Ames Procedural Requirements

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COMPLIANCE IS MANDATORY

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Baseline	1	2012	Originally created
Revision	2	7/13/17	Formatting, Sect. 5.8 added, Appendix E updated
Revision	3	10/18/17	Sect. 2.7.2, Ch 6, Appendix F-J updated
Revision	4	7/11/18	Formatted per 2018 APR Template
Revision	5	6/27/2023	Modifications to conform with 2018 AAUS Standards, updates to Chapter 6 (Medical) due to NPR 1800.1, and general edits per input from Diving Control Board.

TABLE OF CONTENTS

PREFACE

P.1 Purpose

P.2 Applicability

P.3 Authority

P.4 Applicable Documents and Forms

P.5 Measurement/Verification

P.6 Cancellation

CHAPTER 1 GENERAL POLICY

1.1 Scientific Diving Standards

1.2 Operational Control

1.3 Consequences of Violation of Regulations by Scientific Divers

1.4 Consequences of Violation of Regulations by NASA Ames

1.5 Record Maintenance

CHAPTER 2 DIVING REGULATIONS FOR SCUBA (OPEN CIRCUIT, COMPRESSED AIR)

2.1 Introduction

2.2 Pre-Dive Procedures

2.3 Diving Procedures

2.4 Post-Dive Procedures

2.5 Emergency Procedures

2.6 Flying After Diving or Ascending to Altitude (Over 1,000 Feet)

2.7 Recordkeeping and Requirements

CHAPTER 3 DIVING EQUIPMENT

3.1 General Policy

3.2 Equipment

3.3 Auxiliary Equipment

3.4 Support Equipment

3.5 Equipment Maintenance

3.6 Air Quality Standards

3.7 Remote Operations

CHAPTER 4 ENTRY-LEVEL TRAINING REQUIREMENTS

4.1 Evaluation

4.2 Scientific Skin Diving

4.3 SCUBA Training

CHAPTER 5 SCIENTIFIC DIVER CERTIFICATION

5.1 Certification Types

5.2 General Policy

5.3 Requirements for Scientific Diver Certification

5.4 Depth Certifications

5.5 Continuity of Certification

5.6 Revocation of Certification

CHAPTER 6 MEDICAL STANDARDS

6.1 General Requirements

6.2 Content of a Diver's Medical Evaluation

6.3 Information Provided to the Examining Physician

6.4 Frequency of Diver's Medical Evaluations

CHAPTER 7 OTHER DIVING TECHNOLOGIES

7.1 Dry suit Diving

7.2 Dive Computers

7.3 Altitude Diving

7.4 Rebreathers

APPENDIX A. DEFINITIONS

APPENDIX B. ACRONYMS

APPENDIX C. NASA AMES DIVING PROPOSAL FLOW

APPENDIX D. REQUEST FOR DIVING RECIPROCITY VERIFICATION OF DIVER TRAINING AND EXPERIENCE

APPENDIX E. NASA AMES DIVING CONTROL BOARD MEMBERSHIP

APPENDIX F. DIVER'S MEDICAL CLEARANCE FORM

APPENDIX G. CONDITIONS WHICH MAY DISQUALIFY CANDIDATES FROM DIVING

APPENDIX H. GUIDELINES FOR RECREATIONAL SCUBA DIVER'S PHYSICAL EXAMINATION (FROM NAUI MEDICAL STATEMENT IN COLLABORATION WITH RECREATIONAL SCUBA TRAINING COUNCIL AND THE UNDERSEA & HYPERBARIC MEDICAL SOCIETY, 2007)

APPENDIX I. DIVER'S MEDICAL HISTORY QUESTIONNAIRE

APPENDIX J. MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING (FROM AAUS STANDARDS FOR SCIENTIFIC DIVING, 2018)

APPENDIX K. DIVING EMERGENCY MANAGEMENT PROCEDURES

APPENDIX L. GUIDELINES FOR SCIENTIFIC SKIN DIVERS

APPENDIX M. AAUS STATISTICS COLLECTION CRITERIA AND DEFINITIONS

APPENDIX N. RECOMMENDATIONS FOR RESCUE OF SUBMERGED DIVER

PREFACE

P.1 PURPOSE

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

P.2 APPLICABILITY

a. This APR is applicable to all NASA Ames projects or sponsored projects utilizing NASA personnel, funding or equipment requiring scientific diving activities in any type of aquatic environment.

b. This directive applies to contractors, grant recipients, or parties to agreements only to the extent specified or referenced in the appropriate contracts, grants, or agreements.

c. In this directive, all mandatory actions (i.e., requirements) are denoted by statements containing the term "shall." The terms "may" or "can" denote discretionary privilege or permission, "should" denotes a good practice and is recommended, but not required, "will" denotes an expected outcome, and "are/is" denotes descriptive material.

d. In this directive, all document citations are assumed to be the latest version unless otherwise noted.

P.3 AUTHORITY

a. NPR 8715.3, NASA General Safety Program Requirements

b. NASA-STD-8719.10, Standard for Underwater Facility and Non-Open Water Operations

P.4 APPLICABLE DOCUMENTS AND FORMS

a. Scope and Application of Regulations for Commercial Diving Operations, 29 CFR §1910.401

b. NPD 1800.2, NASA Occupational Health Program

c. NPR 1800.1, NASA Occupational Health Program Procedures

d. AAUS Standards for Scientific Diving, 2018[1]

P.5 MEASUREMENT/VERIFICATION

a. Verification of conformance to requirements in this directive are measured through Center and Responsible Organizational management reviews, self-assessments, and subsequent analysis and reports of conformance to requirements, as well as periodic internal audits.

b. Annual diving statistics measured against reported incidents or accidents will determine document success.

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[1] AAUS Standards for Scientific Diving: https://www.aaus.org/diving_standards

P.6 CANCELLATION

APR 8715.4, Standards of Scientific Diving, dated July 11, 2018.

Eugene Tu
Director

DISTRIBUTION STATEMENT:

Internal and external distribution.

CHAPTER 1 GENERAL POLICY

1.1 Scientific Diving Standards

1.1.1 Purpose and Applicability

1.1.1.1 The purpose of these Scientific Diving Standards is to ensure that all scientific diving is conducted in a manner that will maximize protection of scientific divers from accidental injury and/or illness, and to set forth standards for training and certification that will allow a working reciprocity between scientific agencies. Fulfillment of the purposes shall be consistent with the furtherance of research and safety. This document sets requirements for NASA Ames Research Center that meet or exceed the minimum standards established by the American Academy of Underwater Sciences (AAUS) which details recognized scientific diving programs, the organization for the conduct of these programs, and the basic regulations and procedures for safety in scientific diving operations. It also establishes a framework for reciprocity between AAUS organizational members that adhere to these minimum standards.

1.1.1.2 The AAUS standard was developed 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.

1.1.1.3 In 1982, OSHA exempted scientific diving from commercial diving regulations (29 CFR Part 1910, 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). OSHA recognizes AAUS as the scientific diving standard setting organization. The NASA Ames Research Center (NASA Ames) has adopted these and additional standards, which extend this document, according to NASA relevant policies and procedures.

1.1.1.4 Mandatory compliance of these standards is required by all NASA Ames projects or sponsored projects, utilizing NASA personnel, funding or equipment, requiring scientific diving activities in any type of aquatic environment: fresh water, ocean, aquarium, or open water.

1.1.2 Scientific Diving Definition

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

1.1.3 Scientific Diving Exemption

1.1.3.1 OSHA has granted an exemption for scientific diving from commercial diving regulations under the following guidelines:

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

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

c. The tasks of a scientific diver are those of an observer and data gatherer. Construction and troubleshooting 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:

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

(2) Diving Control Board, with the majority of its voting 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, ensure compliance with the manual, certify the depths to which a diver has been trained, investigate instances of unsafe practices and forward any findings to appropriate supervisory officials for possible disciplinary action, and ensure adherence to the buddy system (a diver is accompanied by and is in continuous contact with another diver in the water) for scuba diving.

1.1.4 Review of Standards

As part of NASA Ames Diving Safety Program annual report, generated by the Diving Safety Officer, DSO, any recommendations for modifications of these standards shall be submitted to the AAUS and the Ames Diving Control Board (DCB) for consideration and approval.

1.2 Operational Control

1.2.1 NASA Ames Auspices Defined

For the purposes of these standards the auspices of NASA Ames includes any scientific diving operation in which NASA Ames is connected because the use of NASA equipment, personnel or associates, or funding. The administration of the local diving program will reside with NASA Ames DCB. The requirements herein shall be observed at all locations where scientific diving is conducted.

1.2.2 NASA Ames Scientific Diving Standards and Safety Manual

1.2.2.1 This APR provides for the development and implementation of policies and procedures that will enable NASA Ames to meet requirements of local environments and conditions as well as to comply with the AAUS scientific diving standards. This APR includes, but is not limited to:

a. The AAUS Standards shall be used as a set of minimal guidelines for the development of NASA Ames scientific diving safety manual.

b. Emergency evacuation and medical treatment procedures.

c. The criteria for diver training and certification.

d. Standards written or adopted by reference for diving modes utilized including the following:

(1) Safety procedures for the diving operation.

(2) Responsibilities of the dive team members.

(3) Equipment use and maintenance procedures.

(4) Emergency procedures.

1.2.3 **The Diving Safety Officer (DSO)**

1.2.3.1 The Diving Safety Officer (DSO) serves as a member and Chairman of the DCB. This person shall have broad technical and scientific expertise in research-related diving and shall:

a. Be appointed by NASA Ames Center Management, or his/her designee, with the advice and counsel of the DCB.

b. Be trained as a scientific diver.

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

(1) "Holds a diving instructor certification from a recognized national certifying agency or equivalent, and

(2) Has engaged in sustained or successive scientific diving activities during the past two years, or

(3) Has completed a course in scientific diving that meets the requirements as specified by the most current edition of the AAUS Standards for Scientific Diving."

1.2.3.2 Duties and Responsibilities

a. Shall be responsible, through the DCB, to the responsible administrative officer or designee, for the conduct of the scientific diving program of the membership organization. The routine operational authority for this program, including the conduct of training and certification, approval of dive plans, maintenance of diving records, and ensuring compliance with this standard and all relevant regulations of the membership organization, rests with the Diving Safety Officer.

b. May permit portions of this program to be carried out by a qualified delegate, with the approval of the DCB.

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

d. Shall suspend diving operations that he/she considers to be unsafe or unwise.

1.2.4 **The Diving Control Board (DCB)**

1.2.4.1 The DCB shall:

a. Consist of a majority of active scientific divers. Voting members shall include the Diving Safety Officer and should include other representatives of the diving program such as qualified divers and members selected by procedures established by NASA Ames,

b. Have autonomous and absolute authority over the scientific diving program's operation,

c. Approve and monitor diving projects,

d. Review and revise the diving safety manual,

e. Ensure compliance with the manual,

f. Certify the depths to which a diver has been trained,

g. Investigate instances of unsafe practices and notify the diver's immediate supervisor of the facts for possible disciplinary action,

h. Ensure adherence to the buddy system for scuba diving,

i. Act as the official representative of the membership organization in matters concerning the scientific diving program,

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

k. Recommend the issue, reissue, or the revocation of diving certifications,

l. Recommend changes in policy and amendments to NASA Ames and the AAUS scientific diving manual as the need arises,

m. Establish and/or approve training programs through which the applicants for certification can satisfy the requirements of NASA Ames diving safety manual,

n. Suspend diving programs that it considers to be unsafe,

o. Establish criteria for equipment selection and use,

p. Recommend new equipment or techniques,

q. Establish and/or approve facilities for the inspection and maintenance of diving and associated equipment,

r. Periodically review the Diving Safety Officer's performance and program,

s. Serve on a board of investigation implementing NASA Mishap Investigation Standards,

t. Establish NASA Ames regulations that meet or exceed current American Academy of Underwater Sciences, (AAUS) standards, as interpreted by the DCB, for all NASA scientific, diving activities,

u. Ensure that all NASA Ames Diving Operations meet all relevant community, state, federal, and international diving safety regulations and to make recommendations to the NASA Ames Diving Control Board concerning the management and safe operation of diving programs.

