Guideline	X	X	X
Guideline Following	X	R	R
Buddy Communication	X	R	R
Team Positioning for Normal Entry and Exit	X	X	X
Zero Visibility Drills			
Line Reel Use	X	R	R
Line and Line Arrow Identification and Following	X	R	R
Bump and Go (Skills description)		X	X
Emergency Procedures			
How Far Can You Go Out of Gas? (Skills description)	X	X	X
Team Positioning for Emergency Situations	X	X	X
In-Water			
Demonstrated skills must include, at a minimum:			
A minimum of four (4) cavern dives, preferably to be conducted in a minimum of two (2) different caverns	X		
A minimum of twelve (12) cave dives, preferably to be conducted in a minimum of four (4) different cave sites with		X	X

differing conditions			
Safety drill (S-drill) – Performed on every dive			
Review of Dive Plan and Turn Pressures	X	X	X
Essential Gear Identification, Positioning, and Function Check	X	X	X
Proper Valve Position Check	X	X	X
Bubble Check	X	X	X
Proper Buoyancy Compensator Use	X	X	X
Proper Trim and Body Positioning	X	X	X
Hovering and Buoyancy with Hand Tasks	X	X	X
Specialized Propulsion Techniques and Anti-Silting Techniques (modified flutter kick, modified frog kick, pull and glide, ceiling walk or shuffle)	X	X	X
Proper Light and Hand Signal Use	X	R	R
Proper Reel and Guideline Use	X	X	X
Ability to Deploy a Primary Reel and Tie into a Main Line Under Different Conditions (Flow, Visibility, Bottom/Silt, etc.)	X	X	X
Proper Line Placement and Etiquette	X	X	X
Proper Use of Safety Reel		X	X
Proper Use of Jump/Gap Reel(s)		X	X
Use of Drop/Stage Cylinders			
Proper Placement and Retrieval of Cylinder(s) With Minimal Disturbance of Environment and Visibility		IA	IA
Ability to Deploy and Retrieve Cylinders with Minimal Loss of Forward Progress		IA	IA
Surveying	IA	IA	IA
Ability to Properly Critique Their Dives and Performance	X	X	X
Zero Visibility Drills	IA	X	X
Line Reel Use	X	R	R
Buddy Communication	X		
Line and Line Arrow Identification and Following	X	R	R
Bump and Go (Skills Description)		X	X
Emergency Procedures			
Team Positioning for Emergency Situations	X	X	X
Lost Line (Skills Description)		X	X
Lost Buddy	X	X	X
Gas Sharing While Following Guideline (Conducted with and without visibility, As Donor and Receiver)	X	X	X
Gas Sharing in a Minor Restriction Using a Single File Method as Donor and Receiver		X	X
Valve Manipulation	X	X	X
Proper Attitude, Judgment, and Discipline to Safely Conduct Dives in An Overhead Environment	X	X	X
Written Examination			
A written evaluation approved by the DCB with a predetermined passing score, covering concepts of both classroom and practical training	X	X	X

12.5 Equipment Requirements

Equipment used for SCUBA in cave or cavern diving is based on the concept of redundancy. Redundant SCUBA equipment must be carried whenever the planned penetration distances are such that an emergency swimming ascent is not theoretically possible.

Snorkel shall NOT be worn while cavern or cave diving.

Octopus alternate air systems are recommended over Air2 systems in overhead environments due to the potential need to swim long distances before reaching the surface.

