

***STANDARDS FOR
THE CONDUCT OF SCIENTIFIC DIVING***

June 3, 2004

**OFFICE OF POLAR PROGRAMS
NATIONAL SCIENCE FOUNDATION**

FOREWORD

The Office of Polar Programs (OPP) of the National Science Foundation (NSF) provides support for underwater diving associated with the research activities it funds in Antarctica. The NSF/OPP's *Standards for the Conduct of Scientific Diving* have been developed to ensure that all scientific diving conducted under the aegis of the Office of Polar Programs is conducted in a manner that will maximize protection of scientific divers from accidental injury or illness associated with underwater diving while optimizing the researchers' ability to conduct research. The *OPP Standards* have been patterned after the *American Academy of Underwater Sciences (AAUS) Standards for Scientific Diving*, a document that has provided a template for scientific diving at most academic and research institutions in the United States over the last fifty years. The approach described in the *AAUS Standards for Scientific Diving* has been recognized by the Occupational Safety and Health Administration (OSHA) as providing an alternate means of protecting divers than their commercial diving standards (*i.e.*, Code of Federal Regulations, 29.1910 Subpart T).

There are inherent risks in underwater diving and doing so in polar regions involves additional risks because of the environmental conditions and remoteness. The *OPP Standards for the Conduct of Scientific Diving* provides a framework within which to manage those risks and allow underwater diving in support of the scientific enterprise in Antarctica to proceed safely. Each scientific diver should acknowledge those risks and commit to conducting their underwater diving activities in accordance with the *OPP Standards*.

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**STANDARDS FOR THE CONDUCT OF SCIENTIFIC DIVING
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OFFICE OF POLAR PROGRAMS**

1.0. PROGRAM OVERVIEW

1.1. STATEMENT OF PURPOSE

Underwater diving is an inherently dangerous activity. Diving in polar regions carries additional risks associated with the environmental conditions and often remote diving locations where diving support, medical support, or life support infrastructure are limited or absent. These risks associated with underwater diving in polar regions can be managed if the risks are recognized and effective intervention or risk-reduction strategies are applied to keep those risks within acceptable limits. The *NSF/OPP Standards for the Conduct of Scientific Diving* are intended to provide a framework by which underwater diving for scientific purposes can be conducted safely and effectively while maximizing the utility of this research tool to the scientific enterprise.

The *NSF/OPP Standards for the Conduct of Scientific Diving* are consistent with the Occupational Safety and Health Administration's (OSHA's) recommendations for scientific diving programs exempt from their commercial diving standards¹ and scientific diving standards developed by the American Academy of Underwater Sciences (AAUS)².

1.2. STATEMENT OF POLICY

It is the stated policy of the Office of Polar Programs, National Science Foundation, that underwater diving conducted for scientific purposes under its aegis shall be conducted in accordance with the principles and practices established by the NSF/OPP Scientific Diving Control Board (SDCB) and enunciated in these *Standards for the Conduct of Scientific Diving*. Any diving associated with the operation and maintenance of NSF/OPP facilities or stations shall be conducted in accordance with OSHA's commercial diving standard and are not covered within these *Standards*. Compressed gas diving for recreational purposes is not sanctioned or supported by the NSF/OPP at any of its facilities.

1.3. SCIENTIFIC DIVING DEFINITION

These *Standards* define scientific diving as diving performed as a necessary part of scientific, research, or educational activities by individuals whose sole purpose for diving is to perform those scientific research-related tasks. To further clarify, NSF/OPP requires that:

- a. The underwater diving activity is an integral and essential part of the project;
- b. The project is a scientific, research, or educational activity consistent with NSF's mission to foster research and education in the sciences and engineering;
- c. The specific tasks that the diver performs underwater are observational or involved in data gathering, rather than tasks usually associated with commercial diving; and,

¹ Code of Federal Regulations, Chapter 29 Part 1910. Subpart T (29 CFR 1910.143).

² *The American Academy of Underwater Sciences Standards for Scientific Diving* (2004 ed.) www.aaus.org

- d. The work products of the diving activity are available to the public for review or examination.

