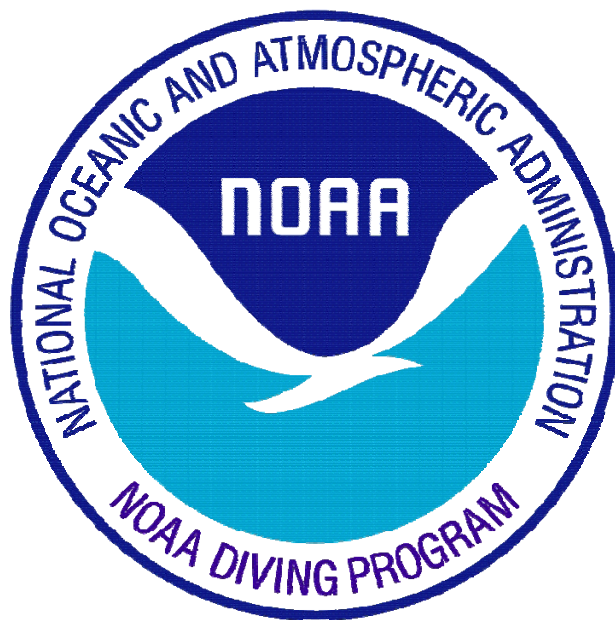


**NATIONAL OCEANIC AND ATMOSPHERIC
ADMINISTRATION**

Scientific Diving Standards & Safety Manual



August 14, 2008

The NOAA Diving Program
Diving for Science and Technology

FOREWORD

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

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

This manual is based on the American Academy of Underwater Sciences (AAUS) Standards for Scientific Diving dated November 2006.

Revision History

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SECTION 1.0 GENERAL POLICY

1.1 Scientific Diving Standards

Purpose

The purpose of this manual is to ensure that all scientific diving is conducted in a manner that will maximize protection of scientific divers from accidental injury and/or illness, and to set forth standards for training and certification that will allow a working reciprocity with other science-oriented diving programs. Fulfillment of the purposes shall be consistent with the furtherance of research and safety.

This manual sets minimum standards for NOAA scientific diving operations, describes the organization for the conduct of scientific diving, and the basic standards and procedures for safety in scientific diving operations. It also establishes a framework for reciprocity between NOAA and other organizations that adhere to these minimum standards.

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

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

For the purposes of this manual, a “scientific diver” is a scientist or scientist in training required to perform dives relying on scientific expertise in order to advance underwater science on behalf of NOAA. “Scientists” are defined as those individuals having expert knowledge of one or more sciences, who study natural phenomena in a systematic manner, and who have acquired their scientific expertise through a combination of academic training and professional field experience. Their employment with NOAA, as described in whole or in part in their position description, is defined as including use of their scientific expertise for the advancement of underwater science. A “scientist-in-training” is an individual actively engaged in academic training and field study necessary to qualify as a scientist, as defined above. In 29 CFR 1910 Subpart T, scientific diving “Means diving performed solely as a necessary part of a scientific, research, or educational activity by employees whose sole purpose for diving is to perform scientific research tasks.”

Examples of scientific diving include but are not limited to: data collection (water or bottom samples, flora and fauna, etc.); observing and documenting (including the use of cameras); and measuring and counting. The tasks which can be completed by a scientific diver are limited to observation and data gathering and are performed for collection of data used for the advancement of science. If tools are used, they include but are not limited to “light” hand tools (e.g., small hammers, pliers, screw drivers, chisels, pneumatic-power drills). Other ancillary equipment such as small lift bags (<50 pounds lifting capacity) and small air lifts can also be used if the tasks are associated with data collection. Tasks such as those described above performed by scientific divers are exempt from the OSHA commercial diving regulations found at 29 CFR, 1910 Subpart T. Working Dives are those conducted to complete tasks typically associated with: ship husbandry (cleaning hulls, sea strainers, replacing zincs, un-fouling a ship’s propeller); use of heavy power tools powered by pneumatics or hydraulics from the surface; lifting, positioning and retrieving heavy objects; construction, and underwater cutting or welding using exothermic cutting lances. Working dives are not exempt from the OSHA commercial diving regulations and as such will not be covered in this manual.

While the scope of this manual is intended to cover the range of policies, procedures and safety considerations for diving operations specific to the scientific component of the NOAA Diving Program (NDP), it will often refer to “routine scientific dives.” For the purposes of this manual ‘routine scientific dives’ are defined as those dives which are conducted under the no-decompression limits while utilizing open-circuit SCUBA and while breathing either air or nitrox mixtures. Further, they comply with all of the standards in this manual. Any dives conducted under the scientific exemption to OSHA and which are outside these parameters, or which deviate from the procedures in this manual, will require consideration and specific approval from the NOAA Diving Control and Safety Board (NDCSB) prior to the conduct of the dive.

The following list of questions is presented to help NOAA divers and their supervisors determine whether underwater tasks constitute a scientific dive. A negative answer to any one of these questions would potentially disqualify the task from being conducted under the exemption. The list is not all-inclusive; for further guidance contact the Unit Diving Supervisor or go to:

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&p_id=3449

Can the tasks be accomplished using simple hand tools (e.g., small hammers, pliers, chisels, wrenches, cameras, measuring tapes, nets, collection jars) weighing <25 pounds underwater?
Do the tasks require the expertise of a scientist or scientist-in-training?
Can the tasks be accomplished with minimal physical exertion?
Can the tasks be accomplished in short duration (e.g., <1-hour)
Do the tasks involve observation of natural phenomena or responses of natural systems and/or gathering of data for scientific analysis?
Do the tasks require moving or lifting objects weighing <100 pounds underwater?
Will the tasks result in the advancement of science?

Scientific Diving Definition

Scientific diving is defined (29CFR1910.401(a)(2)(iv)) as diving performed solely as a necessary part of a scientific, research, or educational activity by individuals whose sole purpose for diving is to perform scientific research tasks.

Scientific Diving Exemption

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

- a) The NOAA Diving Control and Safety Board (NDCSB) consists of a majority of active scientific divers and has autonomous and absolute authority over the scientific diving program's operation.
- b) The purpose of the project using scientific diving is the advancement of science; therefore, information and data resulting from the project are non-proprietary.
- c) The tasks of a scientific diver are those of an observer and data gatherer. Construction and trouble-shooting tasks traditionally associated with commercial diving are not included within scientific diving.
- d) Scientific divers, based on the nature of their activities, must use scientific expertise in studying the underwater environment and therefore, are scientists or scientists-in-training.
- e) In addition, the scientific diving program shall contain at least the following elements (29CFR1910.401):
 1. Diving safety manual, which includes at a minimum: procedures covering all diving operations specific to the program; procedures for emergency care, recompression, and evacuation, and the criteria for diver training and certification.
 2. Diving Control and Safety Board, with the majority of its members being active scientific divers, which shall at a minimum have the authority to: approve and monitor diving projects, review and revise the diving safety manual, assure compliance with the manual, certify the depths to which a diver has been trained, take disciplinary action for unsafe practices, and assure adherence to the buddy system (a diver is accompanied by and is in visual or tactile contact with another diver in the water) for scuba diving.

1.2 Operational Control

General

Duties and responsibilities delegated herein to specific roles and positions may not be further re-delegated unless specifically authorized in this manual.

Dive Program Manager (DPM)

Oversees and manages the day-to-day affairs of the NOAA Diving Program; and serves as the ranking NOAA diving official for matters relating to the interpretation and application of the NOAA diving standards, policies, and procedures. As the individual responsible for managing the NOAA Diving Program, the DPM will review recommendations from the Dive Safety Officer (DSO) and take appropriate action. The DPM serves as a voting member of the NDCSB.

a) Qualifications

1. Shall be selected by the Director, NOAA Office of Marine and Aviation Operations (OMAO) from a ranked list of OPM approved candidates with input from the NDCSB.
2. Shall be a NOAA certified diver.
3. Shall be a current or previously-certified SCUBA instructor from an internationally recognized certifying agency.
4. Shall have a minimum of 15 years experience in a diving or related field.

b) Duties and Responsibilities

1. Shall be responsible to the Director, NOAA Marine and Aviation Operations Centers (MAOC) for the safe conduct of the NOAA Diving Program. The routine operational authority for this program, including the conduct of training and certification, maintenance of diving records, and ensuring compliance with this standard and all relevant regulations, rests with the DPM.
2. May permit portions of this program to be carried out by a qualified delegate, although the DPM may not delegate responsibility for the overall safe conduct of the NDP.
3. Shall be guided in the performance of the required duties by the advice of the DSO, but operational responsibility for the conduct of the NOAA Diving Program will be retained by the DPM.
4. Shall suspend diving operations considered to be unsafe or unwise.
5. Shall monitor and enforce compliance with all applicable diving standards and safety rules.
6. Shall sign all “Letters of Authorization to Dive,” “Dive Certifications,” and “Diver ID cards.”
7. Shall determine equivalency with that of the NDP for diving reciprocity.
8. Shall prepare an annual operational report on the NOAA Diving Program and submit the report to Director, MAOC.
9. Shall suspend, revoke, or restore divers’ certifications to dive.

10. Shall take disciplinary action within the bounds of the NOAA diving standards for unsafe practices.
11. Shall determine completion of certification requirements and issues NOAA diver certifications and authorizations to dive.
12. Shall establish and/or approve dive training programs.
13. Shall establish criteria for equipment selection and use.
14. Shall investigate new diving technologies and techniques.

Diving Safety Officer

a) Qualifications

1. Shall be selected by and report to the Director, OMAO from a ranked list of OPM approved candidates with input from the NDCSB.
2. The Diving Safety Officer (DSO) is a voting member of the NDCSB. This person should have broad technical and/or scientific expertise in research related diving.
3. Shall be a NOAA certified diver.
4. Shall be a current or previously-certified SCUBA instructor from an internationally recognized certifying agency.

b) Duties and Responsibilities

1. Provide advice to the NOAA scientific diving program on all safety and health related issues.
2. May permit portions of this program to be carried out by a qualified delegate, although the DSO may not delegate responsibility for the overall safe conduct of the NOAA scientific diving program.
3. Shall coordinate annual safety inspections of all NOAA dive units and provide findings to the Dive Program Manager, NDCSB, Director OMAO and NOAA CAO.
4. Shall oversee and manage NOAA's air compressor testing program.
5. Subject to and consistent with the incident investigation parameters in NOAA's Safety Policy NAO 209-1, shall investigate all Class B diving mishaps and provide findings to the Dive Program Manager, NDCSB, Director OMAO and NOAA CAO.
6. Shall suspend diving operations considered to be unsafe or unwise.
7. Shall oversee and manage the distribution and maintenance of oxygen first aid kits at all dive units.

8. Shall monitor and enforce compliance with all medical and safety-related training requirements for NOAA science divers (i.e., CPR, first aid, oxygen delivery, emergency drills, etc.).

NOAA Diving Control and Safety Board (NDCSB)

- a) Purpose
 1. The NDCSB reports jointly to the Director, OMAO and the NOAA CAO to promote the safe and effective operation of the NOAA Diving Program.
 2. The NDCSB specifically fulfills the requirements under OSHA regulations at Subpart T 1910.401(a)(2)(iv)(B) concerning a required element for scientific diving as an exempted category from OSHA standards applicable to working (commercial) diving operations.
 3. All dives conducted outside the scientific diving exemption are subject to OSHA regulations at Subpart T as applicable for working (commercial) dives and are further addressed in NAO 209-123.

- b) Membership
 1. Voting members
 - Chairperson – Two year rotating membership, elected by voting members
 - Diving Safety Officer (DSO)
 - Line Office Diving Officers (LODO) - each of whom must be an active scientific diver)
 - OMAO Diving Officer (ODO)
 - Dive Program Manager (DPM)
 2. Advisory Members
 - NOAA Office of the General Counsel
 - NOAA Safety and Environmental Compliance Office (SECO)
 - OMAO Diving Medical Officer (DMO)
 - Such other members as the Director, OMAO and NOAA CAO shall appoint to promote the effective conduct of the Board's responsibilities.
 3. Executive Secretariat

- c) Composition. The Board shall consist of a majority of active scientific divers. The Director, OMAO and NOAA CAO shall periodically review the composition and membership of the Board, including the designation of the Chairperson, and make recommendations to the board for revisions as necessary. The Diving Safety Officer shall serve as the initial Chairperson of the Board. To avoid

conflict of responsibilities, the Dive Program Manager is not eligible to serve as the Board Chairperson.