1.2.4.2 The DCB may delegate operational oversight for portions of the program to the DSO; however, the DCB may not abdicate responsibility for the safe conduct of the diving program.

Note: See Appendix E for DCB membership.

1.2.5 **Instructional Personnel**

1.2.5.1 All personnel involved in diving instruction under the auspices of NASA Ames shall be qualified for the type of instruction being given.

1.2.5.2 All personnel involved in diving instruction under the auspices NASA shall be reviewed and authorized by the DCB.

1.2.6 **Lead Diver**

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

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

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

c. Planning dives in accordance with section 2.2.1.

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

e. Suspending diving operations if in his/her opinion conditions are not safe.

f. Reporting to the DCB, through the DSO, any physical problems or adverse physiological effects including symptoms of pressure-related injuries.

g. Briefing the dive team members on:

(1) Dive objectives.

(2) Unusual hazards or environmental conditions likely to affect the safety of the diving operation.

(3) Modifications to diving or emergency procedures necessitated by the specific diving operation.

(4)

1.2.7 Reciprocity and Visiting Scientific Diver

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

1.2.7.2 A scientific diver from an organizational member shall apply for permission to dive under the auspices of another organizational member by submitting to the Diving Safety Officer of the host organizational member a document containing all the information described in Appendix D (letter of reciprocity), signed by the Diving Safety Officer.

1.2.7.3 A visiting scientific diver may be asked to demonstrate his/her knowledge and skills for the planned diving.

1.2.7.4 If a host organizational member denies a visiting scientific diver permission to dive, the host DCB shall notify the visiting scientific diver and his/her DCB with an explanation of all reasons for the denial.

1.2.8 Waiver of Requirements

The NASA Ames DCB may grant a waiver for specific requirements of training, examinations, depth certification, and minimum activity to maintain certification. AAUS medical standards may not be waived.

1.3 Consequences of Violation of Regulations by Scientific Divers

Failure to comply with the regulations of this APR may be cause for the revocation or restriction of the diver's scientific diving certificate by action of the NASA Ames DCB.

1.4 Consequences of Violation of Regulations by NASA Ames

Failure to comply with the regulations of this standard may be cause for the revocation or restriction of NASA Ames recognition by the AAUS.

1.5 Record Maintenance

1.5.1 The DSO shall maintain records for each individual scientific diver certified, which includes:

a. Evidence of certification level

b. Log sheets

c. Diving medical clearance

d. Waiver(s)

e. Reports of disciplinary actions by the NASA Ames DCB

f. Other pertinent information deemed necessary.

1.5.2 Availability of Records

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

1.5.2.2 Records and documents required by this standard shall be retained by NASA Ames for the following periods:

a. Physician's written reports of medical examinations for divers - duration per NASA record retention protocol.

b. Diving Medical Clearances - 5 years, by the DSO.

c. Manual for diving safety - current document only, by the DSO.

d. Records of dive - 1 year, except 5 years where there has been a mishap, by the DSO.

e. Equipment inspection and testing records - current entry or tag, or until equipment is withdrawn from service, by the DSO.

f. Pressure-related injury assessment - 5 years.

CHAPTER 2 DIVING REGULATIONS FOR SCUBA (OPEN CIRCUIT, COMPRESSED AIR)

2.1 Introduction

No person shall engage in scientific diving operations under the auspices of NASA Ames scientific diving program unless he/she holds a current certification issued pursuant to the provisions of this standard.

2.2 Pre-Dive Procedures

2.2.1 Diving Project Proposal, Appendix C

2.2.1.1 Dives must be planned around the competency of the least experienced diver. Before conducting any diving operations under the auspices of NASA Ames, the lead diver for a proposed operation must formulate and submit a dive proposal to the DCB or designee, at least one month prior to the project start, which includes (Reference Appendix C for Dive Proposal Process Flow):

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

b. Approximate number of proposed dives

c. Location(s) of proposed dives

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

e. 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

f. Available means of transport

g. In water details of the dive plan should include:

(1) Dive Buddy assignments and tasks

(2) Goals and objectives

(3) Maximum depth(s) and bottom time

(4) Gas management plan

(5) Entry, exit, descent and ascent procedures

(6) Perceived environmental and operational hazards and mitigations

(7) Emergency and diver recall procedures

2.2.2 Pre-Dive Briefings

2.2.2.1 Before conducting any diving operations under the NASA auspices, the Lead Diver shall brief team members on:

a. Dive Buddy assignments and tasks

b. Dive objectives.

c. Maximum depth(s) and bottom time

d. Return pressure and target minimum surfacing pressure

e. Entry, exit, descent and ascent procedures

f. Perceived environmental and operational hazards and mitigations

g. Emergency and diver recall procedures

h. Reminder of Diver's Responsibility and Equipment Checks (Sec. 2.2.3)

2.2.3 Pre-Dive Safety Checks

2.2.3.1 Diver's Responsibility:

a. It is the diver's responsibility and duty to refuse to dive if, in his/her judgment, conditions are unfavorable, or if he/she would be violating the precepts of his/her training, or NASA Ames diving manual.

b. 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.

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

2.2.3.2 Equipment Evaluations

a. Each diver shall ensure that his/her equipment is in proper working order and that the equipment is suitable for the type of diving operation.

b. Each diver shall conduct a functional check of his/her diving equipment in the presence of the diving buddy or tender.

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

2.2.4 Site Evaluation

The environmental conditions at the site will be evaluated by the senior diver, lead or assigned Dive Master. Criteria to be evaluated shall include, but not limited to, environmental, site safety, weather, etc.

2.3 Diving Procedures

2.3.1 Solo Diving Prohibition

2.3.2 Decompression Management

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

2.3.2.2 A safety stop performed during the ascent phase of the dive should be conducted on any dive that exceeds 30fsw (9.09m).

2.3.3 Termination of the Dive

2.3.3.1 It is the responsibility of the diver to terminate the dive, without fear of penalty, whenever he/she feels it is unsafe to continue the dive, unless it compromises the safety of another diver already in the water (reference Section 2.22).

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

2.3.4 Emergencies and Deviations from Regulations

Any diver may deviate from the requirements of this manual to the extent necessary to prevent or minimize a situation that is likely to cause death, serious physical harm, or major environmental damage. A written report of such actions must be submitted to the DSO explaining the circumstances and justifications. The DSO shall comply with NASA Ames policy for mishap reporting and investigating.

2.4 Post-Dive Procedures

2.4.1 Post-Dive Safety Checks

2.4.1.1 After the completion of a dive, each diver shall report any physical problems, symptoms of decompression sickness, or equipment malfunctions to the Lead Diver, DSO, and/or DCB.

2.4.1.2 When diving outside the no-decompression limits, the divers should remain awake for at least one hour after diving, and in the company of a dive team member who is prepared to transport him/her to a hyperbaric chamber if necessary.

2.5 Emergency Procedures

Each dive project leader will develop emergency procedures, which follow the standards of care of the community and must include procedures for emergency care, recompression and evacuation for each dive location.

2.6 Flying After Diving or Ascending to Altitude (Over 1,000 Feet)

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

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

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

2.6.4 Before ascending to Altitude above 300 m (1000 feet) by Land Transport: Divers should follow the appropriate guideline for preflight surface intervals unless the decompression procedure used has accounted for the increase in elevation.

2.7 Recordkeeping and Requirements

2.7.1 Logging Dives

2.7.1.1 Each certified scientific diver shall log every dive made under the auspices of the NASA Ames program, and is encouraged to log all other dives. Copies of dive logs shall be submitted monthly to the Diving Safety Officer. These dive logs may be electronic and/or online as specified by the DSO.

2.7.1.2 Dive logs shall include:

a. Name of diver, partner, and Lead Diver.

b. Date, time, and location.

c. Diving modes used.

d. General nature of diving activities.

e. Approximate surface and underwater conditions.

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

g. Diving tables or computers used.

h. Detailed report of any near or actual mishaps.

Note 1: A mishap is defined (in NPR 8621.1) as an unplanned event resulting in at least one of the following:

- *Occupational injury or occupational illness to non-NASA personnel caused by NASA operations or NASA-funded research and development projects.*
- *Occupational injury or occupational illness to NASA personnel caused by NASA operations or NASA-funded research and development projects.*
- *Destruction of or damage to NASA property, public or private property, including foreign property, caused by NASA operations or NASA-funded research and development projects.*
- *NASA mission failure before the scheduled completion of the planned primary mission.*

Note 2: NASA Mishaps can be categories into the following types:

- *Type A Mishap: An occupational injury and/or illness that resulted in a fatality, a permanent total disability, or the hospitalization for inpatient care of 3 or more people within 30 workdays of the mishap. Or total direct cost of mission failure and property damage is $1,000,000 or more.*
- *Type B Mishap: An occupational injury and/or illness have resulted in permanent partial disability or the hospitalization for inpatient care of 1-2 people within 30 workdays of the mishap. Or the total direct cost of mission failure and property damage of at least $250,000 but less than $1,000,000.*
- *Type C Mishap: A nonfatal occupational injury or illness that caused any workdays away from work, restricted duty, or job transfer to another job beyond the workday or shift on which it occurred. Or the total direct cost of mission failure and property damage of at least $25,000 but less than $250,000.*
- *Type D Mishap: Any nonfatal OSHA recordable (more than first aid) occupational injury and/or illness that does not meet the definition of a Type*

C mishap. Or the total direct cost of mission failure and property damage of at least $1,000 but less than $25,000.

- *Close Call: An event in which there is no injury or only minor injury requiring first aid and/or no equipment/property damage or minor equipment/property damage (less than $1000), but which possesses a potential to cause a mishap.*

2.7.2 Required Mishap Reporting

2.7.2.1 All mishaps and close calls must be reported as per the call list below. Any Class A mishap or injury requiring recompression treatment must be reported immediately; any Class B, C, or D mishap or close call must be reported within twenty-four (24) hours.

2.7.2.2 Mishap call list:

a. NASA ARC Emergency Dispatch: 650-604-5555 (staffed 24/7)

b. Ames DSO Bruce Storms: 650-604-1356, bruce.l.storms@nasa.gov

c. Ames Safety office (650) 604-5602

d. The diver's immediate supervisor.

2.7.2.3 In addition, the Lead Diver during the mishap (or DSO as alternate) shall report all mishaps and close calls within twenty-four (24) hours using the NASA Mishap Information System: https://nmis.sma.nasa.gov/

2.7.2.4 The NASA Ames DSO shall forward mishap details to the AAUS as part of the annual reporting requirement.

CHAPTER 3 DIVING EQUIPMENT

3.1 General Policy

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

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

3.2 Equipment

3.2.1 Regulators

3.2.1.1 Approval: Only those makes and models specifically approved by the DSO shall be used.

3.2.1.2 Inspection and testing: Scuba regulators shall be inspected and tested prior to first use and every twelve months thereafter.

3.2.1.3 Standard open-circuit regulator configuration is:

a. A first stage

b. Primary 2nd stage

c. Back up 2nd stage

d. Submersible Pressure Gauge (SPG)

e. Inflator hose for a Buoyancy Compensator Device

3.2.2 Breathing Masks and Helmets

3.2.2.1 Breathing masks and helmets shall have:

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

b. An exhaust valve.

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

3.2.3 Scuba Cylinders

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

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

3.2.3.3 Scuba cylinders must have an internal inspection at intervals not to exceed twelve months.

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

3.2.4 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.

3.2.5 Gauges

3.2.6 Flotation Devices

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

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

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

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

3.2.7 Timing Devices, Depth, and Pressure Gauges

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

3.2.8 Determination of Decompression Status: Dive Tables, Dive Computers

3.2.8.1 A set of diving tables, approved by the DSO, must be available at the dive location.

3.2.8.2 Dive computers may be utilized in place of diving tables. Before using a dive computer, NASA Ames Scientific Divers must successfully complete the NASA Ames Dive Computer exam. The DSO must approve dive computers. AAUS recommendations on dive computers are available at http://www.aaus.org. At no time should the remaining time displayed at depth be less than 10 minutes.