1.4. DIVING ELIGIBILITY

NSF/OPP funded or sanctioned research projects or related educational outreach activities can request underwater diving privileges under the auspices of the NSF/OPP Scientific Diving Program. Diving may be authorized if the dive program meets the definition of scientific diving (see Section 1.3.), the dive plan is consistent with NSF/OPP Diving Standards, the participating divers are current and qualified to perform the dive profiles proposed in the research diving plan, and the operational requirements of the project's dive program can be supported within the resource base available. The NSF/OPP Diving Safety Officer (DSO) will determine whether the dive plan and divers meet the requirements stipulated in the *NSF/OPP Standards for the Conduct of Scientific Diving* and can be authorized to dive. The NSF/OPP Polar Science Support Section will determine whether the overall operational support requirements of the specific research project (including the underwater diving component) can be met within current resource constraints.

2.0. SCIENTIFIC DIVING PROGRAM

The NSF/OPP scientific diving program falls under the administrative management of the NSF/OPP Polar Research Support Section. The NSF/OPP SDCB and the NSF DSO (from the Smithsonian Institution under NSF/SI Interagency Agreement of October 30, 2001) have been appointed to assist NSF/OPP by providing the technical expertise necessary to operate an underwater diving program in support of the NSF's research mission in polar regions. The SDCB members are volunteers from other academic or research institutions, providing their expertise as "special government employees" during the period of their assignment.

2.1. PROGRAM MANAGEMENT

Supervision and control of diving operations shall be conducted as defined below.

- 2.1.1. Safety and Health Officer (SHO): has responsibility for all safety and health facets of the program and is the administrative position to which the SDCB and DSO report. The SHO has ultimate responsibility over all phases of the dive program and its management. The NSF DSO exercises responsibility over all technical components of the scientific diving program.
- 2.1.2. Scientific Diving Control Board (SDCB): is an administrative committee, appointed by the Director, Office of Polar Programs. It is comprised of the DSO, AAUS organizational member programs, home-institution Diving Safety Officers, and experienced Antarctic scientific divers. The Contractor Scientific Diving Coordinator (SDC) serves as the Secretary to the Board. The SDC and other NSF and Raytheon Polar Services Company (RPSC) members, serve as non-voting, ex-officio members of the Board. The SDCB has the responsibility to:

- a. Recommend changes in policy, changes in procedure, and amendments to the *Standards for the Conduct of Scientific Diving* as the need arises;
 - b. Establish and/or approve training programs through which applicants can satisfy the requirements of the *Standards*;
 - c. Develop guidance for safe diving activities (e.g., procedures, locations, conditions) in Antarctica;
 - d. Approve new equipment or techniques for polar use; and,
 - e. Approve facilities for the inspection and maintenance of self-contained underwater breathing apparatus (scuba) and associated equipment.
- 2.1.3. NSF Diving Safety Officer (DSO): acts as the liaison between the SDCB and the research divers. The DSO has the authority to act on behalf of the SDCB in all diving matters, pending acceptance by the SDCB at their next regularly scheduled meeting. The DSO typically represents the NSF/OPP in all technical matters concerning diving operations, diving safety, or projects utilizing diving as a tool in further research. The NSF DSO has the responsibility to:
- a. Review and approve divers, diving plans, and diving locations submitted by the various research projects;
 - b. Evaluate and recommend new equipment for polar diving use;
 - c. Recommend equipment and facilities to support scientific diving in polar regions; and,
 - d. Recommend new diving techniques or procedures to further scientific diving as a research tool in polar regions.
- 2.1.4. Home Institution DSO: is the DSO at the home institution of the Principal Investigator (PI) where the scientific divers are based. The home institution DSO acts in an advisory capacity to the NSF DSO, providing information on current scientific diver status under AAUS standards. The home institution DSO may provide specialized training necessary to prepare the individual divers for diving in polar waters at the request of the NSF DSO. The home institution DSO certifies that the diver meets first aid training, medical and equipment requirements stipulated in the AAUS standards.
- 2.1.5. Contractor Scientific Diving Coordinator (SDC): is responsible for maintaining dive equipment provided on-site, conducting the diving pre-season orientation, orienting new science teams to conditions on-site, providing supervision and instruction during local familiarization dives, and generally supports all scientific diving activities. The SDC has the authority to suspend diving operations if in his/her opinion these are unsafe or unwise, pending review by the NSF DSO. Other duties, authority, and responsibility of an oversight nature may be assigned this individual by the NSF DSO or SHO.
- 2.1.6. Principal Investigator (PI/Lead Diver): generally acts as the Lead Diver of that group, unless that authority is assigned to another more experienced diver in the group. The Lead Diver is a person who has the diving experience, competency, responsibility, and reliability to conduct polar diving operations. The Lead Diver