- d) Roles and Responsibilities: The Board has autonomous and absolute authority over the NOAA scientific diving program's operation. Consistent with this broad responsibility, the Board shall perform the following functions:
1. Approve and monitor diving projects.
 2. Establish such processes and program structure as necessary to effectively approve and monitor scientific diving projects across NOAA's geographically dispersed diving program.
 3. Develop and promulgate the NOAA Scientific Diving Standards and Safety Manual and review and revise the manual as necessary.
 4. Ensure compliance with the NOAA Scientific Diving Standards and Safety Manual, including establishing such compliance inspection and certification programs as necessary to ensure effective oversight of compliance with the manual.
 5. Ensure adherence to the buddy system for scuba diving.
 6. Serve as a board of investigation inquiring in to and reporting to the Director, OMAO and the NOAA CAO the nature and cause of diving incidents (including near-misses) and violations of NOAA or other applicable policies and standards (NOTE: For Class A incidents involving a fatality or severe injury, or other criteria constituting a "serious incident" under the NOAA Safety Policy (NAO 209-1), responsibility for the conduct of the investigation and corrective action is retained by the SECO).
 7. Take disciplinary action for unsafe or noncompliant practices or actions.
 8. Recommend to the DPM the issuance, reissuance, or revocation of diving certifications.
 9. Establish and/or approve training and certification programs for NOAA divers or divers participating in NOAA-sponsored dive projects, including physical conditioning and medical standards required to promote diver safety.
 10. Establish criteria for equipment selection and use.
 11. Recommend new equipment and techniques.
 12. Conduct an annual safety assessment of the NOAA Scientific Diving Program, and such other *ad hoc* assessments as appropriate or as directed by the Director, OMAO and NOAA CAO, and report on the results of such assessments to the Director, OMAO and NOAA CAO including recommendations or actions taken to strengthen the safety and effectiveness of the NOAA scientific diving program.

- e) The Board shall meet annually in person and monthly via teleconference, unless *ad hoc* special meetings are required to address time sensitive issues.
- f) Decision Making Process: The Chairperson will strive for consensus on all Board issues and decisions. Decisions will be made by majority vote; with the Chairperson making the final decision when there is a tie. Every voting member will cast a vote on all decisions. Major objections to the majority vote should be made part of the record. Any voting member of the Board may request that an item be raised to the Director, OMAO or NOAA CAO.

Line Office Diving Officers (LODO)

General

- a) LODOs serve as senior representatives for diving for each NOAA Line Office that utilize divers including the National Marine Fisheries Service, National Ocean Service, National Weather Service, Office of Oceanic and Atmospheric Research, and Office of Marine and Aviation Operations.
- b) LODOs are appointed by their respective Assistant Administrators with concurrence of the NDCSB and approval of the employee's immediate supervisor.
- c) The OMAO Diving Officer is appointed by the Director, MAOC with concurrence of the NDCSB and the employee's immediate supervisor.

Roles and Responsibilities

- a) Safety
 - 1. Conduct, or delegate, annual on-site diving unit safety inspections, and forward reports to the NDCSB by January 31 of each year.
 - 2. Coordinate and assist, as requested, with the SECO and the SECO-assigned investigative teams to serve as subject matter experts for incidents involving a fatality or severe injury, or other criteria constituting a "serious incident" under the NOAA Safety Policy (NAO 209-1), responsibility for conduct of the investigation and corrective action is retained by the SECO).
 - 3. Review diving accidents and incidents which are not covered in section a) 2 above that occur within respective Line Offices, and report findings, recommendations, and/or proposed changes to the NDCSB.
- b) Management and Administration
 - 1. Assist in planning, reviewing and elevating to the NDCSB assigned unit's diving activities and in ensuring compliance with this manual.

2. Maintain familiarity with diving activities within assigned units.
 3. Submit annual reports of all diving activities under assigned jurisdiction to the NDCSB by October 31 of each year for the previous fiscal year.
- c) Training
1. Determine recertification requirements for divers whose diving certifications have lapsed by more than 6-months.
 2. Standardized Equipment Program (SEP). Verifies accuracy of annual SEP assessment charges for assigned units.
- d) Qualifications
1. LODOs must be active NOAA scientific divers.
 2. Meet the requirements for Unit Diving Supervisor.
 3. Have a minimum of 10 years experience in a diving or related field.

Unit Diving Supervisors (UDS)

General

- a) UDSs are assigned throughout the agency to provide administrative oversight of divers within their respective Line Offices.
- b) UDSs are assigned by their LODOs with approval of the NDCSB and concurrence of the employee's immediate supervisor.

Responsibilities

- a) Safety
 1. Ensure that competent Divemasters or Lead Divers are in charge of diving operations.
 2. Ensure that all diving gear and accessory equipment are maintained in a safe operating condition
 3. Report to the LODOs and the NDCSB all diving-related accidents/incidents that occur within their unit as prescribed in this manual, and consistent with NOAA's Safety Policy NAO 209-1.
 4. Approve dive plans and dive accident management plans for all routine scientific dives involving no-decompression profiles, open-circuit SCUBA, and air or nitrox breathing mixtures.
 5. Elevate to the NDCSB all non-routine dive plans and accident management plans for approval prior to commencement of the operation.

- b) Management and Administration
 - 1. Review dive plans and determine whether tasks to be performed meet the criteria for the scientific exemption outlined in Appendix B to 29 CFR 1910 Subpart T and whether the dive meets the elements required for a routine scientific dive.
 - 2. Provide a copy of all approved dive plans to the appropriate Divemaster and Lead Diver responsible for the dive operation.
 - 3. Explain NOAA diving standards, policies and procedures when required.
 - 4. Maintain files on divers in their units, or delegate the responsibility to ship/science party Divemasters or ship Dive Officers, with each diver's files to include, but not be limited to, Letters of Certification, training and medical records pertaining to diving and equipment files.
 - 5. Keep the NDC apprised of any changes to unit roster.
 - 6. Conduct or delegate to the Divemaster or Lead Diver at the unit/ship annual dive locker inspections and submit reports to LODOs by January 15 of each year.
 - 7. Submit reports of unit diving activities for the preceding fiscal year to LODOs by October 15 of each year.
 - 8. Prepare diver training applications and send to NDC.
- c) Training. Conduct operational training and skills evaluation check-out dives as needed.
- d) Standardized Equipment Program
 - 1. Track diver movement into and out of unit and coordinate with NDC.
 - 2. Track SEP equipment and ensure gear is returned to NDC upon diver departure from unit.
 - 3. Verify accuracy of annual SEP assessment charges for assigned divers.

Qualifications

- a) Be a current or former NOAA certified diver.
- b) Complete the NOAA Divemaster training program.
- c) Have a minimum of 5 years experience in a diving or related field.

Instructional Personnel

- a) Shall be qualified for the type of instruction being given.
- b) Must be approved by the NDCSB.

Divemaster

General

- a) A NOAA certified Divemaster should oversee and direct all aspects of the diving operation affecting the safety and health of dive team members at a dive site.
- b) The Divemaster shall:
 1. Have experience and training in conducting the assigned diving operation;
 2. Have absolute authority over execution of on-site diving operations;
 3. Obtain concurrence from the vessel captain prior to initiating diving operations;
 4. Be at the dive location; and
 5. Ensure that the dive is conducted in accordance with the dive plan submitted to and approved by the UDS.

Responsibilities

- a) Safety
 1. Ensure that all diving is planned and conducted in accordance with all prescribed NOAA diving standards, policies and procedures listed in this manual.
 2. Prohibit from diving any diver exhibiting problems of a physical, emotional or psychological nature that can compromise the safety of the diver or dive team.
 3. Ensure there are no apparent unusual hazards or environmental conditions likely to adversely affect the safety of the diving operation.
 4. Ensure emergency procedures are established and clearly understood by all personnel before diving begins.
 5. Ensure all safety and emergency equipment is in working order and at the dive site.
 6. Ensure all divers are monitored after each dive for signs or symptoms of decompression sickness or other diving-related illnesses.
 7. Consistent with NOAA's Safety Policy NAO 209-1, report all diving-related accidents and incidents as prescribed in this manual.
 8. Coordinate with other known activities in the vicinity that are likely to interfere with diving operations.
 9. Ensure that all diver-worn equipment is properly configured in accordance with NOAA diving standards.
 10. Brief dive team members on:

- Dive objectives
 - Unusual hazards or environmental conditions likely to affect the safety of the diving operation
 - Modifications to diving or emergency procedures necessitated by the specific diving operation
 - Suspending diving operations if, in their opinion, conditions are not safe
 - Reporting to the UDS any physical problems or adverse physiological effects including symptoms of pressure-related injuries
 - Adherence to the buddy system
 - The 500-psi minimum cylinder surfacing pressure requirement
- b) Management and Administration
1. Ensure that all divers are certified and properly trained to perform the required diving.
 2. Ensure that the prescribed files are maintained if such responsibilities have been delegated by the UDS.
 3. Ensure qualified individuals are assigned to fulfill all required diving and support positions.
- c) Training. Conduct operational training and skills evaluation check-out of dives as directed by the UDS.
- d) Standardized Equipment Program
1. Ensure that all equipment is in safe operating condition, and that the required maintenance records are maintained as delegated by the UDS.
 2. Assist UDS in tracking SEP equipment and ensuring that gear is returned to NDC upon a diver's departure from the unit.

Qualifications. NOAA Divemasters shall:

- a) Be a current or former NOAA certified diver;
- b) Complete the NOAA Divemaster training program;
- c) Have a minimum of 2 years experience in a diving or related field; and
- d) Be assigned by the UDS or his designee.

Lead Divers

General

- a) When a NOAA Divemaster is unavailable, a Lead Diver will be designated to perform the duties of the Divemaster.

- b) The Lead Diver shall:
 - 1. Have experience in conducting the assigned diving operation;
 - 2. Have absolute authority over execution of on-site diving operations;
 - 3. Obtain concurrence from the vessel captain prior to initiating diving operations;
 - 4. Be at the dive location; and
 - 5. Ensure that the dive is conducted in accordance with the dive plan submitted to and approved by the UDS.

Responsibilities

- a) Safety
 - 1. Ensure that all diving is planned and conducted in accordance with all prescribed NOAA diving standards, policies and procedures listed in this manual.
 - 2. Prohibit from diving any diver exhibiting problems of a physical, emotional or psychological nature that can compromise the safety of the diver or dive team.
 - 3. Ensure there are no apparent unusual hazards or environmental conditions likely to adversely affect the safety of the diving operation.
 - 4. Ensure emergency procedures are established and clearly understood by all personnel before diving begins.
 - 5. Ensure all safety and emergency equipment is in working order and at the dive site.
 - 6. Ensure all divers are monitored after each dive for signs or symptoms of decompression sickness or other diving-related illnesses.
 - 7. Consistent with NOAA's Safety Policy NAO 209-1, report all diving-related accidents and incidents as prescribed in this manual.
 - 8. Coordinate with other known activities in the vicinity that are likely to interfere with diving operations.
 - 9. Ensure that all diver-worn equipment is properly configured in accordance with NOAA diving standards.

10. Brief dive team members on:
 - Dive objectives
 - Unusual hazards or environmental conditions likely to affect the safety of the diving operation
 - Modifications to diving or emergency procedures necessitated by the specific diving operation
 - Suspending diving operations if, in their opinion, conditions are not safe
 - Reporting to the UDS any physical problems or adverse physiological effects including symptoms of pressure-related injuries
 - Adherence to the buddy system
 - The 500-psi minimum cylinder surfacing pressure requirement
- c) Management and Administration
 1. Ensure that all divers are certified and properly trained to perform the required diving.
 2. Ensure qualified individuals are assigned to fulfill all required diving and support positions.
- e) Training. Conduct operational training and skills evaluation check-out of dives as directed by the UDS.

Qualifications. Lead Divers shall:

- a) Be currently certified NOAA divers;
- b) Demonstrate to the UDS, or his designee, the ability to plan and safely execute dive operations; and
- c) Be approved by the UDS or his designee.

Scientific Divers

General

- a) Divers are assigned throughout the agency to conduct underwater tasks in support of the NOAA scientific mission.
- b) NOAA divers shall be certified to dive by the DPM and sufficiently trained and experienced to safely undertake assigned diving tasks.

Responsibilities

It is the responsibility of all NOAA divers to:

- a) Adhere to the standards contained within this manual when conducting a scientific dive;
- b) Refuse to dive when in their judgment, conditions are unsafe, or if they would be violating the precepts of their training or the requirements in this standard;
- c) Report to the Divemaster or Lead Diver any changes of a physical, emotional or psychological nature in either the diver or the buddy that may adversely impact their fitness to dive;
- d) Not begin or continue a dive if problems exist of a physical, emotional or psychological nature that can compromise the safety of the diver or dive team;
- e) Maintain good physical condition and a high level of diving proficiency;
- f) Ensure diving equipment used is maintained in a safe operating condition;
- g) Ensure accountability for NOAA-issued equipment; and
- h) Adhere to the buddy system, actively monitor buddy status and intervene to the maximum extent practicable to ensure the safety of the dive team.

Qualifications

NOAA divers shall meet the requirements outlined in Section 5.0 of this manual.

Reciprocity Divers

General

- a) Reciprocity divers diving under NOAA auspices shall follow the standards outlined in this manual.
- b) Acceptance of any diving standard, for the purposes of granting reciprocity, which deviates from NDP standards will be documented by the NDCSB.
- c) Reciprocity agreements with non-NOAA institutions, agencies and organizations allow divers from both groups to participate in each other's diving activities with minimal administrative requirements.
- d) Such agreements are established with other organizations only after it is determined that their diving programs are equivalent to that of the NDP.
- e) Reciprocity agreements are only applicable to personnel employed and covered for workers compensation by reciprocity organizations and are not transferable to other agencies or institutions with which the agency has reciprocity.