3.3 Auxiliary Equipment

3.3.1 Hand Held Underwater Power Tools

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

3.4 Support Equipment

3.4.1 First Aid Supplies

A first aid kit and emergency oxygen shall be available at the dive site when breathing compressed gases. For scientific skin diving, only a first aid kit is required.

3.4.2 Diver’s Flag

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

3.4.3 Compressor Systems – Organizational Member Controlled

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

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

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

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

3.5 Equipment Maintenance

3.5.1 Recordkeeping

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

a. Regulators

b. Submersible pressure gauges

c. Depth gauges

d. Scuba cylinders

e. Cylinder valves

f. Diving helmets

g. Submersible breathing masks

h. Compressors

i. Gas control panels

j. Air storage cylinders

k. Air filtration systems

l. Analytical instruments

m. Buoyancy control devices

n. Dry suits

3.5.3 Compressor Operation and Air Test Records

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

3.5.3.2 A log shall be maintained showing operation, repair, overhaul, filter maintenance, and

3.5.3.3 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).

Table 3. CGA Pamphlet G-7.1 Breathing Air for Scuba

CGA Grade	
Component	**Maximum**
Oxygen	20 – 22%/v
Carbon Monoxide	10 PPM/v
Carbon Dioxide	1000 PPM/v
Condensed Hydrocarbons	5 mg/m3
Total Hydrocarbons as Methane	25 PPM/v
Water Vapor	2 PPM*
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.*

3.7 Remote Operations

For remote site operations using gas sources not controlled by the OM, every effort should be made to verify breathing gas meets the requirements of this standard. If CGA Grade E gas is not verifiable, the DCB shall develop a protocol to mitigate risk to the diver.

CHAPTER 4 ENTRY-LEVEL TRAINING REQUIREMENTS

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

4.1 Evaluation

4.1.1 Medical Evaluation

4.1.1.1 Applicants for training involving diving with SCUBA or supplied-surface air shall be certified by a qualified physician (i.e., a physician who has been trained in diving medicine, such as a physician certified in occupational medicine, aviation medicine, or hypo/hyperbaric medicine) to be medically fit for diving activities (See Chapter 6.) before proceeding with the training. A diver's medical evaluation is not required to test swimming skills that may be required as a prerequisite for diving classes.

4.1.1.2 A current Diver's Medical Clearance Form must be provided to the DSO by all divers and divers-in-training.

4.1.1.3 An exclusion exists for the entry-level skin diving class.

4.1.2 Swimming Evaluation

4.1.2.1 The applicant for training shall successfully perform the following tests, or their equivalent, in the presence of the DSO or an examiner approved by the DSO:

a. Swim underwater without swim aids for a distance of 25 yards without surfacing.

b. Swim 400 yards in less than 12 minutes without swim aids.

c. Tread water for 10 minutes, or 2 minutes without the use of hands, without swim aids.

d. Without the use of swim aids, transport another person of equal size a distance of 25 yards in the water.

4.2 Scientific Skin Diving

4.2.1 Divers planning to use Skin Diving as their mode of data collection must have prior approval of the DSO and DCB.

4.2.2 Practical Training

At the completion of training, the trainee must satisfy the DSO or the instructor of his/her ability to perform the following, as a minimum, in a pool or in sheltered water as defined in Appendix L.

4.3 SCUBA Training

4.3.1 Practical Training

4.3.1.1 At the completion of training, the trainee must satisfy the DSO or the instructor of his/her ability to perform the following, as a minimum, in a pool or in sheltered water:

a. Enter water with full equipment.

b. Clear facemask.

c. Demonstrate air sharing, including both buddy breathing and the use of alternate air source, as both donor and recipient, with and without a facemask.

d. Demonstrate ability to alternate between snorkel and scuba while kicking.

e. Demonstrate understanding of underwater signs and signals.

f. Demonstrate simulated in-water mouth-to-mouth resuscitation.

g. Rescue and transport, as a diver, a passive simulated victim of an accident.

h. Demonstrate ability to remove and replace equipment while submerged.

i. Demonstrate waterman ship ability that is acceptable to the instructor.

4.3.2 Written Examination

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

a. Function, care, use, and maintenance of diving equipment.

b. Physics and physiology of diving.

c. Diving regulations and precautions.

d. Near-shore currents and waves.

e. Dangerous marine animals.

f. Emergency procedures, including buoyant ascent and ascent by air sharing.

g. Currently accepted decompression procedures.

h. Demonstrate the proper use of dive tables.

i. Underwater communications.

j. Aspects of freshwater and altitude diving.

k. Hazards of breath-hold diving and ascents.

l. Planning and supervision of diving operations.

m. Diving hazards.

n. Cause, symptoms, treatment, and prevention of the following: near drowning, air embolism, carbon dioxide excess, squeezes, oxygen poisoning, nitrogen narcosis, exhaustion and panic, respiratory fatigue, motion sickness, decompression sickness, hypothermia, and hypoxia/anoxia.

4.3.3 Open Water Evaluation

4.3.4 The trainee must satisfy an instructor, approved by the DSO, of his/her ability to perform at least the following in open water:

a. Surface dive to a depth of 10 feet in open water without scuba.

b. Demonstrate proficiency in air sharing, including both buddy breathing and the use of alternate air source, as both donor and receiver.

c. Enter and leave open water or surf, or leave and board a diving vessel, while wearing scuba gear.

d. Kick on the surface 400 yards while wearing scuba gear, but not breathing from the scuba unit.

e. Demonstrate judgment adequate for safe diving.

f. Demonstrate, where appropriate, the ability to maneuver efficiently in the environment, at and below the surface.

g. Complete a simulated emergency swimming ascent

h. Demonstrate clearing of mask and regulator while submerged.

i. Demonstrate ability to achieve and maintain neutral buoyancy while submerged.

j. Demonstrate techniques of self-rescue and buddy rescue.

k. Navigate underwater.

l. Plan and execute a dive.

m. Successfully complete 5 open water dives for a minimum total time of 3 hours, of which 1.5 hours cumulative bottom time must be on scuba. No more than 3 training dives shall be made in any one-day.

CHAPTER 5 SCIENTIFIC DIVER CERTIFICATION

5.1 Certification Types

5.1.1 Scientific Diver Certification

Scientific diver certification signifies a diver has completed all requirements in Section 5.3 and is certified by the NASA to engage in scientific diving without supervision, as approved by the DCB through the DSO. Submission of documents and participation in aptitude examinations does not automatically result in certification. To be certified, the applicant must demonstrate to the DCB, through the DSO, that s/he is sufficiently skilled and proficient, and possess the necessary judgement for their safety and/or that of the dive team. Scientific Diver Certification is only active when required authorizations are in place and current.

5.1.2 Temporary Diver Authorization

5.1.2.1 Only a diver not under the auspices of NASA may be granted a Temporary Diver Authorization. This permit constitutes a waiver of the requirements of Section 5.00 and is issued only following a demonstration of the required proficiency in diving. It is valid only for a limited time, as determined by the DCB. This permit is not to be construed as a mechanism to circumvent existing standards set forth in this standard.

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

5.1.3 Scientific Skin Diver

A scientific skin diver is a diver who has at least met the guidelines outlined in Appendix L and has had specific skin diving orientation and who is diving solely as a skin diver.

5.2 General Policy

5.2.1 The AAUS requires that no person shall engage in scientific diving unless that person is authorized by NASA Ames pursuant to the provisions of this manual. The following are considered minimal standards for a scientific diver certification. Only a person diving under the auspices of an organization that subscribes to the practices of the AAUS is eligible for a scientific diver certification.

5.3 Requirements for Scientific Diver Certification

5.3.1 Submission of documents and participation in aptitude examinations does not automatically result in certification. The applicant must convince the DSO that he/she is sufficiently skilled and proficient to be certified. The signature of the DSO will acknowledge this skill. Any applicant who does not possess the necessary judgment, under diving conditions, for the safety of the diver and his/her partner, may be denied NASA Ames scientific diving privileges. Minimum documentation and examinations required are provided in the following sections.

5.3.2 Prerequisites

5.3.2.1 NASA Ames application for certification.

5.3.2.2 Medical approval - Each applicant must submit a Diver's Medical Clearance Form indicating that the diver is medically fit for diving activities (see Section 6).

5.3.2.3 Diver-In-Training (DIT) Permit - This permit signifies that a diver has been certified as at least an open water/basic diver and a Rescue Diver through a nationally or internationally recognized certifying agency, and has been approved by the DCB. DIT status must only be used when the diver is on his/her way to becoming certified as a scientific diver. While it is recommended for DIT's to have hands-on scientific diver experience during their training, the DIT status is intended to be a temporary authorization, not a substitute for Scientific Diver Certification.

5.3.2.4 Emergency Care Training The trainee must provide proof of current training in the following:

a. Cardiopulmonary resuscitation (CPR).

b. Emergency oxygen administration.

c. Standard first aid for diving accidents (see OSHA Instruction CPL 2-2.53, Jan. 7, 1991).

5.3.3 Training

5.3.3.1 The candidate must successfully complete prerequisites, theoretical aspects, practical training, and examinations for a minimum cumulative time of 100 hours and a minimum of 12 open water dives. Theoretical aspects shall include principles and activities appropriate to the intended area of scientific study. Formats for meeting the 100 hour training requirement include NASA-developed formalized training course, or a combination of formalized and on the job training. Training topics are listed below.

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

5.3.3.3 Any candidate who does not convince the DCB, through the DSO, that they possess the necessary judgment, under diving conditions, for the safety of the diver and his/her buddy, may be denied OM scientific diving privileges.

5.3.3.4 .

5.3.3.5 Required Topics (include, but not limited to):

a. Diving Emergency Care Training

(1) Cardiopulmonary Resuscitation (CPR)

(2) Recognition of DCS and AGE

(3) Accident Management

(4) Field Neurological Exam

(5) Oxygen Administration

b. Dive Rescue

c. Dive Physics

d. Dive Physiology

e. Dive Environments

f. Decompression Theories and its Application

g. AAUS Scientific Diving Regulations and History

(1) Scientific Dive Planning

(2) Coordination with other Agencies

(3) Appropriate Governmental Regulations

h. Scientific Method

i. Data Gathering Techniques (Only items specific to area of study are required)

(1) Quadrating

(2) Transecting

(3) Mapping

(4) Coring

(5) Photography

(6) Tagging

(7) Collecting

(8) Animal Handling

(9) Archaeology

(10) Common Biota

(11) Organism Identification

(12) Behavior

(13) Ecology

(14) Site Selection, Location, and Re-location

(15) Specialized Equipment for data gathering

j. Cylinder Safety Training

(1) HP Cylinders

(2) Chemical Hygiene, Laboratory Safety (Use Of Chemicals)

5.3.3.6 Suggested Topics (include, but not limited to):

a. Specific Dive Modes (methods of gas delivery)

(1) Open Circuit

(2) Hookah

(3) Surface Supplied diving

b. Small Boat Operation

c. Rebreathers

(1) Closed

(2) Semi-closed

d. Specialized Breathing Gas

(1) Nitrox

(2) Mixed Gas

e. Specialized Environments and Conditions

(1) Blue Water Diving,

(2) Ice and Polar Diving (Cold Water Diving)

(3) Zero Visibility Diving

(4) Polluted Water Diving,

(5) Saturation Diving

(6) Decompression Diving

(7) Overhead Environments

(8) Aquarium Diving

(9) Night Diving

(10) Kelp Diving

(11) Strong Current Diving (Live-boating)

(12) Potential Entanglement

f. Specialized Diving Equipment

(1) Full Face Mask

(2) Dry Suit

(3) Communications

5.3.3.7 Practical training must include a checkout dive with evaluation of the skills listed in Section 4.23 with the DSO or qualified delegate followed by at least 11 ocean or open water dives in a variety of dive sites and diving conditions, for a cumulative bottom time of 6 hours. A certified Scientific Diver must supervise Dives following the checkout dive with experience in the type of diving planned, with the knowledge and permission of the DSO.

5.3.3.8 Examinations

a. Written examination

(1) General exam required for scientific diver certification.