is responsible for managing the daily dive operations of the science team, and insuring that all divers in that team follow the established procedures outlined in these *Standards*.

2.1.7. Tenders: are individuals who are qualified to assist divers in their diving activities. They have no direct authority to intervene in diving operations, unless they also serve as PI, Lead Diver, SDC, or other authorized person having dive management control responsibilities.

2.1.8. Divers: individuals having the experience, training, and authorization necessary to dive under NSF OPP auspices.

2.2. DIVING CONTROL

2.2.1. Diving Approval

The NSF DSO determines whether a specific project's dive plan is consistent with the requirements of the *NSF/OPP Standards for the Conduct of Scientific Diving*, based on the information submitted by the Principal Investigator or Lead Diver, and approves the dive plan, if appropriate. Likewise, the NSF DSO reviews each individual diver's credentials and approves/disapproves the diver, as appropriate.

The NSF DSO may grant reciprocity for "current and qualified" scientific divers from AAUS-accredited scientific diving programs, but reserves the right to perform check-out dives to validate proficiencies in skills deemed critical to polar diving activities. Divers from institutions with diving programs must be currently certified as scientific divers by their respective organizations, and meet that institution's training and medical criteria for scientific diving. These institutions must have scientific diving programs in place that conform to the exemption from Subpart T (Commercial Diving Standards) of Federal OSHA for research diving, and that are consistent with AAUS Standards.

Divers coming from institutions without formal scientific diving programs must meet the minimum USAP experience level required of divers from institutional dive programs, which are:

- a. Certification for one year;
- b. 50 open water dives;
- c. 15 dry suit dives; and,
- d. 10 dry suit dives within twelve months of Antarctic dive operations.

These divers may be required to conduct checkout dives prior to deployment with a party designated by the NSF DSO. All divers authorized by the NSF DSO must be currently certified in cardiopulmonary resuscitation (CPR) and oxygen administration, and provide proof of scuba equipment maintenance within 12 months.

Note that diving approval may be revoked for a diver who does not demonstrate proficiency during the in-situ familiarization dives conducted by the NSF DSO or SDC in the field.

2.2.2. Oversight of Diving Activities

The SDC, the NSF DSO, and any member of the SDCB has the authority to suspend diving privileges of any diver or dive team if in his/her opinion the divers are conducting themselves in an unsafe manner or inconsistent with the *NSF/OPP Standards for the Conduct of Scientific Diving*. Temporarily suspended diving privileges can be reinstated under the authority of the NSF DSO, subject to periodic review by the Scientific Diving Control Board.

2.2.3. Consequences of Violation of Regulations by Divers

Failure to comply with these *Standards* may be cause for the revocation or restriction of the diver's authorization to dive in Antarctica or other polar regions where NSF has authority.

3.0. **DIVING REGULATIONS**

3.1. GENERAL POLICY

In no case will individuals be allowed to dive under NSF/OPP auspices unless they are trained and proficient in the type of diving they plan to do and familiar with the equipment that they plan to use.

3.2. DIVING PROCEDURES

3.2.1. Solo Diving Prohibition

All dives conducted under the auspices of the NSF/OPP shall be planned and executed in such a manner as to insure that every diver involved maintains constant, effective communication with at least one other comparably equipped certified research diver in the water, except as permitted in Section 3.2.8 below. This buddy diver system is based upon mutual assistance, especially in the case of an emergency. Dives should be planned around the competency of the least experienced diver. If loss of effective communication occurs within a buddy team, then all divers shall surface and reestablish contact.