- f) Reciprocity divers in good standing with their organizations who are not employees (e.g., students) and are not covered for workers compensation can only be accepted as volunteers if permitted by statutory authority.

Request for Reciprocity

- a) NOAA programs may request that formal diving reciprocity be established with non-NOAA organizations when no such agreements exist.
- b) Such requests, along with a copy of the candidate's organization diving policies and procedures manual, must be forwarded through the appropriate LODO or OMAO Diving Officer to the NDCSB for review.
- c) If the candidate organization meets the minimum reciprocity requirements, reciprocity may be established.
- d) Reciprocity agreements are reviewed at the end of the calendar year and may be renewed at the request of the sponsoring NOAA program.
- e) A list of reciprocity agreements will be posted on the NOAA Diving Program website at: www.ndc.noaa.gov.

Letters of Reciprocity from NOAA

- a) Per the terms of the reciprocity agreements, NOAA divers wanting to dive with a reciprocity organization must send a Letter of Reciprocity (LOR) to the DSO of the receiving organization verifying that the NOAA diver is in an active status with NOAA.
- b) Letters of reciprocity are generated at the NDC and signed by the DPM, or his designee before being sent to the receiving DSO.
- c) LORs will only be sent if the NOAA diver is in an active diving status requiring: dive proficiency (a minimum of one dive per six week period); dive physical (per age-based requirements); and medical training (CPR, first aid and oxygen administration).
- d) LORs for NOAA federal employees will state that the diver is covered under the Federal Employee Compensation Act (FECA), 5 U.S.C. § 8101 et seq., for injuries that may be sustained as the result of an accident occurring during the scope of any official dive; as well as by the provisions of the Federal Tort Claims Act, 28 U.S.C. §§ 1346, 2671, et seq.

Letters of Reciprocity to NOAA

- a) Reciprocity divers wanting to dive with NOAA must present a signed LOR from their organization's DSO to the appropriate UDS, or his designee, verifying that the diver is in an active status with their organization.
- b) The LOR must indicate that the diver is covered under their organization's Workers Compensation policy.

Modification of Requirements

Upon review the NDCSB may modify standards outlined in this manual.

1.3 Consequence of Violation of Standards by Scientific Divers

Failure to comply with the standards outlined in this manual may be cause for the revocation or restriction of the diver's scientific diving certificate by action of the NDCSB.

1.4 Record Maintenance

The NDC shall maintain permanent records for each NOAA Scientific Diver certified. The file shall include evidence of certification level, training, log sheets, results of current physical examination, reports of disciplinary actions by the NDCSB, first aid, cardiopulmonary resuscitation (CPR), and oxygen delivery certifications and other pertinent information deemed necessary by the NDCSB.

Availability of Records

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

SECTION 2.0 DIVING STANDARDS FOR SCUBA (OPEN CIRCUIT, COMPRESSED AIR)

2.1 Introduction

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

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

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

2.2 Pre-Dive Procedures

Dive Plans

A formal written dive plan must be completed and submitted to the appropriate UDS, or his designee, for review, approval and signature prior to each separate routine dive operation. The UDS shall keep a copy of the dive plan on file for the duration of the dive operation, and shall provide a copy of the approved dive plan to the Divemaster or Lead Diver responsible for overseeing the dive. A standardized form (Appendix 4) has been developed for this purpose and can be downloaded from the NDC website at: www.ndc.noaa.gov

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

- a) Names of divers, lead divers, divemasters and support personnel;
- b) Date and time of operations;
- c) Dive location;
- d) Depth of planned dives;
- e) Number of dives planned per day;
- f) Total number of dives planned;
- g) Number of consecutive days of diving;

- h) Evacuation means and time to medical facility;
- i) Purpose of dives and tasks to be performed;
- j) Proper configuration of diver-worn equipment will be ensured according NOAA diving standards;
- k) Special tools/equipment to be used;
- l) Potential hazards/risks; and
- m) Emergency plan with the following information:
 - 1. Name, telephone number, and relationship of person to be contacted for each diver in the event of an emergency;
 - 2. Nearest operational recompression chamber;
 - 3. Nearest accessible hospital; and
 - 4. Available means of transport.

Pre-dive Safety Requirements

- a) Diver's Responsibilities
 - 1. Conduct a functional check of their diving equipment in the presence of the dive buddy.
 - 2. Refuse to dive if, in their judgment, conditions are unfavorable, or if they would be violating the precepts of their training or this manual.
- b) Equipment Evaluations
 - 1. Divers shall ensure that their equipment is in proper working order and suitable for the type of diving operation being conducted.
 - 2. Unless otherwise approved by the LODO, all NOAA divers enrolled in the Standardized Equipment Program (SEP) shall wear their gear in the configuration depicted in Appendix 7.
 - 3. For all NOAA divers enrolled in the SEP, use of equipment other than that issued by the SEP shall be approved by the DSO.
 - 4. For all NOAA divers not enrolled in the SEP, dive equipment must be inspected by the UDS or their designee and approved by the DSO.
- c) Site Evaluation. Ensure environmental conditions at the site are evaluated prior to each dive.

- d) Pre- and Post-Dive Checklist. A formal written pre- and post-dive checklist must be completed by the on-site Divemaster or Lead Diver each diving day. A standardized form (Appendix 5) has been developed for this purpose and can be downloaded from the NDC website at: <http://www.ndc.noaa.gov> The checklist includes a signature and date block that is to be completed by the individual completing the checklist. The checklist will be kept at the dive site or unit level for 48-hours following the dive.

Pre-dive Briefing

A formal pre-dive briefing must be completed prior to each dive by the Divemaster or Lead Diver. At a minimum, the pre-dive briefing shall include: objectives of the dive, maximum depth and bottom time, minimum surfacing pressure of 500 psi, any hazards that may be expected, and accident management procedures.

2.3 Diving Procedures

Solo Diving Prohibition

All diving activities shall assure adherence to accepted standards of the buddy system for scuba diving. The buddy system consists of two comparably equipped scuba divers in the water in constant visual or tactile communication. This buddy system is based upon mutual assistance, especially in the case of an emergency. Scuba divers shall remain close enough during dives to render immediate assistance in an emergency

Reserve Breathing Gas Supply Requirement

- a) Unless otherwise approved by the NDCSB, a diver-carried reserve breathing gas supply of sufficient quantity to allow the diver to reach the surface shall be provided for each diver for all dives conducted:
- Outside the no-decompression limits;
 - In overhead environments where direct ascent to the surface is prevented by a natural or man-made obstruction;
 - In conditions of low visibility where the diver cannot read his cylinder pressure gauge;
 - In enclosed or physically confined spaces;
 - Deeper than 100 feet;
 - By hookah divers;
 - By solo divers being line tended; and
 - When deemed appropriate by the Divemaster or Lead Diver in charge of the dive after on-site hazards have been identified through risk assessment.
- b) The valve of the reserve breathing gas supply shall be in the closed position prior to the dive.

Refusal to Dive

- a) The decision to dive is that of the diver. A diver may refuse to dive, without fear of penalty, whenever they feel it is unsafe for them to make the dive.
- b) The ultimate responsibility for safety rests with the individual diver. It is the diver's responsibility and duty to refuse to dive if, in their judgment, conditions are unsafe or if they would be violating the precepts of their training or the requirements in this standard.

Termination of the Dive

- a) It is the responsibility of the diver to terminate the dive, without fear of penalty, whenever they feel it is unsafe to continue the dive, unless it compromises the safety of another diver already in the water.
- b) The dive shall be terminated while there is still sufficient scuba cylinder pressure to permit the diver and their buddy to safely reach the surface with 500 psi in their cylinders, including decompression time, or to safely reach an additional air source at the decompression station.

Emergencies and Deviations from Standards

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

Minimum Cylinder Surfacing Pressure

All divers must surface from dives with a minimum of 500 psi in their scuba cylinders. Any recorded pressure of less than 500 psi will result in temporary suspension of dive privileges for that individual diver pending review by the on-site Divemaster or Lead Diver.

If the Divemaster or Lead Diver determine that the cause for the infraction is justified (e.g., to render emergency assistance to dive buddy), the individual will be permitted to resume diving and the incident shall be documented and reported to the UDS. If the cause is unjustified, the diver will not be permitted to resume diving until cleared by the UDS. Repeated violation of the minimum pressure rule, even if justified, will result in temporary suspension pending review by the UDS.

The UDS shall report all violations of the 500 psi minimum policy to the NDCSB.

Topside Support

- a) Unless specifically authorized by the UDS, a topside support person must be available at the dive site and be ready, willing and able to render assistance in an emergency for all open-water dives. This person must be familiar with the dive activities being conducted and be physically able to assist in the recovery of an injured diver. A small boat coxswain can serve as the topside support person.
- b) The UDS will base his decision regarding the need for topside support personnel on a thorough review of the dive plan including a detailed knowledge of the tasks to be completed, the competency of the dive team members, the dive location and expected environmental conditions, and risk assessment.

2.4 Post-Dive Procedures

Post-Dive Safety Requirement

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

2.5 Diving Emergency Procedures

Each Divemaster or Lead Diver will develop a Dive Accident Management Plan (DAMP) that shall be submitted to the appropriate UDS, or his designee, for review and approval prior to each separate dive operation. Once approved, the plan shall be available to all divers and support personnel at the dive location. The UDS shall keep the DAMP on file for the duration of the dive operation. A standardized form (NOAA Dive Accident Management Plan Template) has been developed for this purpose and can be downloaded from the NDC website at: www.ndc.noaa.gov

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

Procedures for flying or ascending to altitude over 1,000 feet after diving shall be conducted in accordance with Section 4.5.1.12 of the NOAA Diving Manual, Revision 4.

2.7 Record Keeping Requirements

Personal Diving Log

Each NOAA certified diver is required to log every official dive made under NOAA auspices and is encouraged to log all other dives using the NOAA Diving Program web-based dive logging system.

Required Incident Reporting

All diving incidents requiring recompression treatment, or resulting in moderate or serious injury, or death shall be reported to the NDCSB. The report will specify the circumstances of the incident and the extent of any injuries or illnesses. Additional information must meet the following reporting requirements:

- a) NOAA shall record and report occupational injuries and illnesses in accordance with NOAA incident report procedures and the appropriate Labor Code section for non-federal employees;
- b) All diving-related incidents shall be investigated, documented and reported to NOAA management in accordance with NAO 209-1 and NAO 209-123; and
- c) If pressure-related injuries are suspected, or if symptoms are evident, the following additional information shall be recorded and retained by NOAA, with the record of the dive, for a period of 5 years.
 1. Complete NOAA Dive Incident Report
 2. Written descriptive report to include
 - Name, address, phone numbers of the principal parties involved
 - Summary of experience of divers involved
 - Location, description of dive site, and description of conditions that led up to incident
 - Description of symptoms, including depth and time of onset
 - Description and results of treatment
 - Disposition of case
 - Recommendations to avoid repetition of incident

SECTION 3.0 DIVING EQUIPMENT

3.1 General Policy

All equipment shall be operated and maintained in accordance with the manufacturer's recommendations unless otherwise approved by the NDCSB. Equipment that is subjected to extreme usage under adverse conditions should require more frequent testing and maintenance. All equipment shall be regularly examined by the person using it.

3.2 Equipment

Regulators

- a) Only those makes and models specifically approved by the NDCSB shall be used.
- b) Scuba regulators shall be inspected and tested by a qualified technician prior to first use and every 12 months thereafter.
- c) Regulators will consist of a primary first and second stage and an alternate air source.

Breathing Masks and Helmets

- a) Helmets shall have a non-return valve at the attachment point between helmet or and hose, which shall close readily and positively and which should be checked prior to every dive operation.
- b) Helmets and breathing masks shall have an exhaust valve.
- c) Helmets and breathing masks shall have a minimum ventilation rate capable of maintaining the diver at the depth to which they are diving.
- d) Helmets and breathing masks shall be inspected and tested by a qualified technician prior to first use and every 12 months thereafter.

Scuba Cylinders

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

- d) Scuba cylinder valves shall be functionally inspected at intervals not to exceed 12 months.

Backpacks

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

Gauges

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

Buoyancy Control Devices

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

Timing Devices, Depth, and Pressure Gauges

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

Determination of Decompression Status

- a) A set of diving tables, approved by the NDCSB, must be available at the dive location.
- b) Dive computers may be utilized in place of diving tables, and must be approved by the NDCSB.
- c) A diver-submitted computer user agreement form must be submitted to NDC prior to use and is available at the NDC website at:
<http://www.ndc.noaa.gov/forms.html>

3.3 Specialized Tools/Equipment

The use of any specialized tools/equipment shall be specifically approved by the UDS or his designee as part of the dive plan review process.

3.4 Support Equipment

First Aid Supplies. A first aid kit and a NOAA-approved positive pressure emergency oxygen delivery system shall be available at the dive site.

Dive Flag. When diving in areas capable of supporting marine traffic, a rigid replica of the international code flag “A” and/or the red & white “diver down” sport diving flag (as appropriate for the dive location) shall be displayed at the dive location in a manner which allows all-round visibility, and shall be illuminated during night diving operations.