(2) Examination covering the suggested topics at the DSO's discretion.

b. Examination of equipment.

(1) Personal diving equipment

(2) Task specific equipment

5.4 Depth Certifications

5.4.1 Progression to Next Depth Level

A certified diver diving under the auspices of NASA Ames may exceed his/her depth certification only if accompanied by a diver certified to a greater depth. Under these circumstances the diver may exceed his/her depth limit by one step.

5.4.2 Depth Certification Levels and Progression to Next Depth Level

5.4.2.1 A certified diver diving under the auspices of the organizational member may progress to the next depth level after successfully completing the required dives for the next level. Under these circumstances the diver may exceed their depth limit.

5.4.2.2 Dives shall be planned and executed under close supervision of a diver certified to this depth, with the knowledge and permission of the DSO.

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

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

c. Certification to 100 Foot Depth - A diver holding a 60 foot certificate may be certified to a depth of 100 feet after successfully completing, 6 dives to depths between 61 and 100 feet. The diver shall also demonstrate proficiency in the use of the appropriate decompression profiling method.

d. Certification to 130 Foot Depth - A diver holding a 100 foot certificate may be certified to a depth of 130 feet after successfully completing, 6 dives to depths between 100 and 130 feet. The diver shall also demonstrate proficiency in the use of the appropriate Dive Tables.

e. Certification to 150 Foot Depth - A diver holding a 130 foot certificate may be certified to a depth of 150 feet after successfully completing, 6 dives to depths between 130 and 150 feet. The diver must also demonstrate knowledge of the special problems of deep diving, and of special safety requirements.

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

5.4.3 Diving on air is not permitted beyond a depth of 190 feet.

5.5 Continuity of Certification

5.5.1 Minimum Activity to Maintain Certification

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

5.5.2 Re-qualification of Depth Certificate

Once the initial certification requirements of Section 5.30 are met, divers whose depth certification has lapsed due to lack of activity may be re-qualified by procedures adopted by the DCB.

5.5.3 Medical Evaluation

5.5.3.1 All certified scientific divers shall have a periodic medical evaluation (See Section 6).

5.5.3.2 A medically cleared diver experiencing any Conditions Which May Disqualify Candidates From Diving (Appendix G) shall receive clearance to return to diving from a qualified physician before resuming diving activities. This medical examination requirement cannot be waived for any diver.

5.5.4 Emergency Care Training

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

a. Adult CPR (must be current).

b. Emergency oxygen administration (must be current)

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

5.6 Revocation of Certification

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

5.6.2 Restrictions or suspensions issued by the DSO may be rescinded by the DSO; these issues will be reported to and reviewed by the DCB.

5.6.3 Violations of regulations set forth in this manual, or other governmental subdivisions not in conflict with this manual, may be considered cause.

5.6.4 The DCB or designee shall inform the diver in writing of the reason(s) for revocation. The diver will be given the opportunity to present his/her case in writing for reconsideration and/or recertification. All such written statements and requests, as identified in this section, are formal documents that will become part of the diver's file.

5.6.5 If a diver's certificate expires or is revoked, he/she may be recertified after complying with such conditions as the DCB may impose.

CHAPTER 6 MEDICAL STANDARDS

6.1 General Requirements

6.1.1 All NASA divers, including civil servants, contractors, and students, are required to have a diver's medical evaluation prior being assigned work-related diving activities. Ames Civil Servants may get a diver's medical evaluation from the Ames Health Unit physician or from a qualified physician of their choosing. Contractors should follow their contract procedures in order to obtain a diver's medical evaluation. Students should work with their mentors to identify how they may obtain a diver's medical evaluation.

6.1.2 Based on the results of the diver's medical evaluation, the physician will make a medical clearance determination, documenting whether the diver is medically fit to engage in diving activities, or whether there are medical limitations or restrictions to diving activities. The determination should be communicated in writing, such as with the Ames Health Unit Diver's Medical Clearance Form (Appendix F).

6.1.3 To be medically fit, a diver should be free of any conditions which may disqualify candidates from diving (Appendix G).

6.1.4 Once a determination is made, the Ames Health Unit will provide the Medical Clearance Form to the diver and will forward a copy of the Form to the diver's supervisor and DSO. (Determinations made by non-NASA physicians should be provided to the Ames Health Unit, who will enter the documentation to the diver's medical record and forward a copy of the Form to the diver's supervisor and DSO.)

6.2 Content of a Diver's Medical Evaluation

6.2.1 A diver's medical evaluation shall be conducted in accordance with clinical best practices, NASA Procedural Requirements (i.e. NPR 1800.1), and guidelines from the Undersea and Hyperbaric Medical Society (Appendix H).

6.2.2 Each evaluation must include a Diving Medical History Questionnaire (Appendix I) and a diver's physical examination.

6.2.3 The content of the diver's physical examination should be appropriately selected to address the diver's individual risk(s) and should meet the Scientific Diver requirements of the American Academy of Underwater Sciences (Appendix J).

6.3 Information Provided to the Examining Physician

The NASA Ames Diving Safety Program shall provide a copy of the medical evaluation requirements (Appendix F – J) for the diver to present to the examining physician.

6.4 Frequency of Diver's Medical Evaluations

6.4.1 A diver's medical evaluation must be completed before a diver may be assigned or begin diving activities.

6.4.2 A diver's medical evaluation must be completed no less often than annually.

6.4.3 A physician may rely on medical test results done within the preceding six (6) months, if the diver's health status has not changed substantially since the time of the test, and if the physician believes the test results still provide an accurate assessment of the diver's current health status.

6.4.4 A diver's medical evaluation must be completed before a diver may return to diving activities following any major injury, any major illness, or any condition requiring hospitalization. If the injury, illness, or condition is pressure-related, the evaluation must be done by a qualified physician trained in diving medicine (e.g., a physician certified in occupational, aerospace, or hypo/hyperbaric medicine).

CHAPTER 7 OTHER DIVING TECHNOLOGIES

The NASA Ames Diving Program recognizes requirements for other advanced technologies may be identified. Examples of those technologies are listed below and are not all-inclusive. All Diving Project Plans requiring these advanced technologies will be review and evaluated by the DCB, and if approved will develop special training programs to support the dive plan.

7.1 Dry Suit Diving

7.1.1 Divers planning to use dry suits must have specialized training and prior approval of the DCB.

7.1.2 This training must be obtained by a certified agency.

7.1.3 All special training certifications must be logged with the DSO.

7.2 Dive Computers

7.2.1 All NASA Ames divers using dive computers while diving under the auspices of NASA Ames shall complete a dive computer exam administered by the DSO. Maximum time allowed at depth as displayed by the computer shall not be less than 10 minutes.

7.2.2 Dive computer guidelines are as follows:

a. Only those makes and models of dive computers specifically approved by the Diving Control Board may be used.

b. Any diver desiring the approval to use a dive computer as a means of determining decompression status must apply to the Diving Control Board, complete an appropriate practical training session and pass a written examination.

c. Each diver relying on a dive computer to plan dives and indicate or determine decompression status must have his/her own unit.

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

e. If the dive computer fails at any time during the dive, the dive must be terminated and appropriate surfacing procedures should be initiated immediately.

f. A diver should not dive for 18 hours before activating a dive computer to use it to control their diving.

g. Once the dive computer is in use, it must not be switched off until it indicates complete out gassing has occurred or 18 hours have elapsed, whichever comes first.

h. When using a dive computer, non-emergency ascents are to be at a rate specified for the make and model of dive computer being used.

i. Whenever practical, divers using a dive computer should make a stop between 10 and 30 feet for 5 minutes, especially for dives below 60fsw or 62ffw.

j. Multiple deep dives require special consideration.

7.3 Altitude Diving

Divers planning to dive at sites with elevations greater than 300 meters must have specialized training (reference NOAA Dive Manual, Chapter 4) and prior approval of the DCB.

7.4 Rebreathers

7.4.1 No diver shall use a rebreather without prior review and approval of the DCB.

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

a. Training and/or experience verification requirements for authorization

b. Equipment requirements

c. Operational requirements and additional safety protocols to be used

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

7.4.4 For rebreather dives that also involve staged decompression and/or mixed gas diving, all requirements for each of the relevant diving modes shall be met. Diving Control Board reserves the authority to review each application of all specialized diving modes, and include any further requirements deemed necessary beyond those listed here on a case-by-case basis. In all cases, trainers shall be qualified for the type of instruction to be provided. Training shall be conducted by agencies or instructors approved by DSO and DCB.

7.4.5 Definitions and General Information

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

a. 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.

b. 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").

c. 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.

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

7.4.5.3 Semi-Closed Circuit Rebreathers. Semi-closed circuit rebreathers (SCR) recycle the majority of exhaled breathing gas, venting a portion into the water and replenishing it with a constant or variable amount of a single oxygen-enriched gas mixture. Gas addition and venting is balanced against diver metabolism to maintain safe oxygen levels by means which differ between SCR models, but the mechanism usually provides a semi-constant fraction of oxygen (FO2) in the breathing loop at all depths, similar to open-circuit SCUBA.

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

7.4.6 Prerequisites

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

7.4.6.2 Training Prerequisites

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

b. Completion of a minimum of 50 open-water dives on SCUBA.

c. For SCR or CCR, a minimum 100-fsw-depth qualification is generally recommended, to ensure the diver is sufficiently conversant with the complications of deeper diving. If the sole expected application for use of rebreathers is shallower than this, a lesser depth qualification may be allowed with the approval of the DCB.

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.

7.4.6.3 Classroom Training

a. 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.

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

c. 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:

(a) Hyperoxia (CNS and Pulmonary Oxygen Toxicity)

(b) Middle Ear Oxygen Absorption Syndrome (oxygen ear)

(c) Hyperoxia-induced myopia

(d) Hypoxia

(e) Hypercapnia

(f) Inert gas narcosis

(g) Decompression sickness

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

(a) System design and operation, including:

(b) Counterlung(s)

(c) CO2 scrubber

(d) CO2 absorbent material types, activity characteristics, storage, handling and disposal

(e) Oxygen control system design, automatic and manual

(f) Diluent control system, automatic and manual (if any)

(g) Pre-dive set-up and testing

(h) Post-dive break-down and maintenance

(i) Oxygen exposure management

(j) Decompression management and applicable decompression tracking methods

(k) Dive operations planning

(l) Problem recognition and management, including system failures leading to hypoxia, hyperoxia, hypercapnia, flooded loop, and caustic cocktail

(m) Emergency protocols and bailout procedures

7.4.6.4 Practical Training (with model of rebreather to be used)

Table 7-1. 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 20fsw.

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

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

a. Amount of required in-water time should increase proportionally to the complexity of rebreather system used.

b. Training shall be in accordance with the manufacturer's recommendations.

7.4.6.5 Practical Evaluations

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

(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:

(13) System malfunction recognition and solution

(14) Manual system control

(15) Flooded breathing loop recovery (if possible)

(16) Absorbent canister failure

(17) Alternate bailout options

(18) Symptom recognition and emergency procedures for hyperoxia, hypoxia, and hypercapnia

(19) Proper system maintenance, including:

(20) Full breathing loop disassembly and cleaning (mouthpiece, check-valves, hoses, counterlung, absorbent canister, etc.)

(21) Oxygen sensor replacement (for SCR and CCR)

(22) Other tasks required by specific rebreather models

7.4.6.6 Written Evaluations

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

b. Supervised Rebreather Dives

c. 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.

d. Supervisor for these dives should be the DSO or designee, and should be an active scientific diver experienced in diving with the make/model of rebreather being used. Dives at this level may be targeted to activities associated with the planned science diving application. See the following table for number and cumulative water time for different rebreather types.

Table 7-2. 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 20fsw.

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

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

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

7.4.6.7 Extended Range, Required Decompression, and Helium-Based Inert Gas

a. Rebreather dives involving operational depths in excess of 130fsw, requiring staged decompression, or using diluents containing inert gases other than nitrogen are subject to additional training requirements, as determined by DCB on a case-by-case basis. Prior experience with required decompression and mixed

gas diving using open-circuit SCUBA is desirable, but is not sufficient for transfer to dives using rebreathers without additional training.

b. 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 100fsw to 130fsw range.

c. 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 130fsw.

d. Training shall be in accordance with standards for required-decompression and mixed gas diving, as applicable to rebreather systems, starting at the 130fsw level.