3.2.2. Diving under Ceilings

- a. When diving under ceilings, divers must arrange for at least one safety hole or other alternate surface access. In cases where the divers are tethered, or loss or occlusion of the dive hole is extremely unlikely, and addition of a secondary access would be inordinately difficult, such a secondary hole is not required.
- b. Untethered diving under ceilings is permitted in clear water, provided a down line is deployed and divers adhere to the buddy system.
- c. Any diving under ceilings where there is low visibility, shallow water that restricts the diver's ability to see the entry hole, or a danger of currents, the use of a tended tether is required. A tended tether must also be used when in the diver's, or the SDC's, judgment there is danger of losing surface access during the proposed dive.

- d. When diving under ceilings, divers must carry with them two independent regulators - a primary and a backup. These regulators may be attached to the same or to separate air sources.
- e. When diving under a ceiling with a down line that reaches the bottom within diveable depths, the use of a buoyancy compensator in conjunction with a dry suit is not required.
- f. All dives must be tended. Additionally, during periods of darkness, at least two lights powered by independent sources must be in the hole.

3.2.3. Dive Computers and Pressure Gauges

All members of the diving team shall use a USAP-provided dive computer and a submersible tank pressure gauge. Use of dive computers shall be consistent with AAUS recommendations.

3.2.4. Depth Limits

The diving certification issued by the diver's home institution (or regional DSO for divers with no institutional affiliation) will authorize the holder to dive to, but not exceed, their certification depth.

- a. Depth/Time Limits. Individuals are authorized to dive to either their depth certification for their home institution or to a depth specified by the NSF DSO, whichever is shallower. Dives that require staged decompression are not authorized.
- b. An OPP authorized diver may only exceed his/her depth certification by one step under the following conditions:
 - 1. if accompanied by a diver certified to the greater depth, or,
 - 2. if an emergency situation makes this necessary.

3.2.5. Termination of Dive

A diver may terminate the dive at any time if he/she feels it would be unsafe to continue. Divers should begin terminating their dives by notifying their buddies of the termination, stopping work and commencing ascent. Divers must be at their safety stops with no less than 20 cf (see Table 1.) and must have exited the water with no less than 10 cf.

<u>Cylinder Type (cf)</u>	<u>Pressure at 20 cf (psig)</u>	<u>Pressure at 10 cf (psig)</u>
Single Steel 71.2	700	350
Double Steel 71.2	400	200
Single Steel 95.1	600	300
Double Steel 95.1	300	150
Single Aluminum 80	800	400
Double Aluminum 80	400	200

Table I-- Minimum Reserve Pressures for Selected Cylinder Configurations
(cf = cubic feet; psig = pounds per square inch gauge)

Examples of situations necessitating dive termination include:

- a. Environmental conditions that become unsafe;
- b. One or more divers becoming chilled;
- c. Cylinder gas volume approaching 20 cubic feet;
- d. Dive profiles approaching required stage decompression; or,
- e. Equipment failure that immediately or potentially jeopardizes the safety of the diver.

3.2.6. Refusal to Dive

- a. The decision to dive is that of the individual diver. A diver may refuse to dive whenever he/she feels it is unsafe to make the dive.
- b. Safety – The ultimate responsibility for safety rests with the individual diver. It is the diver's responsibility and duty to refuse to dive if, in his/her judgment, conditions are unsafe or unfavorable, or if he/she would be violating the precepts of his/her training or these *Standards*.

3.2.7. Diver Recall

A method of recalling the divers must be available at each dive site.

3.2.8. Tended Diving with Communications

Single divers using either surface-supplied or tethered-scuba modes of diving may be deployed, providing the following requirements are met:

- a. A full-face mask or helmet is utilized;
- b. The system has a positive, two-way, voice-communication link;
- c. The system has a tether, air supply hose (if appropriate), and communication line;
- d. The diver has received the dive plan authorization number from the NSF DSO for this mode of diving to be used; and,
- e. A fully equipped stand-by diver, who is able to enter the water expeditiously, is present.