Compressor Systems

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

- a) Low-pressure compressors used to supply air to the diver if equipped with a volume tank shall have a check valve on the inlet side, a relief valve, and a drain valve;
- b) Compressed air systems over 500 psig shall have slow-opening shut-off valves; and
- c) All air compressor intakes shall be located away from areas containing exhaust from combustion engines or sources of other contaminants.

3.5 Equipment Maintenance

Record Keeping

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

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

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

Compressor Operation and Air Test Records

- a) Gas analyses and air tests shall be performed on each NOAA-controlled breathing air compressor at regular intervals of no more than 6 months. The results of these tests shall be entered in a formal log and be maintained.
- b) A log shall be maintained showing operation, repair, overhaul, filter maintenance, and temperature adjustment for each compressor.

3.6 Air Quality Standards

Breathing air for scuba shall meet the following specifications as set forth by the Compressed Gas Association (CGA Pamphlet G-7.1).

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

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

SECTION 4.0 ENTRY-LEVEL TRAINING REQUIREMENTS

4.1 Evaluation

Medical Examination

Applicants for NOAA scientific dive training shall be examined by a licensed physician, a nurse practitioner, or a physician's assistant and must also be deemed medically qualified for diving by a NOAA-approved health care provider before proceeding with the training as designated in Sections 4.2 and 6.0. Prior to conducting NOAA-required in-water scuba training or swimming evaluation, medical clearance must be obtained from the NDC DMO.

Swimming Evaluation

Applicant shall successfully perform the following tests, or equivalent, in the presence of the UDS, or his designee:

- a) Swim 550 yards (500 meters) on the surface without stopping using crawl, side stroke or breast stroke in under 15 minutes;
- b) Swim 25 yards (22 meters) underwater without surfacing; and
- c) Tread water for 30 minutes without any flotation aids.

4.2 Scuba Training

Practical Training

At the completion of training, the trainee must satisfy the UDS or the instructor, of their ability to perform the following, at a minimum, in a pool or in sheltered water:

- a) Enter water with full equipment;
- b) Clear face mask;
- c) Demonstrate air sharing, including both buddy breathing and the use of alternate air source, as both donor and recipient, with and without a face mask;
- d) Demonstrate ability to alternate between snorkel and scuba while kicking;
- e) Demonstrate understanding of underwater hand and light signs and signals;
- f) Demonstrate simulated in-water mouth-to-mouth resuscitation;

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

Written Examination

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

- a) Function, care, use, and maintenance of diving equipment;
- b) Physics and physiology of diving;
- c) Diving standards and precautions;
- d) Near-shore currents and waves;
- e) Dangerous marine animals;
- f) Emergency procedures, including ascent while air sharing;
- g) Currently accepted decompression procedures;
- h) Demonstrate the proper use of dive tables;
- i) Underwater communications;
- j) Hazards of breath-hold diving and ascents;
- k) Planning and supervision of diving operations;
- l) Diving hazards; and
- m) Cause, symptoms, treatment, and prevention of the following: near drowning, air embolism, hypercapnia, squeezes, oxygen poisoning, nitrogen narcosis, exhaustion and panic, decompression sickness, hypothermia/hyperthermia, and hypoxia/anoxia.

Open Water Evaluation

The trainee must satisfy an instructor, approved by the UDS, or his designee, ability to perform at least the following in open water:

- a) Demonstrate proficiency in air sharing as both donor and receiver;

- b) Enter and leave open water or surf, and/or leave and board a diving vessel, while wearing scuba gear;
- c) Demonstrate judgment adequate for safe diving;
- d) Demonstrate the ability to maneuver efficiently in the environment, at and below the surface;
- e) Demonstrate clearing of mask and regulator while submerged;
- f) Demonstrate regulator and weight-belt recovery;
- g) Demonstrate ability to achieve and maintain neutral buoyancy while submerged;
- h) Demonstrate techniques of buddy rescue;
- i) Navigate underwater; and
- j) Plan and execute a dive.

SECTION 5.0 SCIENTIFIC DIVER CERTIFICATION

5.1 General Policy

No person shall engage in scientific diving unless that person is certified by NOAA pursuant to the provisions of this standard. Only a person diving under NOAA auspices that subscribes to the practices outlined in this manual is eligible for a scientific diver certification

5.2 Certification Types

Scientific Diver Certification

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

Temporary Diver Certification

This permit constitutes a waiver of the requirements of Section 5.0 and is issued only following a demonstration of the required proficiency in diving. It is valid for a limited time, as determined by the NDCSB. This permit is not to be construed as a mechanism to circumvent existing standards set forth in this standard.

A statement of the temporary diver's qualifications shall be submitted to the UDS as a part of the dive plan. Temporary permits shall be restricted to the planned diving operation and shall comply with all other policies, regulations, and standards of this standard, including medical requirements.

5.3 Requirements for NOAA Scientific Diver Certification

Submission of documents and successful completion of an aptitude examination does not automatically result in certification. The applicant must demonstrate to the DPM or his designee that they are sufficiently skilled and proficient to be certified. This skill will be acknowledged by the signature of the DPM. Any applicant who does not possess the necessary judgment, under diving conditions, for the safety of the diver and their partner, may be denied scientific diving privileges. Minimum documentation and examinations required are as follows:

Prerequisites

- a) Application. Application for certification shall be made to the DPM or his designee.

- b) Swim Evaluation. Each applicant must demonstrate to the NDCSB, or their designee, adequate watermanship by successfully passing the swim evaluation outlined in Section 4.1
- c) Medical Approval. Each applicant for scientific diver certification must complete the medical requirements outlined in Section 6.0 and be medically cleared to dive by the OMAO DMO.
- d) Physical Fitness Test. Each applicant must successfully pass the NOAA physical fitness test outlined in Appendix 2 prior to undergoing initial NOAA dive certification.
- e) Scuba Certification. Each applicant must have completed and been certified above the entry level by a US military or internationally recognized scuba diving certifying agency.
- f) Emergency Care Training. Provide documentation of current CPR training, first aid training, and oxygen administration training.
- g) Experience. Each applicant must show proof of completion of a minimum of 25 open-water dives.

Theoretical and Practical Evaluation

Candidates for NOAA Scientific Diver Certification must:

- a) Complete a NDCSB-approved scientific diving training program.
- b) Pass a written examination covering the topics outlined in Section 4.2 with a minimum score of 80%.
- c) Pass an open-water evaluation consisting of those skills outlined in Section 4.2 to the satisfaction of the DPM or his designee.

5.4 Depth Certifications

NOAA scientific divers shall be limited to a maximum depth of 130 feet unless otherwise approved in writing by the NDCSB before diving begins. Dive supervisors may set shallower depth limits when deemed appropriate.

5.5 Continuation of Certification

Dive Proficiency

- a) All NOAA scientific divers must maintain dive proficiency by logging a dive during each 6-week period.

- b) Failure to meet this requirement may be cause for suspension of certification as determined by the DPM or their designee.
- c) Once the initial certification requirements of Section 5.3 are met, divers whose certifications have lapsed due to failure to comply with a) above, may be re-qualified by procedures approved by the LODOs or their designees.

Medical Examination

All certified scientific divers shall pass a medical examination at the intervals specified in Section 6.1. After each major illness or injury, as described in Section 6.1, a certified scientific diver must receive clearance to return to diving from the OMAO DMO before resuming diving activities.

Emergency Care Training

The scientific diver must provide proof of current training in the following: adult CPR, emergency oxygen administration, and first aid for diving accidents.

Skills Checkout

All NOAA divers must complete a semi-annual checkout dive including in-water rescue skills and the retrieval of an unconscious diver from the water to a vessel or shore. A standardized form (Appendix 6) has been developed for this purpose and can be downloaded from the NDC website at: <http://www.ndc.noaa.gov>

5.6 Revocation of Certification

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

5.7 Recertification

General

Once the initial certification requirements of Section 5.3 are met, divers whose dive certifications have lapsed due to lack of activity shall be temporarily suspended pending the completion of a recertification program.

Requirements

a) Three month lapse

1. If a diver does not complete a minimum of one dive during a six week period, they must perform a training-only, basic checkout dive with an authorized NOAA diver assigned by the UDS.
2. Based on the diver's performance during the checkout dive, the UDS may require additional academic or practical training in order to recertify.
3. Once the diver has met the recertification requirements prescribed by the UDS, the UDS will notify the NOAA Diving Center and the diver will be permitted to resume diving.

b) Six to twelve month lapse

1. If a diver does not complete the required number of dives for a period of six to twelve months they must complete a training-only, basic checkout dive with an authorized NOAA diver assigned by the UDS.
2. The minimum skills required to be performed on the checkout dive are identified on the Diving and Rescue Skills Checkout Report (Appendix 6).
3. The UDS will forward his recommendation for recertification to the LODO for consideration.
4. The LODO will determine if the diver has met the recertification requirements and either authorize the diver to return to diving status or specify any additional requirements needed to recertify.
5. Once the diver is cleared to return to diving, the LODO will notify the NOAA Diving Center, the UDS and the individual diver and at that point the diver may resume diving.

c) More than twelve month lapse

If a diver does not complete the required number of dives for a period of more than twelve months they must complete a refresher training program specified by the LODO.

SECTION 6.0 MEDICAL STANDARDS

6.1 General

- a) All medical evaluations required by this standard shall be performed by a licensed physician, nurse practitioner, or physician's assistant of the applicant-diver's choice, preferably one trained in diving and/or undersea medicine.
- b) An OMAO DMO will review all dive physicals and determine whether divers meet the minimum standards set forth in the NDP Diving Medical Standards and Procedures Manual to engage in diving activities.
- c) All divers must be free of any chronic disabling disease and conditions that may compromise the safety the diver or dive team.
- d) The medical standards for diving under NOAA auspices are prescribed in the NOAA Diving Medical Standards & Procedures Manual.

6.2 Frequency of Medical Evaluations

Medical evaluation shall be completed:

- a) Before a diver may begin diving, unless an equivalent initial medical evaluation has been given within the preceding 12-months.
- b) Thereafter, at 5 year intervals up to age 49, every 2 years after the age of 50-59, and every 12-months after the age of 60.
- c) Clearance to return to diving must be obtained from an OMAO DMO following any major injury or illness, or any condition requiring hospital care or recompression therapy.

6.3 Return to Diving After Medical Suspension

- a) Treatment for Decompression Illness - All cases will be reviewed on an individual basis, but general guidelines are as follows:
 - 1) Divers who have experienced Type I DCS with complete resolution of symptoms after undergoing treatment with Navy Treatment Table 5 may resume diving duties after 48 hours with approval of the DMO.
 - 2) Divers who have experienced Type I DCS (pain only) with complete resolution of symptoms after undergoing treatment with Navy Treatment Table 6 may resume diving activities after 7 days with approval of the DMO.
 - 3) Divers who have experienced Type II DCS that included only patchy peripheral paresthesias (no motor deficits) with complete resolution of

symptoms after undergoing treatment with Navy Treatment Table 6 may resume diving activities after 14 days with approval of the DMO.

- 4) Diver who have experienced more severe neurologic symptoms or who sustained neurologic injury from AGE may resume diving after 4-6 weeks only after a medical examination confirms that all neurologic findings have resolved and with the approval of the DMO.
 - 5) When saturation treatments are needed to restore function, diving should not resume for a minimum of three months and with the approval of the DMO.
 - 6) Return to diving after other treatment protocols will be addressed on a case-by-case basis.
- b) Returning to Diving After Surgery or Serious Illness
- 1) Individuals shall first obtain clearance from their surgeon or medical practitioner before applying to NDC to resume diving.
 - 2) The post-operative or post-illness fitness to dive evaluation will be conducted on a case-by-case basis by the OMAO DMO.
 - 3) In surgeries where the abdominal wall is penetrated or with bone or joint surgery, there will be a minimum of 90 days allowed for healing before the OMAO DMO will evaluate fitness to resume diving.
- c) Returning to Diving After Pregnancy (Obstetric Delivery)
- 1) A periodic physical is required, including all test results, and a post-partum report from the patient's obstetrician.
 - 2) A fitness to dive evaluation will be conducted on a case-by-case basis by the OMAO DMO.

SECTION 7.0 NITROX DIVING

7.1 General

The following guidelines address the use of nitrox by scientific divers under NOAA auspices. For these standards, nitrox is defined as any gas mixture being comprised of an oxygen concentration higher than 22 % by volume.

7.2 Prerequisites

Only certified Scientific Divers (Sections 4.0 and 5.0) diving under NOAA auspices or under the authority of a recognized reciprocity organization are eligible for authorization to use nitrox. After completion, review and acceptance of application materials, training and qualification, an applicant will be authorized to use nitrox within their depth authorization, as specified in Section 5.4.

7.3 Requirements for Authorization to Use Nitrox

Submission of documents and successful completion of an aptitude examination does not automatically result in authorization to use nitrox. The applicant must demonstrate sufficient skills and proficiency to the DPM.

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

Training

The diver must complete additional theoretical and practical training beyond the Scientific Diver air certification level, to the satisfaction of the DPM (Section 7.3).