7.4.6.8 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 130fsw, practicing decompression protocols.

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

7.4.7 Equipment Requirements

7.4.7.1 General Requirements

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

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

c. Unit performance specifications should 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 should supply the DCB with supporting documentation detailing the methods of specification determination by a recognized third-party testing agency, including unmanned and manned testing. Test data should be from a recognized, independent test facility.

e. The following documentation for each rebreather model to be used should be available as a set of manufacturer's specifications. These should 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 PPO2 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

(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.

7.4.7.2 Minimum Equipment

A surface/dive valve in the mouthpiece assembly, allowing sealing of the breathing loop from the external environment when not in use. An automatic gas addition valve, so that manual volumetric compensation during descent is unnecessary. Manual gas addition valves, so that manual volumetric compensation during descent and manual oxygen addition at all times during the dive are possible. 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.

7.4.7.3 Oxygen Rebreathers

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

7.4.7.4 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.

7.4.7.5 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.

7.4.8 Operational Requirements

7.4.8.1 General Requirements

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

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

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

d. Rebreather maintenance is to be in compliance with manufacturer's recommendations including sanitizing, replacement of consumables (sensors, CO2 absorbent, gas, batteries, etc.) and periodic maintenance.

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

(1) Information about the specific rebreather model to be used

(2) Make, model, and type of rebreather system

(3) Type of CO2 absorbent material

(4) Composition and volume(s) of supply gases

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

(6) Other specific details as requested by DCB

7.4.8.2 Buddy Qualifications

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

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

7.4.8.3 Oxygen Exposures

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

7.4.8.4 Decompression Management

a. DCB shall review and approve the method of decompression management selected for a given diving application and project. Decompression management can be safely achieved by a variety of methods, depending on the type and model of rebreather to be used. Following is a general list of methods for different rebreather types:

(1) Oxygen rebreathers: Not applicable.

(2) SCR (presumed constant FO_2):

(a) Use of any method approved for open-circuit scuba diving breathing air, above the maximum operational depth of the supply gas.

(b) Use of open-circuit nitrox dive tables based upon expected inspired FO_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.

(c) 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 PPO2):

(a) Integrated constant PPO2 dive computer.

(b) Non-integrated constant PPO2 dive computer.

(c) Constant PPO2 dive tables.

(d) Open-circuit (constant FO_2) nitrox dive computer, set to inspired FO_2 predicted using PPO2 set point at the maximum planned dive depth.

(e) Equivalent air depth (EAD) correction to standard open-circuit air dive tables, based on the inspired FO_2 predicted using the PPO2 set point at the maximum planned dive depth.

(f) Air dive computer, or air dive tables used above the maximum operating depth (MOD) of air for the PPO2 setpoint selected.

7.4.8.5 Maintenance Logs, CO_2 Scrubber Logs, Battery Logs, and Pre-And Post-Dive Checklists

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

(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

(14) Final operational verification immediately before to entering the water:

(15) PO2 in the rebreather is not hypoxic

(16) Oxygen addition system is functioning;

(17) Volumetric addition is functioning

(18) Bail-out life support is functioning

7.4.8.6 Alternate Life Support System

a. 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:

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

(2) Redundant rebreather

(3) Pre-positioned life support equipment with topside support CO2 Absorbent Material

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

(b) 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.

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

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

b. 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.

7.4.9 Oxygen Rebreathers

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

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

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

7.4.10 Semi-Closed Circuit Rebreathers

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

7.4.10.2 Maximum operating depth shall be based upon the FO2 in the active supply cylinder.

7.4.10.3 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 30fsw during ascent on dives deeper than 30fsw, and at bottom depth on dives 30fsw and shallower.

7.4.11 Closed-Circuit Rebreathers

7.4.11.1 The FO2 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 PPO2 greater than 0.20 atm but no greater than 1.4 atm. Maximum operating depth shall be based on the FO2 of the diluent in use during each phase of the dive, so as not to exceed a PO2 limit of 1.4 atm. 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).

7.4.11.2 The PPO2 set point shall not be lower than 0.4 atm or higher than 1.4 atm.

APPENDIX A. DEFINITIONS

Air Sharing	The sharing of an air supply between divers.
Atmospheres Absolute (ATA)	The total pressure exerted on an object, by a gas or mixture of gases, at a specific depth or elevation, including normal atmospheric pressure.
Bottom Time	The total elapsed time measured in minutes from the time when the diver leaves the surface in descent to the time that the diver reaches the surface upon ascent. Does not include precautionary decompression time ("safety stop").
Breath-hold Diving	A diving mode in which the diver uses no self-contained or surface-supplied air or oxygen supply.
Buddy Breathing	The sharing of a single air source between divers.
Buddy Diver	Second member of the dive team.
Buddy System	Two comparably equipped scuba divers in the water in constant communication.
Buoyant Ascent	An ascent made using some form of positive buoyancy.
Burst Pressure	The pressure at which a pressure containment device would fail structurally.
Certified Diver	A diver who holds a recognized valid certification from NASA Ames or a recognized training 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 that may result from gas and 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. (Also called dive tables.)
Dive	A descent into the water, an underwater diving activity utilizing compressed gas, an ascent, and return to the surface.
Dive Computer	A microprocessor based device which computes a diver's theoretical decompression status, in real time, by using pressure (depth) and time as input to a decompression model, or set of decompression tables, programmed into the device.
Dive Location	A surface or vessel from which a diving operation is conducted.

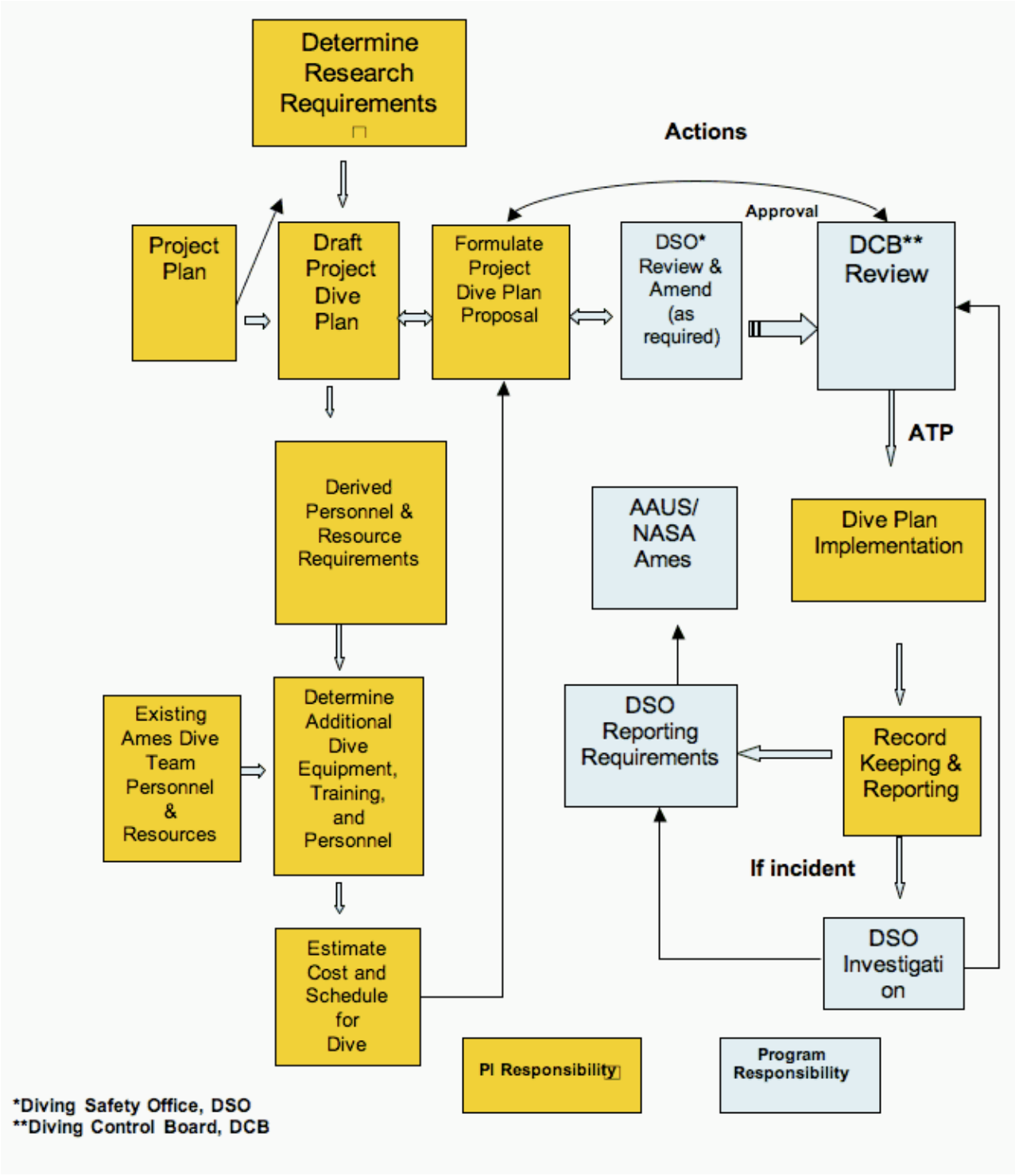
Dive Site	The physical location of a diver during a dive.
Diver	An individual in the water who uses apparatus, including snorkel, which supplies breathing gas at ambient pressure.
Diver-In-Training (DIT)	An individual gaining experience and training in additional diving activities under the supervision of a dive team member experienced in those activities.
Diving Mode	A type of diving requiring specific equipment, procedures, and techniques; for example, snorkel, scuba, surface-supplied air, or mixed gas.
Diving Control Board (DCB)	The group of individuals who act as the official representatives of the membership organization in matters concerning the scientific diving program (see Section 1.24).
Diving Safety Officer (DSO)	The individual responsible for the safe conduct of the scientific diving program of the membership organization (see Section 1.23).
Emergency Ascent	An ascent made under emergency conditions where the diver exceeds the normal ascent rate.
Hyperbaric Chamber	See decompression chamber.
Hyperbaric Conditions	Pressure conditions in excess of normal atmospheric pressure at the dive location.
Lead Diver	The certified scientific diver with experience and training to conduct the diving operation.
Maximum Working Pressure	The maximum pressure to which a pressure vessel may be exposed under standard operating conditions.
Member Organization	An organization which is a current member of the AAUS, and which has a program that adheres to the standards of the AAUS as set forth in the AAUS Standards for Scientific Diving Certification and Operation of Scientific Diving Programs.
Mixed-Gas Diving	A diving mode in which the diver is supplied in the water with a breathing gas other than air.
Maximum Operating Depth (MOD)	Usually determined as the depth at which the pO2 for a given gas mixture reaches a predetermined maximum.
National Oceanic and Atmospheric Administration (NOAA) Diving Manual	Refers to the *NOAA Diving Manual, Diving for Science and Technology*, 1999 edition. National Oceanic and Atmospheric Administration, Office of Undersea Research, US Department of Commerce.
No-Decompression Limits	The depth-time limits of the "no-decompression limits and repetitive dive group designations table for no-decompression air dives" of the U.S. Navy Diving Manual or equivalent limits.
Normal Ascent	An ascent made with an adequate air supply at a rate prescribed by the decompression strategy being used (generally 40 feet per minute or less).