- 3.2.9. Surface-Supplied Diving
Special consideration by the NSF DSO, acting on behalf of the DCB, is required.
- 3.2.10. Blue-Water Diving
Special consideration by the NSF DSO, acting on behalf of the DCB, is required.
- 3.2.11. Rebreathers
Special consideration by the NSF DSO, acting on behalf of the DCB, is required.
- 3.2.12. Mixed Gases/Oxygen Enriched Air (Nitrox)
Special consideration by the NSF DSO, acting on behalf of the DCB, is required.

4.0. *DIVING OPERATIONS*

4.1. LEAD DIVER

For each dive, one individual shall be designated as the Lead Diver. He/she shall be at the dive site during the diving operation. The Lead Diver shall be responsible for:

- a. Coordination. Diving shall be coordinated with other known activities in the vicinity, which are likely to interfere with diving operations.
- b. Briefing. The dive team members shall be briefed on:
 - 1. Dive Objectives;
 - 2. Any unusual hazards or environmental conditions likely to affect the safety of the diving operation;
 - 3. Any modifications to diving or emergency procedures necessitated by the specific diving operation; and,
 - 4. The need to immediately report any physical problems or adverse physiological effects, particularly symptoms of pressure-related injuries.
- c. Dive Planning. Planning of a diving operation shall include considerations of the safety and health aspects of the following:
 - 1. Diving mode;
 - 2. Surface and underwater conditions and hazards;
 - 3. Breathing gas supply;
 - 4. Thermal protection;
 - 5. Dive equipment;
 - 6. Dive team assignment;
 - 7. Residual inert gas status of dive team members;
 - 8. Decompression schedule and altitude corrections; and,
 - 9. Emergency procedures.

4.2. DIVE PLANS

Before conducting any diving operations, the lead diver for a proposed operation must consider and provide the following information:

- a. Participating divers, their qualifications and depth certifications;

- b. Name, telephone number and relationship of person to be contacted for each diver in the event of an emergency;
- c. Approximate number of proposed dives;
- d. Location of proposed dives;
- e. Estimated depths and bottom times anticipated; and,
- f. Proposed work, equipment and/or boats to be employed, repetitive dives (if required), and details of any hazardous conditions anticipated.

4.3. PRE-DIVE SAFETY CHECKS

a. Diver's Responsibility

1. Each diver shall conduct a functional check of his/her diving equipment in the presence of the dive buddy or tender. This functional check shall include, but not be limited to, the following:
 - confirming that the tank valve positively opens and closes;
 - confirming that the submersible pressure gauge works and that it registers the expected amount of air in the cylinder;
 - breathing on both primary and backup regulators to confirm adequate air delivery and absence of free flow;
 - confirming that the dry suit inflator valve delivers air without free flow and that the dry suit exhaust valve vents air when open;
 - confirming that the buoyancy compensator inflator valve delivers air without free flow and that the exhaust valve vents air when open;
 - confirming the integrity of mask and fin straps; and,
 - confirming that any other gear operates according to specifications or expectations;
2. It is the diver's responsibility and duty to refuse to dive if:
 - in his/her judgment, conditions are unfavorable;
 - he/she would be violating the precepts of his/her training, NSF OPP diving standards, or the home institution's diving manual;
3. No dive team member shall be required to be exposed to hyperbaric conditions against his/her will, except when necessary to prevent or treat a pressure-related injury;
4. No dive team member shall be permitted to dive for the duration of any known condition that is likely to adversely affect the safety and health of the diver or other dive team members; and,
5. The diver shall terminate the dive while there is still sufficient breathing gas volume to permit the diver to safely reach the safety stop (20 cf minimum) and be out of the water with 10 cf minimum (See Table 1.).

b. Equipment Requirements

1. A functional emergency oxygen kit shall be present at the dive site for every dive and all participating divers and tenders shall be trained in its use;
2. Each diver shall have a submersible pressure gauge for monitoring scuba cylinder pressure, capable of being monitored by the diver during the dive; and,