Minimum Equipment	Cavern OC	Rebreather Cavern	Cave OC	Rebreather Cave
Key: X = include, R = Review, IA = If Applicable, OC = Open Circuit				
At a minimum, a single cylinder with adequate volume and configured to allow divers to exit from farthest/deepest penetration while supporting self and dive buddy equipped with a “K” valve; standard OC regulator configuration (Section 3.2.2); and BCD	X			
At minimum, a single cylinder equipped with an “H” or “Y” valve Or an alternate gas supply with adequate volume and configured to allow divers to exit from farthest/deepest penetration while supporting self and dive buddy			IA	
Off-board/bailout gas supply of sufficient volume and configured to allow diver to exit from farthest/deepest penetration	IA	X		X
A BCD capable of being inflated from the cylinder	X	X	X	X
Slate and pencil	X	X	X	X
A functioning primary light with sufficient burn time for the planned dive			X	X
Two functioning battery powered secondary lights	X	X	X	X
Two cutting devices	X	X	X	X
One primary reel of at least 350 feet (106 m) for each team	X	X	X	X
Safety reel with at least 150 feet (45.6 m) of line			X	X
Directional Line Markers			X	X
Cylinders with dual orifice isolation valve manifold Or independent SCUBA systems* with enough volume for the planned dive plus required reserve			X	
Two completely independent regulators, at least one of each having submersible tank pressure gauge and a low-pressure inflator for the BCD			X	
One regulator to be configured with a five foot or longer second stage hose	IA		X	
Rebreather		X		X
Off-board Bailout of sufficient capacity for the diver to exit to the surface		X		X
*Independent SCUBA systems must be configured to allow for monitoring of gas pressures in each cylinder				

12.6 Operational Requirements and Safety Protocols

Operational Requirements and Safety Protocols	Cavern	Cave
Diving must not be conducted at penetration distance into the overhead environment greater than 200 feet (60 m) from the water's surface, with a depth limit of 100 feet (30 m)	X	
Dive teams must perform a safety drill prior to each dive that includes equipment check, gas management, and dive objectives	X	X
Each team within the overhead zone must utilize a continuous guideline appropriate for the environment leading to a point from which an uninterrupted ascent to the surface may be made	X	X
Gas management must be appropriate for the planned dive with special considerations made for; DPV's, siphon diving, rebreathers, etc.	X	X
The entire dive team is to immediately terminate the dive whenever any dive team member calls (terminates) the dive	X	X

Appendices

Appendix 1 through 3

APPENDIX 1
DEFINITION OF TERMS

Air sharing - Sharing of an air supply between divers.

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

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

Authorization - To permit a diver to conduct diving operations taking into consideration the training, experience, and knowledge of the diver, the work to be conducted, the tools to be used, and the depths of the intended dives.

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

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

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

Buddy Diver / Buddy System - Two comparably equipped scuba divers who remain in constant visual communication or physical contact and are close enough to each other to render immediate assistance in an emergency.

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

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

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

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

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

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

Cylinder - A pressure vessel for the storage of gases.

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

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

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

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

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

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

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

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

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

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

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

DPIC - See Designated Person-In-Charge.

EAD - Equivalent Air Depth (see below).

Emergency Swimming Ascent - An ascent made under emergency conditions where the diver may exceed the normal ascent rate.

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

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

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

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

FSW - Feet of seawater.

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

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

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

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

Hyperbaric Chamber - See recompression chamber.

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

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

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

Life Support Equipment - Underwater equipment necessary to sustain life.

Lead Diver - Certified scientific diver with experience and training to be responsible and accountable for the conduct of the diving operation.

Organizational Member (OM) - An organization which is a current member of the AAUS, and which has a program, which adheres to the standards of the AAUS as, set forth in the *AAUS Manual*.

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

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

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

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

Near-Miss - Any event which did not result in injury or illness to personnel, or property damage, but had the potential to do so.

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

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

OTU - Oxygen Toxicity Unit

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

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

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

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

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

Pressure Vessel - See cylinder.

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

Primary Reel - Initial guideline used by the dive team from open water to maximum penetration or a permanently installed guideline.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

UDO - Unit Diving Officer

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

APPENDIX 2
EMERGENCY ACTION PLAN

Introduction

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

General Procedures

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

1. Make appropriate contact with victim or rescue as required.
2. Establish (A)irway (B)reathing (C)irculation or (C)irculation (A)irway (B)reathing as appropriate
3. Stabilize the victim
3. Administer 100% oxygen, if appropriate (in cases of Decompression Illness, or Near Drowning).
    - 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 or your SI dive plan for information to contact diving physician and recompression chamber, etc.
6. Notify DSO or designee according to the Emergency Action Plan of the dive operation.
7. Complete and submit incident report in compliance with Section 2.7.3.

List of Emergency Contact Numbers Appropriate for Dive Location

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Available Procedures

1. Emergency care
2. Recompression
3. Evacuation

Emergency Plan Content

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

APPENDIX 3
Rescue of a Submerged Unresponsive Compressed-Gas Diver

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