Oxygen Compatible	A gas delivery system that has components (o-rings, valve seats, diaphragms, etc.) that is compatible with oxygen at a stated pressure and temperature.
Oxygen Service	A gas delivery system that is both oxygen clean and oxygen compatible.
Oxygen Toxicity	Any adverse reaction of the central nervous system (“acute” or “CNS” oxygen toxicity) or lungs (“chronic”, “whole-body”, or “pulmonary” oxygen toxicity) brought on by exposure to an increased (above atmospheric levels) partial pressure of oxygen.
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.
Qualified Physician	A physician trained in diving medicine (e.g., certified in occupational medicine, aviation medicine, or hypo/hyperbaric medicine).
Recompression Chamber	See Decompression Chamber.
Scientific Diving	Scientific diving is defined (29 CFR 1910.402) as diving performed solely as a necessary part of a scientific, research, or educational activity by employees whose sole purpose for diving is to perform scientific research tasks.
Scuba Diving	A diving mode independent of surface supply in which the diver uses open circuit self-contained underwater breathing apparatus.
Surface Supplied Diving	A diving mode in which the diver in the water is supplied from the dive location with compressed gas for breathing.
Swimming Ascent	An ascent that can be done under normal or emergency conditions accomplished by simply swimming to the surface.
Working Pressure	The normal pressure at which the system is designed to operate.

APPENDIX B. ACRONYMS

ATA	Atmospheres Absolute
DIT	Diver-In-Training
FFW	Feet of Fresh Water, or equivalent static head
FSW	Feet of Seawater, or equivalent static head
MOD	Maximum Operating Depth
MSW	Meters of Seawater, or equivalent static head
NOAA	National Oceanic and Atmospheric Administration
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	Pounds per Square Inch (a unit of pressure)
Psig	Pounds per Square Inch Gauge

APPENDIX C. NASA AMES DIVING PROPOSAL FLOW



APPENDIX D. REQUEST FOR DIVING RECIPROCITY VERIFICATION OF DIVER TRAINING AND EXPERIENCE

D.1 A scientific diver that is currently certified under the auspices of an organizational member institution of the American Academy of Underwater Sciences (AAUS) shall be recognized by any other organizational member of AAUS and may apply for reciprocity in order to dive with the host organization. Organizational members that are in good standing with AAUS operate, at a minimum, under the AAUS Standards for Scientific Diving Certification and Operation of Scientific Diving Programs (2003 edition). The visiting diver will comply with the diving regulations of the host organization's Diving Safety Manual unless previously arranged by both organizations' DCBs.

D.2 The host organization has the right to approve or deny this request and may require, at a minimum, a checkout dive with the DSO or designee of the host organization. If the request is denied, the host organization should notify the DSO of the visiting diver the reason for the denial. The DSO for the visiting scientific diver has confirmed the following information:

a. Name of Investigator:
b. Date of Request:
c. Date of Event:
d. Research Site:
e. Names of Divers:
f. Certifications:
    (1) Scientific Diving,
    (2) Altitude,
    (3) Rescue Diving, EMT
    (4) Depth Certification
g. Medical Exam, CPR, O2:
h. Last 10 Logged Dives:
i. Equipment Inspection:
j. Any restrictions to Diving: if yes explain
k. Emergency Contact Information, Name and Phone:

Note: This document is only valid if signed by the Diving Safety Officer.

D.3 This is to verify that the above individual is currently a certified scientific diver at NASA Ames and that NASA Ames is an organizational member of AAUS. If you have questions about this diver or the information provided, please contact:

Bruce Storms

NASA Ames Diving Safety Officer,

650.604.1356

Bruce.L.Storms@nasa.gov

APPENDIX E. NASA AMES DIVING CONTROL BOARD MEMBERSHIP

Dr. Liane Guild

Mr. Bruce Storms

Dr. Juan Torres Perez

Mr. Richard Kolyer

Dr. Jonas Jonsson

Dr. Jordan Firestone

Note: The list above is the Board membership as of April 2023. The membership may change at the discretion of the Diving Safety Officer.

APPENDIX F. DIVER'S MEDICAL CLEARANCE FORM

NASA Ames Health Unit
M/S 215-8
Moffett Field, CA 94035
(650) 604-5287 (office)
(650) 604-0640 (fax)

Diver's Medical Clearance Form

Part 1: *To be completed by the diver-applicant.*

Name:	Date of Birth:	☐ Civil Servant
Occupation:	Work phone:	☐ Contractor
Supervisor:	ARC Org Code:	☐ Intern/Student ☐ Other

Part 2: *To be completed by the evaluating physician.*

I performed a diver's medical evaluation. Examination date: _____

☐ This individual IS medically cleared for diving activities.

☐ This individual is NOT medically cleared for diving activities.

☐ More information is needed before a determination can be made.

☐ This individual may be cleared for diving activities with the following restrictions.
Specifically:_____
_____
_____
_____

_____ Date: _____
Physician's Signature

_____ _____
Physician's Printed Name Medical License Number

_____
Phone

_____
Address

_____
City, State Zip Code

Diver's Medical Clearance Form 10.2017

The American Academy of Underwater Sciences

STANDARDS FOR SCIENTIFIC DIVING

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

a) Abnormalities of the tympanic membrane, such as perforation, presence of a monomeric membrane, or inability to auto inflate the middle ears.
b) Hearing loss; Vertigo including Meniere's Disease.
c) Stapedectomy or middle ear reconstructive surgery.
d) Recent ocular surgery.
e) Psychiatric disorders including claustrophobia, suicidal ideation, psychosis, anxiety states, depression.
f) Substance abuse, including alcohol.
g) Episodic loss of consciousness.
h) History of seizure.
i) History of stroke or a fixed neurological deficit.
j) Recurring neurologic disorders, including transient ischemic attacks.
k) History of intracranial aneurysm, other vascular malformation or intracranial hemorrhage.
l) History of neurological decompression illness with residual deficit.
m) Head injury.
n) Hematologic disorders including coagulopathies.
o) Risk factors or evidence of coronary artery disease.
p) Atrial septal defects.
q) Significant valvular heart disease - isolated mitral valve prolapse is not disqualifying.
r) Significant cardiac rhythm or conduction abnormalities.
s) Implanted cardiac pacemakers and cardiac defibrillators (ICD).
t) Inadequate exercise tolerance.
u) Hypertension.
v) History of pneumothorax.
w) Asthma.
x) Chronic pulmonary disease, including radiographic evidence of pulmonary blebs, bullae or cysts.
y) Diabetes mellitus.
z) Pregnancy.

APPENDIX H. GUIDELINES FOR RECREATIONAL SCUBA DIVER'S PHYSICAL EXAMINATION (FROM NAUI MEDICAL STATEMENT IN COLLABORATION WITH RECREATIONAL SCUBA TRAINING COUNCIL AND THE UNDERSEA & HYPERBARIC MEDICAL SOCIETY, 2007)

Guidelines for Recreational Scuba Diver's Physical Examination

Instructions to the Physician:

Recreational **SCUBA** (Self-Contained Underwater Breathing Apparatus) can provide recreational divers with an enjoyable sport safer than many other activities. The risk of diving is increased by certain physical conditions, which the relationship to diving may not be readily obvious. Thus, it is important to screen divers for such conditions.

The **RECREATIONAL SCUBA DIVER'S PHYSICAL EXAMINATION** focuses on conditions that may put a diver at increased risk for decompression sickness, pulmonary overinflation syndrome with subsequent arterial gas embolization and other conditions such as loss of consciousness, which could lead to drowning. Additionally, the diver must be able to withstand some degree of cold stress, the physiological effects of immersion and the optical effects of water and have sufficient physical and mental reserves to deal with possible emergencies.

The history, review of systems and physical examination should include as a minimum the points listed below. The list of conditions that might adversely affect the diver is not all-inclusive, but contains the most commonly encountered medical problems. The brief introductions should serve as an alert to the nature of the risk posed by each medical problem.

The potential diver and his or her physician must weigh the pleasures to be had by diving against an increased risk of death or injury due to the individual's medical condition. As with any recreational activity, there are no data for diving enabling the calculation of an accurate mathematical probability of injury. Experience and physiological principles only permit a qualitative assessment of relative risk.

For the purposes of this document, **Severe Risk** implies that an individual is believed to be at substantially elevated risk of decompression sickness, pulmonary or otic barotrauma or altered consciousness with subsequent drowning, compared with the general population. The consultants involved in drafting this document would generally discourage a student with such medical problems from diving. **Relative Risk** refers to a moderate increase in risk, which in some instances may be acceptable. To make a decision as to whether diving is contraindicated for this category of medical problems, physicians must base their judgement on an assessment of the individual patient. Some medical problems which may preclude diving are **temporary** in nature or responsive to treatment, allowing the student to dive safely after they have resolved.

Diagnostic studies and specialty consultations should be obtained as indicated to determine the diver's status. A list of references is included to aid in clarifying issues that arise. Physicians and other medical professionals of the Divers Alert Network (DAN) associated with Duke University Health System are available for consultation by phone +1 919 684 2948 during normal business hours. For emergency calls, 24 hours 7 days a week, call +1 919 684 8111 or +1 919 684 4DAN (collect). Related organizations exist in other parts of the world – DAN Europe in Italy +39 039 605 7858, DAN S.E.A.P. in Australia +61 3 9886 9166 and Divers Emergency Service (DES) in Australia +61 8 8212 9242, DAN Japan +81 33590 6501 and DAN Southern Africa +27 11 242 0380. There are also a number of informative websites offering similar advice.

NEUROLOGICAL

Neurological abnormalities affecting a diver's ability to perform exercise should be assessed according to the degree of compromise. Some diving physicians feel that conditions in which there can be a waxing and waning of neurological symptoms and signs, such as migraine or demyelinating disease, contraindicate diving because an exacerbation or attack of the preexisting disease (e.g.: a migraine with aura) may be difficult to distinguish from neurological decompression sickness. A history of head injury resulting in unconsciousness should be evaluated for risk of seizure.

Relative Risk Conditions

- **Complicated Migraine Headaches whose symptoms or severity impair motor or cognitive function, neurologic manifestations**
- **History of Head Injury with sequelae other than seizure**
- **Herniated Nucleus Pulposus**
- **Intracranial Tumor or Aneurysm**
- **Peripheral Neuropathy**
- **Multiple Sclerosis**
- **Trigeminal Neuralgia**
- **History of spinal cord or brain injury**

Temporary Risk Condition

History of cerebral gas embolism without residual where pulmonary air trapping has been excluded and for which there is a satisfactory explanation and some reason to believe that the probability of recurrence is low.

Severe Risk Conditions

Any abnormalities where there is a significant probability of unconsciousness, hence putting the diver at increased risk of drowning. Divers with spinal cord or brain abnormalities where perfusion is impaired may be at increased risk of decompression sickness.

Some conditions are as follows:

- **History of seizures other than childhood febrile seizures**
- **History of Transient Ischemic Attack (TIA) or Cerebrovascular Accident (CVA)**
- **History of Serious (Central Nervous System, Cerebral or Inner Ear) Decompression Sickness with residual deficits**

CARDIOVASCULAR SYSTEMS

Relative Risk Conditions

The diagnoses listed below potentially render the diver unable to meet the exertional performance requirements likely to be encountered in recreational diving. These conditions may lead the diver to experience cardiac ischemia and its consequences. Formalized stress testing is encouraged if there is any doubt regarding physical performance capability. The suggested minimum criteria for stress testing in such cases is at least 13 METS.* Failure to meet the exercise criteria would be of significant concern. Conditioning and retesting may make later qualification possible. Immersion in water causes a redistribution of blood from the periphery into the central compartment, an effect that is greatest in cold water. The marked increase in cardiac preload during immersion can precipitate pulmonary edema in patients with impaired left ventricular function or significant valvular disease. The effects of immersion can mostly be gauged by an assessment of the diver's performance while swimming on the surface. A large proportion of scuba diving deaths in North America are due to coronary artery disease. Before being approved to scuba dive, individuals older than 40 years are recommended to undergo risk assessment for coronary artery disease. Formal exercise testing may be needed to assess the risk.

* METS is a term used to describe the metabolic cost. The MET at rest is one, two METS is two times the resting level, three METS is three times the resting level, and so on. The resting energy cost (net oxygen requirement) is thus standardized. (Exercise Physiology; Clark, Prentice Hall, 1975.)

Relative Risk Conditions

- History of Coronary Artery Bypass Grafting (CABG)
- Percutaneous Balloon Angioplasty (PCTA) or Coronary Artery Disease (CAD)
- History of Myocardial Infarction
- Congestive Heart Failure
- Hypertension
- History of dysrythmias requiring medication for suppression
- Valvular Regurgitation

Pacemakers

The pathologic process that necessitated should be addressed regarding the diver's fitness to dive. In those instances where the problem necessitating pacing does not preclude diving, will the diver be able to meet the performance criteria?