3. Each diver shall have the capability of achieving and maintaining positive buoyancy.
- c. **Diver's Qualifications**
Each research diver shall be trained and qualified for the diving mode being used and each dive team member shall have experience or training in the following:
1. The use of the instruments and equipment appropriate to the diving activity to be conducted;
 2. Dive planning and emergency procedures;
 3. CPR, diver rescue techniques, oxygen administration, and diving-related first aid;
 4. Diving-related physics and physiology and the recognition of pressure related injuries; and,
 5. Supplemental qualifications the OPP SDCB may impose (*e.g.*, the number of dry suit dives or other qualifications not required by AAUS).
- d. **Tenders** - All dives conducted under the auspices of the NSF/OPP shall be tended by personnel (who shall remain on site at the surface during the course of the dive) and are qualified to tend that specific type of diving activity.

4.4. POST-DIVE SAFETY CHECKS

After the completion of a dive, each diver shall report any physical problems, symptoms of decompression sickness or equipment malfunctions to the P.I. and the SDC.

4.5. EMERGENCIES - DEVIATION FROM REGULATIONS

Any diver may deviate from the requirements of these standards 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 SDC, NSF DSO, and NSF/OPP Safety and Health Office explaining the circumstances and justifications for such action. Potentially dangerous diving incidents must be communicated to the on-site divers as soon as possible.

5.0. ***RECORD KEEPING REQUIREMENTS***

5.1. PERSONAL DIVING LOG

- a. Each diver shall log every dive made under the auspices of the NSF/OPP. Log sheets shall be submitted to the SDC, who will forward to the NSF DSO. The diving log shall be in a form specified by the OPP and shall include at least the following:
 1. Dive date;
 2. Names of diver and partner;
 3. Total dive time;
 4. Maximum depth attained;
 5. Location of dive;
 6. Dive computer used;

7. Regulator used;
 8. Mixed gas composition and tables, if used;
 9. Mode of diving (scuba, surface supply, etc.);
 10. Safety stop depth and time; and,
 11. Any accidents, equipment failures, or dangerous incidents experienced during the dive
- b. If an emergency causes divers to incur a staged decompression obligation, this shall be noted in the log.
 - c. Completed dive logs must be submitted to the SDC or other approved NSF/OPP representative on a monthly basis.

5.2. RECORD MAINTENANCE

The SDC and NSF DSO shall maintain records for each authorized scientific diver, including these items for at least the following period:

- a. Record of dive - One (1) year, except five (5) years where there has been an incident of pressure-related injury;
- b. Pressure-related injury assessment - Five (5) years;
- c. Records of hospitalization - Five (5) years; and,
- d. Equipment inspection and testing records - current entry or tag, or until equipment is withdrawn from service.

Institutional DSO's may request diver information maintained by USAP. Approval by the diver is required. The file shall include evidence of certification, log sheets, and other pertinent information deemed necessary.

Availability of Records: Institutional DSO's are required by AAUS standards to maintain certain permanent records. Divers under the auspices of NSF/OPP must agree to the release of that information deemed necessary for the NSF DSO to make a reasonable safety and health judgment regarding the divers' qualifications to dive. Failure to provide sufficient information may result in denial of NSF/OPP diving authorization.

5.3. REQUIRED ACCIDENT REPORTING

- a. The SDC shall report to the NSF DSO, who shall record the occurrence of any diving-related injury or illness that requires any dive team member to be hospitalized for 24 hours or more, or after an episode of unconsciousness related to diving activity, or after treatment in a recompression chamber following diving. The circumstances of the incident and the extent of any injuries or illnesses shall be specified. This record shall also contain:
 1. Description of symptoms - including depth and time of onset;
 2. Description and results of treatment;
 3. Printout of dive computer profile(s);
 4. Dive history for prior 7 days; and,
 5. History of flying within those 7 days.
- b. The SDC and the NSF DSO shall prepare a report of any diving accident requiring recompression or resulting in serious injury and shall immediately notify the SHO and the diver's home institution DSO.