Examinations

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

- a) Written examinations covering the information presented in the classroom training session(s) (i.e., gas theory, oxygen toxicity, partial pressure determination, etc.).
- b) Practical examinations covering the information presented in the practical training session(s) (i.e., gas analysis, documentation procedures, etc.).
- c) Complete two open-water checkout dives using nitrox to demonstrate the application of theoretical and practical skills learned.

Minimum Activity to Maintain Authorization

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

7.4 Nitrox Training Guidelines

Training in these guidelines should be in addition to training outlined in Section 4.0. It may be included as part of training to satisfy the Scientific Diver training requirements (Section 5.3).

Classroom Instruction

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

Practical Training

The practical training portion will consist of a review of skills as stated for scuba (Section 4.0), with additional training as follows:

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

Written Examination (based on classroom instruction and practical training)

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

- a) Function, care, use, and maintenance of equipment cleaned for nitrox use
- b) Physical and physiological considerations of nitrox diving
- c) Diving standards and procedures as related to nitrox diving
- d) Given the proper information, calculation of:
 - 1. Equivalent air depth (EAD) for a given fO_2 and actual depth
 - 2. PO_2 exposure for a given fO_2 and depth
 - 3. Optimal nitrox gas for a given pO_2 exposure limit and planned depth
 - 4. Maximum operational depth (MOD) for a given gas blend and pO_2 exposure limits.
- e) Dive table selection and usage
- f) Nitrox production methods and considerations
- g) Oxygen analysis
- h) Nitrox operational guidelines (Section 7.4) and dive planning

Open-water Dives

A minimum of two supervised open-water dives using nitrox is required for certification. If the MOD for the gas being used can be exceeded at the training location, direct, in-water supervision is required.

7.5 Scientific Nitrox Diving Standards

Dive Personnel Requirements

- a) **Scientific Diver.** A Scientific Diver who has completed the requirements of Section 5.0 and the training and authorization sections of these guidelines, may be authorized by the DPM to use nitrox. Depth authorization to use nitrox should be the same as those specified in the diver's authorization, as described in Section 5.4.
- b) **Divemaster/Lead Diver.** On any dive during which nitrox will be used by any team member, the Divemaster/Lead Diver should be authorized to use nitrox, and hold appropriate authorizations required for the dive, as specified in this manual. Divemaster/Lead Diver authorization for nitrox dives by the UDS should occur as part of the dive project approval process.

In addition to responsibilities listed in Section 1.2, the Divemaster/Lead Diver should:

1. As part of the dive planning process, verify that all divers using nitrox on a dive are properly qualified and authorized.
2. As part of the pre-dive procedures, confirm with each diver the percentage of nitrox gas the diver is using, and establish dive team maximum depth and time limits, according to the shortest time limit or shallowest depth limit among the team members.
3. Reduce the maximum allowable pO_2 exposure limit for the dive team if on-site conditions so indicate.

Dive Parameters

a) Oxygen Exposure Limits

1. The inspired oxygen partial pressure experienced at depth should not exceed 1.6 ATA. All dives performed using nitrox breathing gases should comply with the current NOAA Diving Manual “Oxygen Partial Pressure Limits for ‘Normal’ Exposures.”
2. The maximum allowable exposure limit should be reduced in cases where cold or strenuous dive conditions, or extended exposure times are expected. The UDS should consider this in the review of any dive plan application, which proposes to use nitrox. The Lead Diver should also review on-site conditions and reduce the allowable pO_2 exposure limits if conditions indicate.
3. If using the equivalent air depth (EAD) method the maximum depth of a dive should be based on the oxygen partial pressure for the specific nitrox breathing gas to be used.

b) Bottom Time Limits

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

c) Dive Tables and Gases

1. A set of NDCSB approved nitrox dive tables should be available at the dive site.
2. When using the equivalent air depth (EAD) method, dives should be conducted using air dive tables approved by the NDCSB.

3. If nitrox is used to increase the safety margin of air-based dive tables, the MOD and oxygen exposure and time limits for nitrox gases being dived should not be exceeded.
 4. Nitrox breathing gases used while performing in-water decompression, or for bail-out purposes, should contain the same or greater oxygen content as that being used during the dive, within the confines of depth limitations and oxygen partial pressure limits set forth in section.
- d) Nitrox Dive Computers
1. Dive computers may be used to compute decompression status during nitrox dives. Manufacturers' guidelines and operations instructions should be followed.
 2. Nitrox dive computer users should demonstrate a clear understanding of the display, operations, and manipulation of the unit being used for nitrox diving prior to using the computer, to the satisfaction of the UDS or designee.
 3. If nitrox is used to increase the safety margin of an air-based dive computer, the MOD and oxygen exposure and time limits for the nitrox gas being dived should not be exceeded.
 4. Dive computers capable of pO_2 limit and fO_2 adjustment should be checked by the diver prior to the start each dive to assure compatibility with the gas being used.
- e) Repetitive Diving
1. Repetitive dives using nitrox gases should be performed in compliance with procedures required of the specific dive tables used.
 2. Residual nitrogen time should be based on the EAD for the specific nitrox gases to be used on the repetitive dive, and not that of the previous dive.
 3. The total cumulative exposure (bottom time) to a partial pressure of oxygen in a given 24 hour period should not exceed the current NOAA Diving Manual 24-hour Oxygen Partial Pressure Limits for "Normal" Exposures.
- f) Oxygen Parameters
1. Authorized Nitrox Gases. Gases meeting the criteria outlined in this section may be used for nitrox diving operations, upon approval of the NDCSB.
 2. Purity. Oxygen used for nitrox-breathing gas should meet the purity levels for "Medical Grade" (U.S.P.) or "Aviator Grade" standards. In addition to the Air Purity Guidelines (Section 3.6), the following standard should be met for breathing air that is either: placed in contact with oxygen concentrations greater than 40% or used in nitrox production

by the partial pressure blending method with gases containing greater than 40% oxygen as the enriching agent.

g) Gas Blending and Analysis: Personnel Requirements

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

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

2. In situations where NOAA owns or operates the compressors, only those individuals approved by the DSO should be responsible for blending nitrox gases.
3. It is the responsibility of the UDS to approve the specific nitrox production method used.
4. It is the responsibility of each diver to analyze prior to the dive the oxygen content of his/her scuba cylinder and acknowledge in writing the following information for each cylinder: fO₂, MOD, cylinder pressure, date of analysis, and user's name.
5. Individual dive log reporting forms should report fO₂ of nitrox used, if different than 21%.

7.6 Nitrox Diving Equipment

All of the designated equipment and stated requirements regarding scuba equipment required in these standards should apply to nitrox scuba operations. Additional minimal equipment necessary for nitrox diving operations includes labeled scuba cylinders and oxygen analyzers

Oxygen Cleaning and Maintenance Requirements

a) Requirement for Oxygen Service

1. All equipment, which during the dive or cylinder filling process is exposed to concentrations greater than 40% oxygen at pressures above 150 psi, should be cleaned and maintained for oxygen service.
2. Equipment used with oxygen or nitrox gases containing over 40% by volume oxygen shall be designed and maintained for oxygen service. Oxygen systems over 125 psig shall have slow-opening shut-off valves. This should include the following equipment: scuba cylinders, cylinder valves, scuba and other regulators, cylinder pressure gauges, hoses, diver support equipment, compressors, and fill station components and plumbing.

b) Scuba Cylinder Identification

Scuba cylinders to be used with nitrox gases should have the following identification documentation affixed to the cylinder.

1. Cylinders should be marked “NITROX”, or “EANx”, or “Enriched Air”.
2. Nitrox identification color-coding should include a 4-inch wide green band around the cylinder, starting immediately below the shoulder curvature. If the cylinder is not yellow, the green band should be bordered above and below by a 1-inch yellow band.
3. The alternate marking of a yellow cylinder by painting the cylinder crown green and printing the word “NITROX” parallel to the length of the cylinder in green print is acceptable.
4. Other markings, which identify the cylinder as containing gases other than Air, may be used with the approval of the DSO.
5. A contents label should be affixed, to include the current fO₂, date of analysis, and MOD.
6. The cylinder should be labeled to indicate whether the cylinder is prepared for oxygen or nitrox gases containing greater than 40% oxygen.
7. Scuba cylinders specifically designated for use with nitrox breathing gases should only be filled with appropriate nitrox gases.

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

d) Other Support Equipment

1. An oxygen analyzer is required which is capable of determining the oxygen content in the scuba cylinder. The analyzer should be capable of reading a scale of 0 to 100% oxygen, within 1% accuracy.
2. All diver and support equipment should be suitable for the fraction of oxygen (fO₂) being used.

e) Compressor system

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

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

SECTION 8.0 STAGED DECOMPRESSION DIVING

8.1 General

Decompression diving shall be defined as any diving during which the diver cannot perform a direct return to the surface without performing a mandatory decompression stop to allow the release of inert gas from the diver's body.

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

8.2 Minimum Experience and Training Requirements

- a) Prerequisites:
 - 1. Scientific Diver qualification according to Section 5.0 of this manual;
 - 2. Minimum of 100 logged dives;
 - 3. Demonstration of the ability to safely plan and conduct dives deeper than 100 feet; and
 - 4. Nitrox certification/authorization according to NOAA Section 7.0 of this manual is recommended.
- b) Training shall be appropriate for the conditions in which dive operations are to be conducted.
- c) Minimum Training shall include the following:
 - 1. A minimum of 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;
 - 2. It is recommended that at least one training session be conducted in a pool or sheltered water setting, to cover equipment handling and familiarization, swimming and buoyancy control, to estimate gas consumption rates, and to practice emergency procedures;
 - 3. At least six open-water training dives simulating/requiring decompression shall be conducted, emphasizing planning and execution of required decompression dives, and including practice of emergency procedures;
 - 4. No training dives requiring decompression shall be conducted until the diver has demonstrated acceptable skills under simulated conditions;

5. The following are the minimum skills the diver must demonstrate proficiently during dives simulating and requiring decompression;
 - Buoyancy control
 - Proper ascent rate
 - Proper depth control
 - Equipment manipulation
 - Stage/decompression bottle use as pertinent to planned diving operation
 - Buddy skills
 - Gas management
 - Time management
 - Task loading
 - Emergency skills
6. Divers shall demonstrate to the satisfaction of the DPM, or his designee proficiency in planning and executing required decompression dives appropriate to the conditions in which diving operations are to be conducted; and
7. Upon completion of training, the diver shall be authorized to conduct required decompression dives with approval from the NDCSB.

8.3 Minimum Equipment Requirements

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

1. Decompression Schedules;
2. Dive Timing Devices;
3. Depth gauges;
4. Buoyancy Control Devices;
5. Cutting devices; and
6. Lift bags and line reels.

8.4 Minimum Operational Requirements

- a) Approval of dive plan applications to conduct required decompression dives shall be on a case-by-case basis.
- b) The maximum pO_2 to be used for planning required decompression dives is 1.6. It is recommended that a pO_2 of less than 1.6 be used during bottom exposure.
- c) Divers gas supplies shall be adequate to meet planned operational requirements and foreseeable emergency situations.
- d) Decompression dives may be planned using dive tables, dive computers, and/or PC software approved by the NDCSB.
- e) Breathing gases used while performing in-water decompression shall contain the same or greater oxygen content as that used during the bottom phase of the dive.
- f) The dive team prior to each dive shall review emergency procedures appropriate for the planned dive.
- g) If breathing gases other than air are used for required decompression, their use shall be in accordance with those requirements set forth in the appropriate sections of this standard.
- h) The maximum depth for required decompression using air as the bottom gas shall be 190 feet.
- i) Use of additional nitrox and/or high-oxygen fraction decompression gases as travel and decompression gases to decrease decompression obligations is encouraged.
- j) Use of alternate inert gases to limit narcosis is encouraged for depths greater than 150 feet.
- k) If a period of more than 6 months has elapsed since the last staged decompression dive, a series of progressive workup dives to return the diver(s) to proficiency status prior to the start of project diving operations are recommended.

SECTION 9.0 MIXED GAS DIVING

9.1 General

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

9.2 Minimum Experience and Training Requirements

- a) Prerequisites:
 - 1. Nitrox certification and authorization (Section 7.00);
 - 2. If the intended use entails required decompression stops, divers will be previously certified and authorized in decompression diving (Section 8.0); and
 - 3. Divers shall demonstrate to the satisfaction of the NDCSB, sufficient skills, knowledge, and attitude appropriate for training in the safe use of mixed gases.

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

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

9.3 Equipment and Gas Quality Requirements

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

9.4 Minimum Operational Requirements

- a) Approval of dive plan applications to conduct mixed gas dives shall be on a case-by-case basis.
- b) All applicable operational requirements for nitrox and decompression diving shall be met.
- c) The maximum pO_2 to be used for planning required decompression dives is 1.6ATA. It is recommended that a pO_2 of less than 1.6 ATA be used during bottom exposure.
- d) Maximum planned Oxygen Toxicity Units (OTU) will be considered based on mission duration.
- e) Divers decompressing on high-oxygen concentration mixtures shall closely monitor one another for signs of acute oxygen toxicity.
- f) If a period of more than 6 months has elapsed since the last mixed gas dive, a series of progressive workup dives to return the diver(s) to proficiency status prior to the start of project diving operations are recommended.