*** NOTE: Pacemakers must be certified by the manufacturer as able to withstand the pressure changes involved in recreational diving.**

Severe Risks

Venous emboli, commonly produced during decompression, may cross major intracardiac right-to-left shunts and enter the cerebral or spinal cord circulations causing neurological decompression illness. Hypertrophic cardiomyopathy and valvular stenosis may lead to the sudden onset of unconsciousness during exercise.

PULMONARY

Any process or lesion that impedes airflow from the lungs places the diver at risk for pulmonary overinflation with alveolar rupture and the possibility of cerebral air embolization. Many interstitial diseases predispose to spontaneous pneumothorax: Asthma (reactive airway disease), Chronic Obstructive Pulmonary Disease (COPD), cystic or cavitating lung diseases may all cause air trapping. The 1996 Undersea and Hyperbaric Medical Society (UHMS) consensus on diving and asthma indicates that for the risk of pulmonary barotrauma and decompression illness to be acceptably low, the asthmatic diver should be asymptomatic and have normal spirometry before and after an exercise test. Inhalation challenge tests (e.g.: using histamine, hypertonic saline or methacholine) are not sufficiently standardized to be interpreted in the context of scuba diving.

A pneumothorax that occurs or reoccurs while diving may be catastrophic. As the diver ascends, air trapped in the cavity expands and could produce a tension pneumothorax.

In addition to the risk of pulmonary barotrauma, respiratory disease due to either structural disorders of the lung or chest wall or neuromuscular disease may impair exercise performance. Structural disorders of the chest or abdominal wall (e.g.: prune belly), or neuromuscular disorders, may impair cough, which could be life threatening if water is aspirated. Respiratory limitation due to disease is compounded by the combined effects of immersion (causing a restrictive deficit) and the increase in gas density, which increases in proportion to the ambient pressure (causing increased airway resistance). Formal exercise testing may be helpful.

Relative Risk Conditions

- History of Asthma or Reactive Airway Disease (RAD)*
- History of Exercise Induced Bronchospasm (EIB)*
- History of solid, cystic or cavitating lesion*
- Pneumothorax secondary to:
  - -Thoracic Surgery
  - -Trauma or Pleural Penetration*
  - -Previous Overinflation Injury*
- Obesity
- History of Immersion Pulmonary Edema Restrictive Disease*
- Interstitial lung disease: May increase the risk of pneumothorax

* Spirometry should be normal before and after exercise

Active Reactive Airway Disease, Active Asthma, Exercise Induced Bronchospasm, Chronic Obstructive Pulmonary Disease or history of same with abnormal PFTs or a positive exercise challenge are concerns for diving.

Severe Risk Conditions

- **History of spontaneous pneumothorax.** Individuals who have experienced spontaneous pneumothorax should avoid diving, even after a surgical procedure designed to prevent recurrence (such as pleurodesis). Surgical procedures either do not correct the underlying lung abnormality (e.g.: pleurodesis, apical pleurectomy) or may not totally correct it (e.g.: resection of blebs or bullae).
- **Impaired exercise performance due to respiratory disease.**

GASTROINTESTINAL

Temporary Risks

As with other organ systems and disease states, a process which chronically debilitates the diver may impair exercise performance. Additionally, dive activities may take place in areas remote from medical care. The possibility of acute recurrences of disability or lethal symptoms must be considered.

Temporary Risk Conditions

- **Peptic Ulcer Disease associated with pyloric obstruction or severe reflux**
- **Unrepaired hernias of the abdominal wall large enough to contain bowel within the hernia sac could incarcerate.**

Relative Risk Conditions

- **Inflammatory Bowel Disease**
- **Functional Bowel Disorders**

Severe Risks

Altered anatomical relationships secondary to surgery or malformations that lead to gas trapping may cause serious problems. Gas trapped in a hollow viscous expands as the divers surfaces and can lead to rupture or, in the case of the upper GI tract, emesis. Emesis underwater may lead to drowning.

Severe Risk Conditions

- **Gastric outlet obstruction of a degree sufficient to produce recurrent vomiting**
- **Chronic or recurrent small bowel obstruction**
- **Severe gastroesophageal reflux**
- **Achalasia**
- **Paraesophageal Hernia**

ORTHOPAEDIC

Relative impairment of mobility, particularly in a boat or ashore with equipment weighing up to 18 kgs/40 pounds must be assessed. Orthopaedic conditions of a degree sufficient to impair exercise performance may increase the risk.

Relative Risk Conditions

- **Amputation**
- **Scoliosis must also assess impact on respiratory function and exercise performance.**
- **Aseptic Necrosis possible risk of progression due to effects of decompression (evaluate the underlying medical**

cause of decompression may accelerate/escalate the progression).

Temporary Risk Conditions

- **Back pain**

HEMATOLOGICAL

Abnormalities resulting in altered rheological properties may theoretically increase the risk of decompression sickness. Bleeding disorders could worsen the effects of otic or sinus barotrauma, and exacerbate the injury associated with inner ear or spinal cord decompression sickness. Spontaneous bleeding into the joints (e.g.: in hemophilia) may be difficult to distinguish from decompression illness.

Relative Risk Conditions

- **Sickle Cell Disease**
- **Polycythemia Vera**
- **Leukemia**
- **Hemophilia/Impaired Coagulation**

METABOLIC AND ENDOCRINOLOGICAL

With the exception of diabetes mellitus, states of altered hormonal or metabolic function should be assessed according to their impact on the individual's ability to tolerate the moderate exercise requirement and environmental stress of sport diving. Obesity may predispose the individual to decompression sickness, can impair exercise tolerance and is a risk factor for coronary artery disease.

Relative Risk Conditions

- **Hormonal Excess or Deficiency**
- **Obesity**
- **Renal Insufficiency**

Severe Risk Conditions

The potentially rapid change in level of consciousness associated with hypoglycemia in diabetics on insulin therapy or certain oral hypoglycemic medications can result in drowning. Diving is therefore generally contraindicated, unless associated with a specialized program that addresses these issues. [See "Guidelines for Recreational Diving with Diabetes" at www/wrstc.com and www.diversalertnetwork.org.]

Pregnancy: The effect of venous emboli formed during decompression on the fetus has not been thoroughly investigated. Diving is therefore not recommended during any stage of pregnancy or for women actively seeking to become pregnant.

BEHAVIORAL HEALTH

Behavioral: The diver's mental capacity and emotional make-up are important to safe diving. The student diver must have sufficient learning abilities to grasp information presented to him by his instructors, be able to safely plan and execute his own dives and react to changes around him in the underwater environment. The student's motivation to learn and his ability to deal with potentially dangerous situations are also crucial to safe scuba diving.

Relative Risk Conditions

- **Developmental delay**
- **History of drug or alcohol abuse**
- **History of previous psychotic episodes**
- **Use of psychotropic medications**

Severe Risk Conditions

- **Inappropriate motivation to dive – solely to please spouse, partner or family member, to prove oneself in the face of personal fears**
- **Claustrophobia and agoraphobia**
- **Active psychosis**
- **History of untreated panic disorder**
- **Drug or alcohol abuse**

OTOLARYNGOLOGICAL

Equalisation of pressure must take place during ascent and descent between ambient water pressure and the external auditory canal, middle ear and paranasal sinuses. Failure of this to occur results at least in pain and in the worst case rupture of the occluded space with disabling and possible lethal consequences.

The inner ear is fluid filled and therefore noncompressible. The flexible interfaces between the middle and inner ear, the round and oval windows are, however, subject to pressure changes. Previously ruptured but healed round or oval window membranes are at increased risk of rupture due to failure to equalise pressure or due to marked overpressurisation during vigorous or explosive Valsalva manoeuvres.

The larynx and pharynx must be free of an obstruction to airflow. The laryngeal and epiglotic structure must function normally to prevent aspiration.

Mandibular and maxillary function must be capable of allowing the patient to hold a scuba mouthpiece. Individuals who have had mid-face fractures may be prone to barotrauma and rupture of the air filled cavities involved.

Relative Risk Conditions

- **Recurrent otitis externa**
- **Significant obstruction of external auditory canal**
- **History of significant cold injury to pinna**
- **Eustachian tube dysfunction**
- **Recurrent otitis media or sinusitis**
- **History of TM perforation**
- **History of tympanoplasty**
- **History of mastoidectomy**
- **Significant conductive or sensorineural hearing impairment**
- **Facial nerve paralysis not associated with barotrauma**
- **Full prosthedontic devices**
- **History of mid-face fracture**
- **Unhealed oral surgery sites**
- **History of head and/or neck therapeutic radiation**
- **History of temperomandibular joint dysfunction**
- **History of round window rupture**

Severe Risk Conditions

- **Monomeric TM**
- **Open TM perforation**
- **Tube myringotomy**
- **History of stapedectomy**
- **History of ossicular chain surgery**
- **History of inner ear surgery**
- **Facial nerve paralysis secondary to barotrauma**
- **Inner ear disease other than presbycusis**
- **Uncorrected upper airway obstruction**
- **Laryngectomy or status post partial laryngectomy**
- **Tracheostomy**
- **Uncorrected laryngocele**
- **History of vestibular decompression sickness**

APPENDIX I. DIVER'S MEDICAL HISTORY QUESTIONNAIRE

NASA Ames Health Unit
M/S 215-8
Moffett Field, CA 94035
(650) 604-5287 (office)
(650) 604-0640 (fax)

Diver's Medical History Questionnaire

Date:

Diver's Name:	Birthdate:	Work Phone:	☐ Civil Servant ☐ Contractor ☐ Intern/Student ☐ Other
Diver's Supervisor:	Org Code:	Work Location:	

Medical History Please mark the conditions you have had and provide a brief explanation below.

☐	Glaucoma	☐	Frequent colds, sinusitis, or bronchitis	☐	Back injury or back pain
☐	Glasses or contact lenses	☐	Allergies or sinus trouble	☐	Diabetes
☐	Ear infection	☐	Lung or breathing problems	☐	Decompression sickness
☐	Hearing problems or ear pain	☐	Asthma, wheezing, or reactive airways	☐	Car, sea, or air-related motion sickness
☐	Difficulty clearing/equalizing ears	☐	Collapsed lung, pneumothorax	☐	Diving-related problems
☐	Ruptured ear drum	☐	Abnormal chest x-ray	☐	Dental plate, dentures, oral prosthesis
☐	High blood pressure	☐	Migraines or frequent headaches	☐	Bleeding disorder
☐	Heart murmur	☐	Head injury, "knocked unconscious"	☐	Surgery
☐	Chest pain or angina	☐	Convulsions, seizures, or epilepsy	☐	Restricted from sports activities
☐	Heart attack or heart disease	☐	Fainting, dizzy spells, or blackouts	☐	Paralysis or muscle weakness
☐	Stomach or digestive problems	☐	Depression / Anxiety	☐	Pregnant
☐	Ulcers, acid reflux, or heartburn	☐	Claustrophobia	☐	Smoking habit
☐	Hernia	☐	Alcoholism or drug abuse	☐	NONE OF THE ABOVE

Please explain all marked answers:

MEDICATIONS: Please list all medications you are taking. Include birth control pills, vitamins, aspirin and any other over-the-counter health aids and supplements.

1.	4.	7.
2.	5.	8.
3.	6.	9.

ALLERGIES: Please list any allergies to medications or other substances. ☐ **NO KNOWN ALLERGIES**

APPENDIX J. MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING (FROM AAUS STANDARDS FOR SCIENTIFIC DIVING, 2018)

Name of Applicant (Print or Type) Date of Medical Evaluation (Month/Day/Year)

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

TESTS: THE FOLLOWING TESTS ARE REQUIRED:

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

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

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

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

APPENDIX K. DIVING EMERGENCY MANAGEMENT PROCEDURES

Introduction

A diving victim could be any person who has been breathing air underwater regardless of depth. It is essential that emergency procedures are pre-planned and that medical treatment is initiated as soon as possible. As part of each NASA Ames Diving Project Proposal, procedures for diving emergencies, including evacuation and medical treatment for each dive location, will be described in detail and approved by the DSO.