6.0 DIVING EQUIPMENT

All diving equipment used by certified scientific divers, regardless of ownership, shall conform to the standards of performance and maintenance established by the American Academy of Underwater Sciences. This equipment shall further be approved for use by the SDCB. Upon request, the SDC will provide a list of regulators and other equipment tested and found to function satisfactorily in polar waters. Any equipment issued to scientific divers by RPSC shall be issued, maintained, and certified by the SDC or other approved representative.

6.1. EQUIPMENT INSPECTION

All inspections, tests, maintenance, and record keeping referred to in this section must be performed by the SDC or other approved maintenance facility.

Record keeping - Each equipment modification, repair, test, calibration or maintenance service shall be logged. The logs shall include the date and nature of work performed, serial number of item and the name of the person performing the work for the following equipment:

Compressors	Submersible pressure gauges
Regulators	Depth gauges
Scuba cylinders	Cylinder valves
Diving helmets	Dive computers
Gas control panels	Air storage cylinders
Air filtration systems	Dry suits

6.1.1. Regulators and Dive Computers

- a. Approval - Only those makes and models specifically approved by the SDCB shall be used.
- b. Inspection and Testing - Scuba regulators and dive computers used in the scientific diving program shall be inspected and tested prior to their first use of the season and thereafter as necessary.
- c. At dive locations where no SDC or other approved equipment maintenance technician is available, dive teams must be prepared to provide pre- and post-dive care for their own regulators and dive computers, in accordance with these *Standards*. The PI or Lead Diver will be responsible for reporting problems, violations or other concerns to the SDC, who will be responsible for reporting to the NSF DSO.

6.1.2. Breathing Masks and Helmets

Breathing masks and helmets shall have:

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

- c. A minimum ventilation rate capable of maintaining the diver at the diving depth.

6.1.3. Auxiliary Equipment

- a. Approval - All auxiliary equipment shall be of a type approved by the SDCB.
- b. Air Cylinders - Scuba cylinders shall be designed, constructed and maintained in accordance with provisions of the applicable *Unfired Pressure Vessel Safety Orders*.
 - 1. Scuba cylinders must be hydrostatically tested in accordance with Department of Transportation (DOT) standards;
 - 2. Scuba cylinders in use must have an internal visual inspection prior to issue, and thereafter at intervals not to exceed twelve (12) months, or sooner if suspected of having internal moisture; and,
 - 3. Scuba cylinder valves shall be functionally tested at intervals not to exceed 12 months.
- c. Backpacks and Weight Systems - Backpacks and weight systems shall be regularly examined by the persons using them.
- d. Pressure gauges shall be inspected and tested prior to first use of the season, and thereafter as necessary.
- e. Quick Release Devices - When used in open water, all weight systems and scuba backpacks worn by the diver shall be equipped with quick release devices designed to permit jettisoning of the gear. The quick release device must operate easily with a single motion from either hand.
- f. Personal flotation systems, buoyancy compensators, dry suits or other variable volume buoyancy compensation devices shall be equipped with an over-pressure relief and emergency dump valve. These devices shall be functionally inspected and tested prior to first use of the season and thereafter as needed.
- g. First Aid Supplies
 - 1. Both oxygen and a first-aid kit adequate for the diving operation shall be available at the dive location.
 - 2. When used in a hyperbaric chamber or bell, the first-aid kit shall be suitable for use under hyperbaric conditions.
- h. Underwater Tools
 - 1. Hand-held electrical tools and equipment used underwater shall be specifically approved for this purpose; and,
 - 2. Hand-held electrical tools and equipment shall not be supplied with power to the dive location until requested by the diver.

6.2. BREATHING AIR MINIMAL STANDARDS

Breathing air for scuba shall meet Compressed Gas Association (CGA) Grade E air quality standards.