SECTION 10.0 OTHER DIVING TECHNOLOGIES

10.1 General

Certain types of diving, some of which are listed below, require equipment or procedures that require training. Divers shall comply with all scuba diving procedures in this standard unless specified.

10.2 Blue Water Diving

Blue water diving is defined as diving in open water where the bottom is greater than 130 feet or the MOD of the breathing gas, whichever is shallower. It requires special training and the use of multiple-tethered diving techniques.

10.3 Ice and Polar Diving

Divers planning to dive under ice or in polar conditions should use the following: "Guidelines for Conduct of Research Diving", National Science Foundation, Division of Polar Programs, 1990.

10.4 Overhead Environments

Where an enclosed or confined space is not large enough for two divers, a diver shall be stationed at the underwater point of entry and an orientation line shall be used.

10.5 Saturation Diving

If using open circuit compressed air scuba in saturation diving operations, divers shall comply with the saturation diving guidelines of the organizational member.

10.6 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 depth, time, and diving profile.

10.7 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 diver may rely on the tender at the surface to keep up with the diver's depth, time and diving profile.

SECTION 11.0 REBREATHERS

11.1 General

This section defines specific considerations regarding the following issues for the use of rebreathers: training and/or experience verification requirements for authorization; equipment requirements; and operational requirements and additional safety protocols to be used.

Application of this standard is in addition to pertinent requirements of all other sections contained within this manual.

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

No diver shall conduct planned operations using rebreathers without prior review and approval of the NDCSB.

In all cases, instructors shall be qualified for the type of training to be provided. Training shall be conducted by agencies or instructors approved by the NDCSB.

11.2 Definitions and General Information

- a) Rebreathers are defined as any device that recycles some or all of the exhaled gas in the breathing loop and returns it to the diver. Rebreathers maintain levels of oxygen and carbon dioxide that support life by metered injection of oxygen and chemical removal of carbon dioxide. These characteristics fundamentally distinguish rebreathers from open-circuit life support systems, in that the breathing gas composition is dynamic rather than fixed.
 1. Advantages of rebreathers may include increased gas utilization efficiencies that are often independent of depth, extended no-decompression bottom times and greater decompression efficiency, and reduction or elimination of exhaust bubbles that may disturb aquatic life or sensitive environments.
 2. Disadvantages of rebreathers include high cost and, in some cases, a high degree of system complexity and reliance on instrumentation for gas composition control and monitoring, which may fail. The diver is more likely to experience hazardous levels of hypoxia, hyperoxia, or hypercapnia, due to user error or equipment malfunction, conditions which may lead to underwater blackout and drowning. Inadvertent flooding of

the breathing loop and wetting of the carbon dioxide absorbent may expose the diver to ingestion of an alkaline slurry ("caustic cocktail").

3. An increased level of discipline and attention to rebreather system status by the diver is required for safe operation, with a greater need for self-reliance. Rebreather system design and operation varies significantly between make and model. For these reasons when evaluating any dive plan incorporating rebreathers, risk-management emphasis should be placed on the individual qualifications of the diver on the specific rebreather make and model to be used, in addition to specific equipment requirements and associated operational protocols.
- b) **Oxygen Rebreathers.** Oxygen rebreathers recycle the diver's breathing gas, consisting of pure oxygen, replenishing the oxygen metabolized by the diver. Oxygen rebreathers are generally the least complicated design, but are normally limited to a maximum operation depth of 20 fsw due to the risk of unsafe hyperoxic exposure.
 - c) **Semi-Closed Circuit Rebreathers.** Semi-closed circuit rebreathers (SCR) recycle the majority of exhaled breathing gas, venting a portion into the water and replenishing it with a constant or variable amount of a single oxygen-enriched gas mixture. Gas addition and venting is balanced against diver metabolism to maintain safe oxygen levels by means which differ between SCR models, but the mechanism usually provides a semi-constant fO_2 in the breathing loop at all depths, similar to open-circuit scuba.
 - d) **Closed-Circuit Mixed Gas Rebreathers.** Closed-circuit mixed gas rebreathers (CCR) recycle all of the exhaled gas and replace metabolized oxygen via an electronically controlled valve, governed by electronic oxygen sensors. Manual oxygen addition is available as a diver override, in case of electronic system failure. A separate inert gas source (diluent), usually containing primarily air, heliox, or trimix, is used to maintain oxygen levels at safe levels when diving below 20 fsw. CCR systems operate to maintain a constant oxygen partial pressure (PO_2) during the dive, regardless of depth.

11.3 Prerequisites

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

Training Prerequisites

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

- b) Completion of a minimum of 50 open-water dives on SCUBA.
- c) For SCR or CCR, a minimum 130-fsw-depth qualification is generally recommended, to ensure the diver is sufficiently conversant with the complications of deeper diving. If the sole expected application for use of rebreathers is shallower than this, a lesser depth qualification may be allowed with the approval of the NDCSB.
- d) Nitrox training. Training in use of nitrox mixtures containing 25% to 40% oxygen is required. Training in use of mixtures containing 40% to 100% oxygen may be required, as needed for the planned application and rebreather system. Training may be provided as part of rebreather training.

Training

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

- a) Satisfactory completion of a rebreather training program authorized or recommended by the manufacturer of the rebreather to be used, or other training approved by the NDCSB. Successful completion of training does not in itself authorize the diver to use rebreathers. The diver must demonstrate to the NDCSB that the diver possesses the proper attitude, judgment, and discipline to safely conduct rebreather diving in the context of planned operations.
- b) Classroom training shall include:
 - 1. A review of those topics of diving physics and physiology, decompression management, and dive planning included in prior scientific diver, nitrox, staged decompression and/or mixed gas training, as they pertain to the safe operation of the selected rebreather system and planned diving application.
 - 2. In particular, causes, signs and symptoms, first aid, treatment and prevention of the following must be covered:
 - Hyperoxia (CNS and Pulmonary Oxygen Toxicity)
 - Middle Ear Oxygen Absorption Syndrome (oxygen ear)
 - Hyperoxia-induced myopia
 - Hypoxia
 - Hypercapnia
 - Inert gas narcosis
 - Decompression sickness
 - 3. Rebreather-specific information required for the safe and effective operation of the system to be used, including:
 - System design and operation, including:

- Counterlung(s)
- CO₂ scrubber
- CO₂ absorbent material types, activity characteristics, storage, handling and disposal
- Oxygen control system design, automatic and manual
- Diluent control system, automatic and manual (if any)
- Pre-dive set-up and testing
- Post-dive break-down and maintenance
- Oxygen exposure management
- Decompression management and applicable decompression tracking methods
- Dive operations planning
- Problem recognition and management, including system failures leading to hypoxia, hyperoxia, hypercapnia, flooded loop, and caustic cocktail
- Emergency protocols and bailout procedures

Practical Training (with model of rebreather to be used)

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

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

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

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

Practical Evaluations

- a) Upon completion of practical training, the diver must demonstrate to the NDCSB proficiency in pre-dive, dive, and post-dive operational procedures for the particular model of rebreather to be used.
- b) Skills shall include, at a minimum:

1. Oxygen control system calibration and operation checks;
2. Carbon dioxide absorbent canister packing;
3. Supply gas cylinder analysis and pressure check;
4. Test of one-way valves;
5. System assembly and breathing loop leak testing;
6. Pre-dive breathing to test system operation;
7. In-water leak checks;
8. Buoyancy control during descent, bottom operations, and ascent;
9. System monitoring and control during descent, bottom operations, and ascent;
10. Proper interpretation and operation of system instrumentation (PO2 displays, dive computers, gas supply pressure gauges, alarms, etc, as applicable);
11. Unit removal and replacement on the surface;
12. Bailout and emergency procedures for self and buddy, including:
 - System malfunction recognition and solution
 - Manual system control
 - Flooded breathing loop recovery (if possible)
 - Absorbent canister failure
 - Alternate bailout options
13. Symptom recognition and emergency procedures for hyperoxia, hypoxia, and hypercapnia; and
14. Proper system maintenance, including:
 - Full breathing loop disassembly and cleaning (mouthpiece, check-valves, hoses, counterlung, absorbent canister, etc.)
 - Oxygen sensor replacement (for SCR and CCR)
 - Other tasks required by specific rebreather models

Written Evaluation.

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

Supervised Rebreather Dives

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

- a) Supervisor for these dives shall be approved by the NDCSB and should be an active scientific diver experienced in diving with the make/model of rebreather being used.
- b) Dives at this level may be targeted to activities associated with the planned science diving application. See the above table for number and cumulative water time for different rebreather types.
- c) Maximum ratio of divers per designated dive supervisor is 4:1. The supervisor may dive as part of the planned operations.

Extended Range, Required Decompression and Helium-Based Inert Gas

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

- a) As a prerequisite for training in staged decompression using rebreathers, the diver shall have logged a minimum of 25 hours of underwater time on the rebreather system to be used, with at least 10 rebreather dives in the 100 fsw to 130 fsw range.
- b) As a prerequisite for training for use of rebreathers with gas mixtures containing inert gas other than nitrogen, the diver shall have logged a minimum of 50 hours of underwater time on the rebreather system to be used and shall have completed training in stage decompression methods using rebreathers. The diver shall have completed at least 12 dives requiring staged decompression on the rebreather model to be used, with at least 4 dives near 130 fsw.
- c) Training shall be in accordance with standards for required-decompression and mixed gas diving, as applicable to rebreather systems, starting at the 130 fsw level.

Maintenance of Proficiency.

- a) To maintain authorization to dive with rebreathers, an authorized diver shall make at least one dive using a rebreather every 8 weeks. For divers authorized for the conduct of extended range, stage decompression or mixed-gas diving, at least one dive per month should be made to a depth near 130 fsw, practicing decompression protocols.
- b) For a diver in arrears, the NDCSB shall approve a program of remedial knowledge and skill tune-up training and a course of dives required to return the diver to full authorization.

11.4 Equipment Requirements

General Requirements

- a) Only those models of rebreathers specifically approved by NDCSB shall be used.
- b) Rebreathers shall be manufactured according to acceptable Quality Control/Quality Assurance protocols, as evidenced by compliance with the essential elements of ISO 9004. Manufacturers should be able to provide to the NDCSB supporting documentation to this effect.
- c) Unit performance specifications shall be within acceptable levels as defined by standards of a recognized authority (CE, US Navy, Royal Navy, NOAA, etc).
- d) Prior to approval, the manufacturer shall supply the NDCSB with supporting documentation detailing the methods of specification determination by a recognized third-party testing agency, including unmanned and manned testing. Test data should be from a recognized, independent test facility.
- e) The following documentation for each rebreather model to be used shall be available as a set of manufacturer's specifications. These shall include:
 1. Operational depth range;
 2. Operational temperature range;
 3. Breathing gas mixtures that may be used;
 4. Maximum exercise level which can be supported as a function of breathing gas and depth
 5. Breathing gas supply durations as a function of exercise level and depth
 6. CO₂ absorbent durations, as a function of depth, exercise level, breathing gas, and water temperature
 7. Method, range and precision of inspired PO₂ control, as a function of depth, exercise level, breathing gas, and temperature
 8. Likely failure modes and backup or redundant systems designed to protect the diver if such failures occur
 9. Accuracy and precision of all readouts and sensors
 10. Battery duration as a function of depth and temperature; and
 11. Mean time between failures of each subsystem and method of determination.
- f) A complete instruction manual is required, fully describing the operation of all rebreather components and subsystems as well as maintenance procedures.

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

Minimum Equipment

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

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

Semi-Closed Circuit Rebreathers

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

Closed Circuit Mixed-gas Rebreathers

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

11.5 Operational Requirements

General Requirements

- a) All dives involving rebreathers must comply with applicable operational requirements for open-circuit SCUBA dives to equivalent depths.
- b) No rebreather system shall be used in situations beyond the manufacturer's stated design limits (dive depth, duration, water temperature, etc).
- c) Modifications to rebreather systems shall be in compliance with manufacturer's recommendations.
- d) Rebreather maintenance is to be in compliance with manufacturer's recommendations including sanitizing, replacement of consumables (sensors, CO₂ absorbent, gas, batteries, etc) and periodic maintenance.
- e) Dive Plan. In addition to standard dive plan components stipulated in Section 2.0 of this manual, all dive plans that include the use of rebreathers must include, at minimum, the following details:
 - 1. Information about the specific rebreather including make, model and type of rebreather system to be used and other specific details as requested by the NDCSB;
 - 2. Type of CO₂ absorbent material;
 - 3. Composition and volume(s) of supply gases; and
 - 4. Complete description of alternate bailout procedures to be employed, including manual rebreather operation and open-circuit procedures.

Buddy Qualifications

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

Oxygen Exposures

- a) Planned oxygen partial pressure in the breathing gas shall not exceed 1.4 atmospheres at depths greater than 30 feet.