General Procedures

Depending on and according to the nature of the diving accident, stabilize the patient, administer 100% oxygen, contact local Emergency Medical System (EMS) for transport to medical facility, contact diving accident coordinator, as appropriate. Explain the circumstances of the dive incident to the evacuation teams, medics and physicians. Do not assume that they understand why 100% oxygen may be required for the diving accident victim or that recompression treatment may be necessary.

1. Make appropriate contact with victim or rescue as required.
2. Establish (A)irway, (B)reathing, (C)irculation as required.
3. Administer 100% oxygen, if appropriate (in cases of Decompression Illness, or Near Drowning).
4. Call local Emergency Medical System (EMS) for transport to nearest medical treatment facility.
5. Secure SCUBA gear of victim:
    - Turn air off, but note number of turns.
    - Rinse in fresh water, but do not disassemble.
    - Note gage readings; take photos of gages & setup.
    - Bring gear (or at least dive computer) to medical facility.
    - Obtain documentation of gear transfer.
6. Notify Ames personnel as follows:
    - NASA ARC Emergency Dispatch: 650-604-5555 (staffed 24/7)
    - Ames DSO Bruce Storms: 650-604-1356, Bruce.L.Storms@nasa.gov
    - Ames Safety office (650) 604-5602
    - Your supervisor
7. Complete a Mishap Report within 24 hours at https://nmis.sma.nasa.gov/.

IN ANY EMERGENCY, THE CORRECT PROCEDURE IS TO CALL 911.

NASA Ames Emergency Personnel

NASA Ames Health Center Mon-Fri, 8a-4:30p, 650.604.5287,

Diving Safety Office, (650) 604-1356

Ames Safety Office, (650) 604-5602

Mishap Program Manager, (650) 604-2850, 24 hrs., (650) 604-5416

Other References;

- Divers Alert Network (DAN) **Emergency (919) 684-8111**
- Community Hospital of the Monterey Peninsula (CHOMP) 23625 WR Holman Highway, Monterey **Emergency (831) 625-4900**
- Pacific Grove Hyperbaric Facility **Emergency 911,** (831) 624-7695
- Catalina Hyperbaric Chamber **Emergency (213) 510-1053** Business (213) 743-6793
- LA CO/USC Med. Alert Center **Emergency (213) 221-4114**
  - USC Med Center Public Info (213) 226-2345
  - Northridge Med Center **Emergency (800) 682-9000** Business (818) 993-0263
- Doctors Medical Center **Emergency (510) 235-3483** East Bay Area, San Pablo 7 days 8a-5p only
- John Muir Medical Center **Emergency (925) 947-3212** Walnut Creek
- Saint Francis Hospital **Emergency (415) 353-6700,** San Francisco

APPENDIX L. GUIDELINES FOR SCIENTIFIC SKIN DIVERS

1. All Skin Diver candidates may be asked to pass a confined water swimming and snorkeling evaluation consisting of:
   - Swim underwater without swim aids for a distance of 25 yards without surfacing.
   - Swim 400 yards in less than 12 minutes without swim aids.
   - Tread water for 10 minutes without swim aids.
   - Without the use of swim aids, transport another person of equal size a distance of 25 yards.
   - Swim 900 yards in less than 20 minutes in full skin diving gear using only fin kicks.
2. All Skin Diver candidates may be asked to perform each of the below skills in confined water:
   - Enter and exit water with full equipment both from a simulated shore and vessel.
   - Clear facemask and snorkel.
   - Demonstrate understanding of hand signals.
   - Rescue and transport, as a diver, a passive simulated victim of an accident.
   - Demonstrate self-rescue and buddy assist techniques.
   - Perform at least 3 different surface dives.
   - Demonstrate watermanship ability, which is acceptable to the instructor
3. All Skin Diver candidates may be asked to pass a written examination covering;
   - Function, care, use, and maintenance of diving equipment.
   - Physics and physiology involved in Free Diving.
   - Planning and supervision of diving operations.
   - Diving regulations and precautions.
   - Near-shore currents and waves.
   - Dangerous marine animals.
   - Emergency procedures.
   - Skin Diving hazards.
   - Hand signals.
   - Cause, symptoms, treatment, and prevention of the following: near drowning, carbon dioxide excess, squeezes, exhaustion and panic, respiratory fatigue, motion sickness, hypothermia, hyperthermia and hypoxia/anoxia.
4. All Skin Divers may be asked to perform the below listed skills in open water:
   - Surface dive to a depth of at least 10 feet in open water once to ditch the weight belt and the second time to recover and replace it. Enter and leave open water fully suited from the shore.
   - Kick on the surface 650 yards while fully suited as a skin diver using only fin kicks.
   - Demonstrate judgment adequate for safe diving including safely planning and executing a dive.
   - Demonstrate, where appropriate, the ability to maneuver efficiently in the environment, at and below the surface.
   - Demonstrate clearing of mask and snorkel.
   - Demonstrate ability to perform 3 different surface dives.
   - Demonstrate techniques of self-rescue and buddy rescue, performing a complete rescue of an unconscious diver.
   - Swim underwater at least 25 yards on one breath.
   - Demonstrate the ability to remove and replace all skin diving gear on the surface.
   - Dive to a depth of at least 10 feet three times to retrieve an object from the bottom.

APPENDIX M. AAUS STATISTICS COLLECTION CRITERIA AND DEFINITIONS

COLLECTION CRITERIA:

The "Dive Time in Minutes", The Number of Dives Logged", and the "Number of Divers Logging Dives" will be collected for the following categories:

- Dive Classification
- Breathing Gas
- Diving Mode
- Decompression Planning and Calculation Method
- Depth Ranges
- Specialized Environments
- Incident Types

Dive Time in Minutes is defined as the surface-to-surface time including any safety or required decompression stops.

A Dive is defined as a descent underwater utilizing compressed gas and subsequent ascent/return to the surface with a minimum surface interval of 10 minutes.

Dives will not be differentiated as open water or confined water dives. But open water and confined water dives will be logged and submitted for AAUS statistics classified as either scientific or training/proficiency.

A "Diver Logging a Dive" is defined as a person who is diving under the auspices of your scientific diving organization. Dives logged by divers from another AAUS Organization will be reported with the diver's home organization. Only a diver who has actually logged a dive during the reporting period is counted under this category.

Incident(s) that occur during the collection cycle: Only incidents that occurred during, or resulting from, a dive where the diver is breathing a compressed gas will be submitted to AAUS.

DEFINITIONS:

Dive Classification:

- Scientific Dives: Dives that meet the scientific diving exemption as defined in 29 CFR 1910.402. Diving tasks traditionally associated with a specific scientific discipline are considered a scientific dive. Construction and trouble-shooting tasks traditionally associated with commercial diving are not considered a scientific dive.

- Training and Proficiency Dives: Dives performed as part of a scientific diver-training program, or dives performed in maintenance of a scientific diving certification/authorization.

Breathing Gas:

- Air: Dives where the bottom gas used for the dive is air.
- Nitrox: Dives where the bottom gas used for the dive is a combination of nitrogen and oxygen percentages different from those of air.

• Mixed Gas: Dives where the bottom gas used for the dive is a combination of oxygen, nitrogen, and helium (or other inert gas), or any other breathing gas combination not classified as air or nitrox.

Diving Mode:

- Open Circuit SCUBA: Dives where the breathing gas is inhaled from a self-contained underwater breathing apparatus and all of the exhaled gas leaves the breathing loop.
- Surface Supplied: Dives where the breathing gas is supplied from the surface by means of a pressurized umbilical hose. The umbilical generally consists of a gas supply hose, strength member, pneumofathometer hose, and communication line. The umbilical supplies a helmet or full-face mask. The diver may rely on the tender at the surface to monitor the divers' depth, time and diving profile.
- Hookah: While similar to Surface Supplied in that the breathing gas is supplied from the surface by means of a pressurized hose, the supply hose does not require a strength member, pneumofathometer hose, or communication line. Hookah equipment may be as simple as a long hose attached to a standard scuba cylinder supplying a standard scuba second stage. The diver is responsible for monitoring his/her own depth, time, and diving profile.
- Rebreathers: Dives where the breathing gas is repeatedly recycled in a breathing loop. The breathing loop may be fully closed or semi-closed. Note: A rebreather dive ending in an open circuit bailout is still logged as a rebreather dive.

Decompression Planning and Calculation Method:

- Dive Tables
- Dive Computer
- PC Based Decompression Software

Depth Ranges:

Depth ranges for sorting logged dives are: 0-30, 31-60, 61-100, 101-130, 131-150, 151-190, 191-250, 251-300, and 301->. Depths are in feet seawater (when measured in meters: 0-10, >10-30, >30-40, >40-

45, >45-58, >58-76, >76-92, and >92->). A dive is logged to the maximum depth reached during the dive. Note: Only "The Number of Dives Logged" and "The Number of Divers Logging Dives" will be collected for this category.

Specialized Environments:

- Required Decompression: Any dive where the diver exceeds the no-decompression limit of the decompression planning method being employed.
- Overhead Environments: Any dive where the diver does not have direct access to the surface due to a physical obstruction.
- Blue Water Diving: Open water diving where the bottom is generally greater than 200 feet deep and requires the use of multiple-tethers diving techniques.
- Ice and Polar Diving: Any dive conducted under ice or in polar conditions. Note: An Ice Dive would also be classified as an Overhead Environment dive.
- Saturation Diving: Excursion dives conducted as part of a saturation mission are to be logged by "classification", "mode", "gas", etc. The "surface" for these excursions is defined as leaving and surfacing within the Habitat. Time spent within the Habitat or chamber shall not be logged by AAUS.
- Aquarium: An aquarium is a shallow, confined body of water, which is operated by or under the control of an institution and is used for the purposes of specimen exhibit, education, husbandry, or research (Not a swimming pool).

Incident Types:

- Hyperbaric: Decompression Sickness, AGE, or other barotrauma requiring recompression therapy.
- Barotrauma: Barotrauma requiring medical attention from a physician or medical facility, but not requiring recompression therapy.
- Injury: Any non-barotrauma injury occurring during a dive that requires medical attention from a physician or medical facility.
- Illness: Any illness requiring medical attention that can be attributed to diving.
- Near Drowning/ Hypoxia: An incident where a person asphyxiates to the minimum point of unconsciousness during a dive involving a compressed gas. But the person recovers.
- Hyperoxic/Oxygen Toxicity: An incident that can be attributed to the diver being exposed to too high a partial pressure of oxygen.
- Hypercapnia: An incident that can be attributed to the diver being exposed to an excess of carbon

dioxide.

- Fatality: Any death accruing during a dive or resulting from the diving exposure.
- Other: An incident that does not fit one of the listed incident types

Incident Classification Rating Scale:

- Minor: Injuries that the OM considers being minor in nature. Examples of this classification of incident would include, but not be limited to:
    - Mask squeeze that produced discoloration of the eyes.
    - Lacerations requiring medical attention but not involving moderate or severe bleeding.
    - Other injuries that would not be expected to produce long term adverse effects on the diver's health or diving status.
- Moderate: Injuries that the OM considers being moderate in nature. Examples of this classification would include, but not be limited to:
    - DCS symptoms that resolved with the administration of oxygen, hyperbaric treatment given as a precaution.
    - DCS symptoms resolved with the first hyperbaric treatment.
    - Broken bones.
    - Torn ligaments or cartilage.
    - Concussion.
    - Ear barotrauma requiring surgical repair.
- Serious: Injuries that the OM considers being serious in nature. Examples of this classification would include, but not be limited to:
    - ▪Arterial Gas Embolism.
    - ▪DCS symptoms requiring multiple hyperbaric treatment. ▪ Near drowning.
    - ▪Oxygen Toxicity.
    - ▪Hypercapnia.
    - ▪Spinal injuries.
    - ▪Heart attack.
    - ▪Fatality.

APPENDIX N. RECOMMENDATIONS FOR RESCUE OF SUBMERGED DIVER

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