6.3. COMPRESSOR SYSTEMS

6.3.1. Design and Location of Compressor

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

6.3.2. Compressor Operation and Air Test Records

- a. Gas analyses and air tests shall be performed on breathing air compressors by the SDC or other approved representative at regular intervals of not more than 100 hours of operation or 6 months, whichever occurs first. The results of these tests shall be entered in a formal log and be maintained by the SDC.
- b. A log shall be maintained by the SDC or other approved representative showing operation, repair, overhaul, filter maintenance and temperature adjustment for each compressor.

6.4. OXYGEN SAFETY

- a. Equipment used with oxygen or mixtures containing over forty percent (40%) oxygen by volume shall be designed and maintained for oxygen service.
- b. Components (except umbilical) exposed to oxygen or mixtures containing over forty percent (40%) oxygen by volume shall be cleaned of flammable materials before being placed in service.
- c. Oxygen systems over 125 psig shall have slow-opening shut-off valves.

7.0 GLOSSARY

American Academy of Underwater Sciences (AAUS): The national association of scientific diving scientists, diving technicians, and diving safety officers, which is generally responsible for setting community diving standards for scientific diving.

Bottom Time: The total elapsed time (measured in minutes) from when the diver leaves the surface until the diver resurfaces.

Buddy Diver: Second member of the dive team.

Certified Diver: A diver who holds a current certification from an AAUS scientific diving program or recognized certifying agency.

Cylinder: A pressure vessel for storage of gases.

Decompression Sickness (DCS): A condition with a variety of symptoms that may result from gas and bubbles in the tissues of divers after pressure reduction. DCS can be caused by exceeding no-decompression limits or exceeding the prescribed rate of ascent.

Depth: The dive log should denote the maximum depth of the dive.

Depth Certification: The depth to which a diver is certified to dive.

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

Dive Computer: An electronic device for tracking depth and time and computing inert gas uptake and offgassing.

Dive Site: The physical location of a dive.

Dive Table: A profile or set of profiles of depth-time relationships, including their ascent rates, for particular breathing mixtures to be followed after a specific depth-time exposure or exposures (*syn.* Decompression Table).

Dive Team: Divers and support individuals who are exposed to or control the exposure of others to hyperbaric conditions.

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

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

Diving Safety Officer: Individual with scientific diving expertise responsible for advising NSF/OPP on scientific diving matters and authorizing divers and dive plans to dive under its aegis.

Dry Suit: An exposure suit, with airtight seals at the neck and wrists, which allows the introduction and exhaust of compressed air through valves and keeps the diver dry during the dive.

Hyperbaric: A condition defined by pressure greater than one atmosphere at sea level.

Lead Diver: A certified scientific diver with the experience and training to lead the diving operation.

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

No-Decompression Limits: The depth and time parameters of the "no-decompression limits and repetitive dive group designations table for no-decompression air dives" of the *US Navy Diving Manual*, or equivalent dive computer algorithm limits.

Principal Investigator: The scientist in charge of a science project, usually the senior scientist.

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 barotrauma.

Recompression Chamber: A pressure vessel for treatment of pressure-related dive accidents such as CAGE and DCS (*syn.* Hyperbaric Chamber).

Regulator: A device for delivering air from high pressure to ambient pressure, usually for breathing purposes.

Scientific Diving Control Board (SDCB): The group of individuals that act as an appointed body of expertise to NSF/OPP in all matters relating to scientific diving operations.

Scientific Diving: All diving performed by individuals necessary to and part of a scientific, research, or educational activity, in conjunction with a project or study under the jurisdiction of any public or private research or educational institution or similarly recognized organization, department, or group.

Scientific Diving Coordinator: Individual with scientific diving expertise and logistical responsibilities, employed by NSF/OPP Antarctic support contractor, coordinates closely with DSO and Health and Safety Officer.

SCUBA Diving (scuba): 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 in which the diver in the water is supplied from the surface with compressed gas for breathing, either from an air bank or from a compressor with volume tank.

Tender: A qualified person on the surface who is responsible for assisting and communicating with divers during a dive by various means, including a tether.

Tether: A line attached to a diver(s) to prevent their becoming lost underwater or under ice due to poor visibility or swift current. This is also a means of diver-to-surface communication.