- b) Planned oxygen partial pressure set point for CCR shall not exceed 1.4 atm. Set point at depth should be reduced to manage oxygen toxicity according to the NOAA Oxygen Exposure Limits.
- c) Oxygen exposures should not exceed the NOAA oxygen single and daily exposure limits. Both CNS and pulmonary (whole-body) oxygen exposure indices should be tracked for each diver.

Decompression Management

- a) The NDCSB shall review and approve the method of decompression management selected for a given diving application and project.
- b) Decompression management can be safely achieved by a variety of methods, depending on the type and model of rebreather to be used. Following is a general list of methods for different rebreather types:
 - 1. Oxygen rebreathers: Not applicable.
 - 2. SCR (presumed constant fO_2):
 - Use of any method approved for open-circuit scuba diving breathing air, above the maximum operational depth of the supply gas.
 - Use of open-circuit nitrox dive tables based upon expected inspired fO_2 . In this case, contingency air dive tables may be necessary for active-addition SCR's in the event that exertion level is higher than expected.
 - Equivalent air depth correction to open-circuit air dive tables, based upon expected inspired fO_2 for planned exertion level, gas supply rate, and gas composition. In this case, contingency air dive tables may be necessary for active-addition SCR's in the event that exertion level is higher than expected.
 - 3. CCR (constant PO_2):
 - Integrated constant PO_2 dive computer.
 - Non-integrated constant PO_2 dive computer.
 - Constant PO_2 dive tables.
 - Open-circuit (constant fO_2) nitrox dive computer, set to inspired fO_2 predicted using PO_2 set point at the maximum planned dive depth.
 - Equivalent air depth (EAD) correction to standard open-circuit air dive tables, based on the inspired fO_2 predicted using the PO_2 set point at the maximum planned dive depth.
 - Air dive computer, or air dive tables used above the maximum operating depth (MOD) of air for the PO_2 setpoint selected.

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

- a) Logs and checklists will be developed for the rebreather used, and will be used before and after every dive. Divers shall indicate by initialing that checklists have been completed before and after each dive. Such documents shall be filed and maintained as permanent project records.
- b) No rebreather shall be dived which has failed any portion of the pre-dive check, or is found to not be operating in accordance with manufacturer's specifications.
- c) Pre-dive checks shall include:
 1. Gas supply cylinders full;
 2. Composition of all supply and bail-out gases analyzed and documented;
 3. Oxygen sensors calibrated;
 4. Carbon dioxide canister properly packed;
 5. Remaining duration of canister life verified;
 6. Breathing loop assembled;
 7. Positive and negative pressure leak checks;
 8. Automatic volume addition system working;
 9. Automatic oxygen addition systems working;
 10. Pre-breathe system for 3 minutes (5 minutes in cold water) to ensure proper; oxygen addition and carbon dioxide removal (be alert for signs of hypoxia or hypercapnia);
 11. Other procedures specific to the model of rebreather used;
 12. Documentation of ALL components assembled;
 13. Complete pre-dive system check performed; and
 14. Final operational verification immediately before entering the water including;
 - PO₂ in the rebreather is not hypoxic
 - Oxygen addition system is functioning.
 - Volumetric addition is functioning
 - Bail-out life support is functioning

Alternate Life Support System

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

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

CO₂ Absorbent Material

- a) CO₂ absorption canister shall be filled in accordance with the manufacturer's specifications.
- b) CO₂ absorbent material shall be used in accordance with the manufacturer's specifications for expected duration.
- c) If CO₂ absorbent canister is not exhausted and storage between dives is planned, the canister should be removed from the unit and stored sealed and protected from ambient air, to ensure the absorbent retains its activity for subsequent dives.
- d) Long-term storage of carbon dioxide absorbents shall be in a cool, dry location in a sealed container. Field storage must be adequate to maintain viability of material until use.

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

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

Unit Disinfections

The entire breathing loop, including mouthpiece, hoses, counterlungs, and CO₂ canister, should be disinfected periodically according to manufacturer's specifications. The loop must be disinfected between each use of the same rebreather by different divers.

11.6 Oxygen Rebreathers

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

11.7 Semi-Closed Circuit Rebreathers

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

11.8 Closed-Circuit Rebreathers

- a) The fO_2 of each diluent gas supply used shall be chosen so that, if breathed directly while in the depth range for which its use is intended, it will produce an inspired PO_2 greater than 0.20 atm but no greater than 1.4 atm.
- b) Maximum operating depth shall be based on the fO_2 of the diluent in use during each phase of the dive, so as not to exceed a PO_2 limit of 1.4 atm.
- c) Divers shall monitor both primary and secondary oxygen display systems at regular intervals throughout the dive, to verify that readings are within limits, that redundant displays are providing similar values, and whether readings are dynamic or static (as an indicator of sensor failure).
- d) The PO_2 set point shall not be lower than 0.4 atm or higher than 1.4 atm.

APPENDIX 1

DEFINITION OF TERMS

Air sharing - Sharing of a single air supply between divers who are using independent second stages.

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

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

Buddy Breathing – Two divers sharing a single air source from a single second stage.

Buddy Diver - Second member of the dive team.

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

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

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

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

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

Cylinder - A pressure vessel for the storage of gases.

Decompression Chamber - A pressure vessel for human occupancy, also called a hyperbaric chamber or recompression chamber.

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

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

Dive - A descent into the water, an underwater activity breathing 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), breathing gas composition, and

time as input to a decompression model, or set of decompression tables, programmed into the device.

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

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

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

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

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

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

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

EAD - Equivalent Air Depth (see below).

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

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

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

fN₂ - Fraction of nitrogen in a gas mixture, expressed as either a decimal or percentage, by volume.

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

FFW – Feet or freshwater or equivalent static head.

FSW - Feet of seawater, or equivalent static head.

Hookah - While similar to surface supplied diving 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 depth, time, and diving profile.

Hyperbaric Chamber - See decompression chamber.

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

In-line Alternate Air Source – An additional second stage regulator that is attached to the diver's BCD inflator assembly and is used in the event a dive buddy needs to share air. It also serves as a redundant second stage for the diver.

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

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

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

Mixed-Gas Diving - A diving mode in which the diver is breathing a gas mixture containing proportions greater than 1% by volume of an inert gas other than nitrogen.

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

MSW - Meters of seawater or equivalent static head.

Nitrox - Any gas comprised predominately of nitrogen and oxygen, most frequently containing between 21% and 40% oxygen.

NOAA Science Diver – A scientific diver who has been authorized by the Director of the NOAA Diving Program to conduct dives in support of NOAA's science activities.

NOAA Diving Control and Safety Board (NDCSB) - Group of individuals who are the official representatives of NOAA in matters concerning the scientific diving program.

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

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

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

Oxygen Clean - All combustible contaminants have been removed.

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

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

OTU - Oxygen Toxicity Unit

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

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

Pressure Vessel - See cylinder.

PN₂ - Inspired partial pressure of nitrogen, usually expressed in units of atmospheres absolute.

PO₂ - Inspired partial pressure of oxygen, usually expressed in units of atmospheres absolute.

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

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

Recompression Chamber - See decompression chamber.

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

Scientist – One who engages in a systematic activity to acquire knowledge of the biological, chemical, geological, or physical environment or an individual that engages in such practices and traditions that are linked to schools of thought or philosophy.

Scientist in training – One who engages in learning processes or formal education to acquire knowledge of the biological, chemical, geological, or physical environment necessary to become a scientist.

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

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

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

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

Unit Diving Supervisor – Mid-level supervisors within the NOAA Diving Program responsible for overseeing diving activities at the unit level.

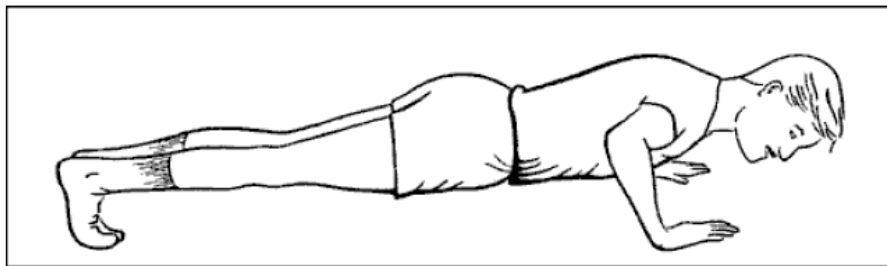
Working Pressure - Normal pressure at which the system is designed to operate.

APPENDIX 2
NOAA DIVING PHYSICAL FITNESS STANDARDS

Age	Pushups, male, 2 min	Pushups, female, 2 min	Curl-ups, both, 2 min.
Up to 25	37	16	45
26-30	32	13	40
31-40	25	9	34
41-50	20	6	27
51+	10	4	25

All fields must be completed including names and signatures!

All repetitions for each exercise (pushups and sit-ups) must be performed in a 2 minute timed period with a short break (if necessary) between them.



Push-ups

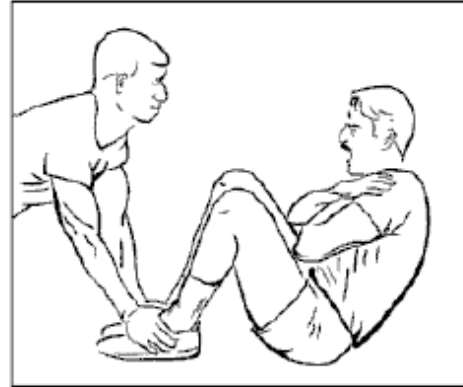
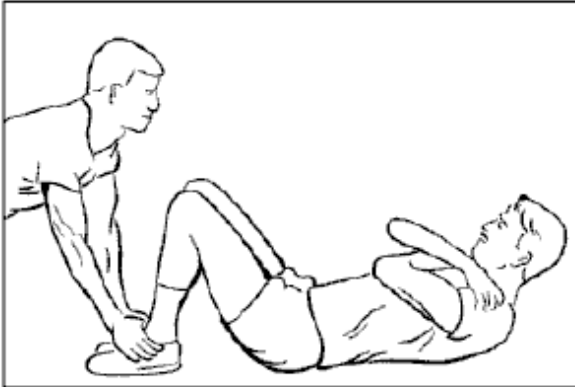
- (1) Push-ups shall be performed on a firm or suitably padded, level surface. Shoes are optional.
- (2) Push-ups shall be performed as follows:
 - (a) Participant shall begin in "front-leaning rest" position, palms of hands placed on floor directly beneath or slightly wider than shoulders. Both feet together on floor.
 - (b) Back, buttocks, and legs shall be straight from head to heels and must remain so throughout test. Toes and palms of hands shall remain in contact with floor. Feet shall not contact a wall or other vertical support surface.
 - (c) Timer shall signal start for participants and calls out 15-second time intervals until two minutes have elapsed.
 - (d) Participants shall lower entire body as a single unit by bending elbows until upper arms, shoulders, and lower back are aligned and parallel to deck.
 - (e) Participants shall return to starting position by extending elbows, raising body as a single unit until arms are straight.
 - (f) Participants may rest only in up position while maintaining arms, back, buttocks, and legs in straight position.
- (3) Push-ups are repeated correctly as many times as possible in two minutes. Test Administrator will monitor participants for correct form and counts correctly performed push-ups. Incorrect

push-ups shall not be counted. Results for event ended in less than two minutes shall be number of push-ups properly performed at time of termination.

(4) Event is ended if participant:

- (a) Touches deck with any part of body except hands and feet.
- (b) Raises one or both feet or hands off deck or ground.
- (c) Fails to maintain back, buttocks, and legs straight from head to heels.

Source: OPNAVINST 6110.1G 10 October 2002 USN Physical Readiness Test



Curl-ups

- (1) Event shall be conducted with partner on a level surface on a blanket, mat, or other suitable padding. Shoes are optional.
- (2) Curl-ups are conducted as follows:
 - (a) Participants shall start by lying flat on back with knees bent, heels about 10 inches from buttocks. Arms shall be folded across and touching chest with hands touching upper chest or shoulders.
 - (b) Feet shall be held to floor only by partner's hands.
 - (c) Timer shall signal start for participants and call out 15-second time intervals until two minutes have elapsed.
 - (d) Participants curls body up, touching elbows to thighs while keeping hands in contact with chest or shoulders.
 - (e) After touching elbows to thighs, participants lie back, touching lower edge of shoulder blades to deck.
 - (f) Participants may rest in either up or down position.
- (3) Curl-ups are repeated correctly as many times as possible in 2 minutes. Test Administrator monitors participants for correct form and counts number of correctly performed curl-ups. Incorrectly performed curl-ups shall not be counted. Results for event ended in less than two minutes shall be the number of curl-ups properly completed at time of termination.

(4) Event is ended if participant:

- (a) Lowers legs
- (b) Raises feet off ground or floor
- (c) Lifts buttocks off ground or floor
- (d) Fails to keep arms folded across and touching chest.
- (e) Fails to keep hands in contact with chest or shoulders.

Source: OPNAVINST 6110.1G 10 October 2002 USN Physical Readiness Test

Applicants Printed Name/Unit	Push-up Results	Curl-up Results	Age

Printed Name of Test Administrator _____ Date _____

Test Administrator's Signature _____

APPENDIX 3

NOAA DIVE ACCIDENT MANAGEMENT PLAN TEMPLATE

- I. Dive Accident Plan: Conscious and Alert Diving Accident Victim
 - A. Evaluate victim's Airway, Breathing, and Circulation (ABCs)
 - B. Put the victim on 100% oxygen using a positive-pressure/demand oxygen resuscitator.
 - C. Call 911 (local EMS) and the U.S. Coast Guard at [LOCATION] at [USCG TELEPHONE NUMBER], or hail them on VHF radio, channel 16, to report the diving accident. The EMS dispatcher will notify land transportation, [NAME OF LOCAL HOSPITAL], and the [NAME OF THE CLOSEST RECOMPRESSION CHAMBER].
 - D. Evaluate the victim and gather additional information about the incident:
 - Perform a 5-minute field neurological examination on the stricken diver
 - Gather as much information about the dive as possible
 - Interview the victim's dive buddy for additional information
 - Secure victim's dive gear for examination (DO NOT DISASSEMBLE GEAR OR EXHAUST ANY AIR FROM THE SYSTEM)
 - E. If decompression sickness is suspected, or any other type of pressure-related injury (arterial gas embolism, pneumothorax, etc.) keep the victim on his/her back (DO NOT RAISE THE VICTIM'S LEGS). Place the victim on his/her side if nauseated or vomiting – keep the airway clear.
 - F. The victim should be transported to [NAME OF LOCAL HOSPITAL] for evaluation. The [NAME OF CLOSEST RECOMPRESSION CHAMBER] is the closest available recompression chamber.
 - If not nauseated and not experiencing altered level of consciousness, give the victim water to drink during transportation to the [NAME OF LOCAL HOSPITAL].
 - Continue oxygen administration
 - Send any and all information about the dive with the victim to the hospital including results of field neurological examination.
 - Keep victim comfortable and observe for shock or change in condition.
 - G. Based on the evaluation by the doctor at [NAME OF LOCAL HOSPITAL], the victim may be transported to the [NAME OF CLOSEST RECOMPRESSION CHAMBER] for treatment.

II. Dive Accident Plan: Unconscious and Non-Responsive Dive Accident Victim

- A. Evaluate victim's Airway, Breathing, and Circulation (ABCs)
- B. Start cardio-pulmonary resuscitation, or rescue breathing using a positive-pressure/demand oxygen resuscitator.
- C. Call 911 (local EMS) and the U.S. Coast Guard at [LOCATION] at [USCG TELEPHONE NUMBER], or hail them on VHF radio, channel 16, to report the diving accident. The EMS dispatcher will notify land transportation, [NAME OF LOCAL HOSPITAL], and the [NAME OF THE CLOSEST RECOMPRESSION CHAMBER].
- D. Evaluate the victim and gather additional information about the incident:
 - Gather as much information about the dive as possible
 - Interview the victim's dive buddy for additional information
 - Secure victim's dive gear for examination (DO NOT DISASSEMBLE GEAR OR EXHAUST ANY AIR FROM THE SYSTEM)
- E. Transport the victim to the harbor closest to the dive site [NAME OF NEAREST HARBOR OR EVACUATION SITE] where a local ambulance should be standing-by to evacuate the victim to [NAME OF LOCAL HOSPITAL] by local ambulance.
- F. If there is a problem transporting the victim to the nearest harbor or if the time delay is significant (>2 hours), call or radio the USCG at [USCG TELEPHONE NUMBER] or VHF – channel 16, to arrange air evacuation of the victim. The USCG air evacuation team will coordinate with [NAME OF LOCAL HOSPITAL].

II. Medical Assistance and Recompression Chamber Contact Information

- A. Before commencing dive operations, the Divemaster will contact the primary recompression chamber to ensure that the chamber is operational and available to receive patients. If the primary chamber is not operational, alternate facilities should be contacted.
- B. Primary recompression chamber facility:
 - [LOCATION]
 - [ADDRESS]
 - [TELEPHONE NUMBER DURING NORMAL BUSINESS HOURS]
 - TELEPHONE NUMBER AFTER HOURS]
- C. Alternate telephone numbers for recompression chambers and medical advice are:
 - [FIRST ALTERNATE & TELEPHONE NUMBER]
 - [SECOND ALTERNATIVE & TELEPHONE NUMBER]
- D. Divers Alert Network
 - [ADDRESS]
 - (919) 684-8111 (24 hour emergency telephone number)

APPENDIX 4
NOAA DIVE PLANNING AND APPROVAL FORM

Date(s) of operation?	Time of Operations?
Dive location(s)?	Depths of planned dives?
Number dives planned per day?	Total number dives planned?
Number of consecutive days of diving?	Evacuation means and time to medical facility?

Names of divers & divemaster?
Purpose of dives and tasks to be performed?
Diver-worn equipment and breathing gas to be used?
Special tools/equipment to be used?
Potential hazards/risks and control measures?
Printed name and signature of person submitting plan and date
Printed name and signature of person approving plan and date

APPENDIX 5

NOAA PRE AND POST DIVE CHECKLIST

PRE-DIVE

1. Mission Safety

- Dive objectives and goals are defined, reviewed and understood by the dive and support personnel.
- The Diving Accident Management Plan is posted, coordinated and reviewed (i.e., chamber availability, evacuation route, etc.), and all personnel are informed of their duties.
- Conduct a pre-dive briefing (including adherence to the buddy system & 500-psi surfacing requirement).

2. Evaluate and Prepare for Potential Hazards

- Identify dive site entry procedures and exit access point(s).
- Define depth, bottom time and cylinder ending pressure limits for the planned dive.
- Evaluate and discuss potential for entrapment, entanglement, other physical or mechanical hazards, bottom obstructions, dangerous bottom conditions or marine life, and marine traffic hazards.
- Complete Dive Safe Ship Operations (NOAA Form 64-3), if applicable.

3. Diving and Support Personnel

- Ensure that all divers are authorized to perform their assigned duties according to their NOAA certification levels (i.e., Scientific Diver, Temporary Diver, or Observer Diver).
- Ensure that all divers are qualified to complete assigned underwater tasks safely.
- Ensure support personnel understand all diver hand signals, emergency recall signals and can offer immediate assistance in case of an emergency.
- Provide an assessment of repetitive dive designations of a previous dive was made within 12 hours.

4. Equipment

- All support equipment (boats, compressor, oxygen kit, tools, etc.) are operated by trained personnel.
- All dive techniques to be used are safe and appropriate and authorized.
- All tools used are appropriate for the task.
- Complete diving first aid kit, first aid handbook, oxygen resuscitator, divemaster kit, a complete set of no-decompression air and Nitrox Tables, and dive flags are on site.

POST-DIVE

- Dive team buddies have remained together for a minimum of 30 minutes after each dive and have monitored each other's condition during that time.
- Notify watch on the vessel's bridge when operations are completed (if applicable).
- Ensure that all personal dive and support equipment is thoroughly cleaned and properly stowed.
- Monitor divers for signs and symptoms of pressure-related illnesses or injuries for a minimum of 30 minutes after each dive.
- Conduct a dive debrief and critique operations, including procedures for flying after diving (if applicable).

Name of person completing checklist: _____ Date: _____

APPENDIX 6

NOAA DIVING AND RESCUE SKILLS CHECKOUT REPORT

Name of diver being evaluated: _____ Date: _____

Certification level: SCIENTIFIC WORKING

Name / location of Dive Unit: _____ Name of UDS: _____

Name of diver conducting evaluation: _____

Signature of evaluator: _____

PRELIMINARY OBSERVATIONS

Current training & medical:

Gear present and in good working condition:

- Dive Physical
- CPR
- First Aid
- Oxygen Delivery

- | | | |
|---|--|--|
| <input type="checkbox"/> Regulator | <input type="checkbox"/> Dive Computer | <input type="checkbox"/> Snorkel |
| <input type="checkbox"/> Alt. 2nd Stage | <input type="checkbox"/> BCD | <input type="checkbox"/> Fins |
| <input type="checkbox"/> Pressure Gauge | <input type="checkbox"/> Wet/Dry Suit | <input type="checkbox"/> Knife |
| <input type="checkbox"/> Depth Gauge | <input type="checkbox"/> Cylinder | <input type="checkbox"/> Wt belt/harness |
| <input type="checkbox"/> Bottom Timer | <input type="checkbox"/> Mask | |

DIVER SKILL EVALUATION

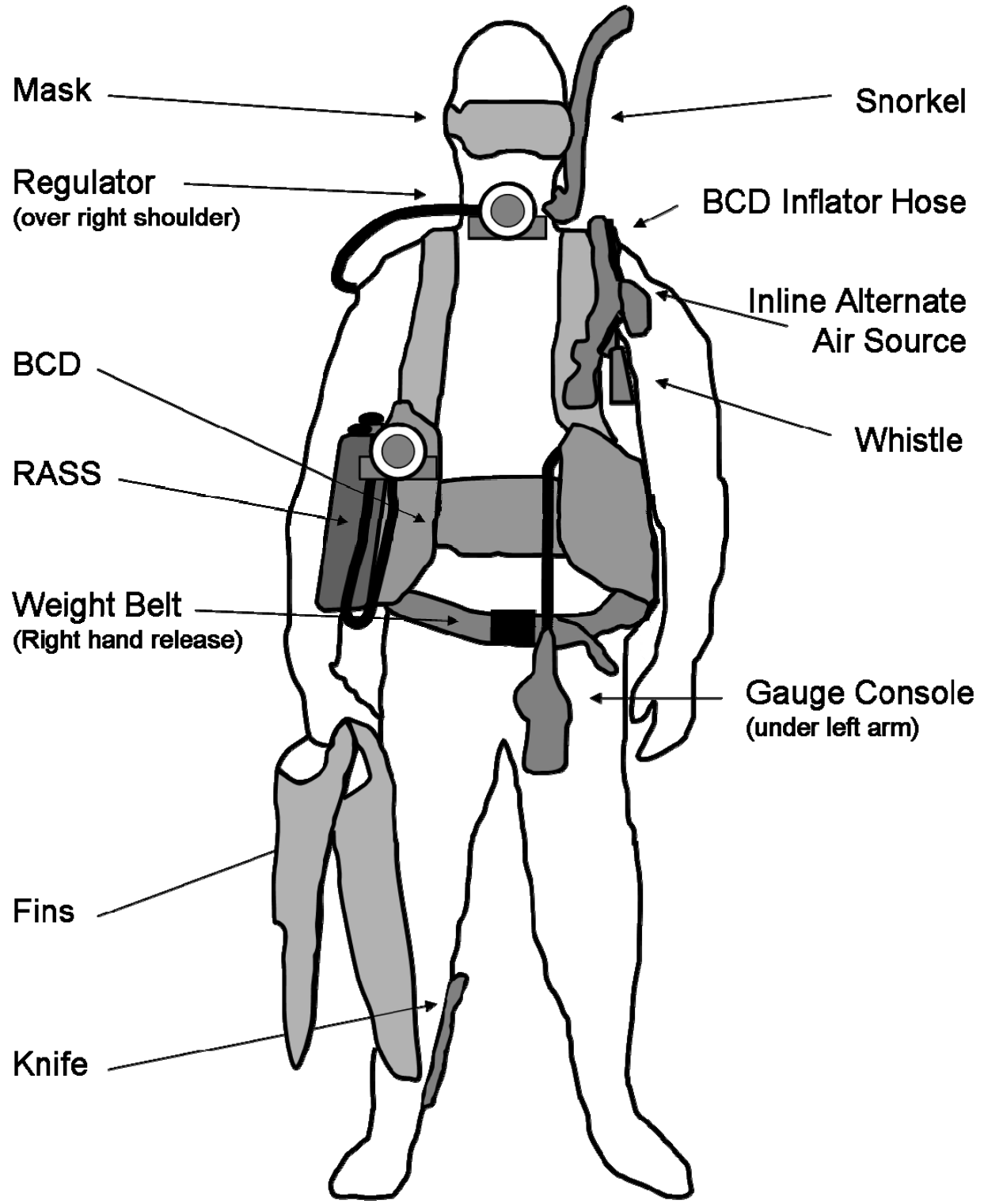
(Note as U = Unsatisfactory, N = Needs Improvement, S = Satisfactory, E = Excellent)

Physical fitness	_____	U/W navigation & orientation	_____
Swimming ability	_____	Weight belt removal / replacement	_____
Properly weighted	_____	Disconnect / reconnect inflators (BCD/Dry Suit)	_____
Buoyancy control	_____	V.V.D.S. roll outs & venting	_____
Pre-dive buddy check	_____	Controlled descent / ascent rate	_____
Buddy breathing	_____	Buddy contact and awareness during dive	_____
Regulator recovery	_____	U/W communication (hand signals)	_____
Ditch and don BCD	_____	Surface unconscious diver	_____
Mask removal	_____	Recover unconscious diver from water	_____

POST DIVE ASSESSMENT

Critique of ability and skills: _____

APPENDIX 7
NOAA STANDARDIZED DIVE EQUIPMENT
CONFIGURATION
WETSUIT CONFIGURATION w/RASS



DRYSUIT CONFIGURATION

