U.S. ENVIRONMENTAL PROTECTION AGENCY

DIVING SAFETY MANUAL
(Revision 2.0)

Office of Administration and Resources Management
Safety and Sustainability Division

Washington, D.C.

May 7, 2022

Acknowledgments

The Safety and Sustainability Division (SSD) acknowledges the cooperative participation of members of United States Environmental Protection Agency (EPA's) Diving Safety Board (DSB) over the years, including those members listed below.

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The contents of this manual reflect the views of EPA's Diving Safety Board in presenting the standards for their operations.

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APPENDICES

GLOSSARY OF ABBREVIATIONS AND ACRONYMS*

AAUS	American Academy of Underwater Sciences
AED	Automated External Defibrillator
AGE	Arterial Gas Embolism
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Atmosphere Absolute
BCD	Buoyancy Compensation Device
BGV	Bag Valve Mask
CBW	Chemical and Biological Warfare
CFR	Code of Federal Regulations
CGA	Compressed Gas Association
CPR	Cardiopulmonary Resuscitation
CRZ	Contamination Reduction Zone
cu ft	Cubic Foot
DAN	Divers Alert Network
DCI	Decompression Illness (includes both DCS and AGE)
DCS	Decompression Sickness
DECON	Decontamination
DMS	Diving Medical Specialist
DOT	U.S. Department of Transportation DOT
DPIC	Designated Person in Charge
DPV	Diver Propulsion Vehicle
DSB	Diving Safety Board
DSO	Dive Safety Officer
DUI	Diving Unlimited International
EGS	Emergency Gas Supply
ENR	Enoyl-Acyl Carrier-Protein Reductase
EPA	U.S. Environmental Protection Agency
EZ	Exclusion Zone
FFM	Full-face Mask
FO_2	Fraction of Oxygen or Percent of Oxygen
FSW	Feet of Seawater
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
IPA	Isopropyl Alcohol
MD	Doctor of Medicine
mg/m3	milligrams per cubic meter
MOA	Memorandum of Agreement
MOD	Maximum Operating Depth
MSDS	Material Safety Data Sheet
MTV	Manual Triggered Valve
NAUI	National Association of Underwater Instructors
NITROX	Oxygen Enriched Air
NOAA	National Oceanic and Atmospheric Administration

OA	Office of Administration
OSC	On-Scene Coordinator
OSHA	Occupational Safety and Health Administration (Department of Labor)
PADI	Professional Association of Diving Instructors
PFD	Personnel Floatation Device
PO_2	Partial Pressure of Oxygen
PPE	Personal Protective Equipment
PPM	Parts per Million
PSI	Pounds per Square Inch
QATS	Quaternary-Ammonium Compounds
RNT	Residual Nitrogen Time
ROV	Remotely Operated Vehicle
RPM	Remedial Project Manager
RSTC	Recreational Scuba Training Council
SCUBA	Self-Contained Underwater Breathing Apparatus
SDI	Scuba Diving International
SEE	Senior Environmental Employee
SEI	SCUBA Educators International
SHEMP	Safety, Health and Environmental Management Program
SMB	Surface Marker Buoy
SOP	Standard Operating Procedure
SPG	Submersible Pressure Gauge
SS	Surface Supplied
SSD	Safety and Sustainability Division
SSI	SCUBA Schools International
SZ	Support Zone
TSP	Tri-Sodium Phosphate
U/W	Underwater
UDO	Unit Diving Officer
UHMS	Undersea and Hyperbaric Medical Society
USC	United States Code
USN	US Navy
VHF	Very High Frequency
VIP	Visual Inspection Process
VVDS	Variable Volume Dry Suit
WP	Working Pressure

* Abbreviations and Acronyms for EPA Diving Safety Manual and Appendices.

1.0 DIVE PROGRAM POLICY

1.1 Purpose

This policy section prescribes the administration and safety rules for the United States Environmental Protection Agency (EPA) Diving Safety Program. *Federal law requires that individual underwater activities (diving) conducted in performance of any employment condition must conform with Occupational Safety and Health Administration (OSHA) regulations 29 Code of Federal Regulations (CFR) Part 1910 — OSH Standards; Subpart T — Commercial Diving Operations. Most of EPA's dives are conducted in accordance with the scientific diving exemption as codified in that document. However, some EPA dives are commercial in nature (such as those involving light maintenance, inspection or repair). Those dives must follow the requirements within 29 CFR 1910, Subpart T (see section 1.4.3). This* Diving Safety Manual *represents the safe work practices manual as required by 29 CFR 1910, Subpart T outlined in EPA Diving Safety Manual and therefore, must be available to all dive team members and at all dive locations.*

Hereafter, "EPA diver" or "Diver" refers to an EPA Scientific/Light Working Diver throughout this manual.

This directive sets forth EPA's policy for minimizing its worker's occupational hazards to the underwater environment. Divers must be aware of the additional specific underwater-related hazards such as drowning, near-drowning and hyperbaric illnesses, which include nitrogen narcosis, decompression sickness (DCS), arterial gas embolism (AGE), oxygen toxicity, and other ancillary health and safety issues.

The program's objectives include compliance with applicable federal, state, and local governmental laws, regulations, standards, guidelines, and executive orders; incorporation of appropriate elements of nationally recognized consensus standards; and effective use of the wide range of both internal and external resources and expertise available to EPA.

Standard Operating Procedures (SOPs), maintained under this program establish the general approaches and work practices that are implemented at the operations level to achieve the various requirements of the program in laboratory, field, and other settings.

The program and its associated SOPs incorporate nationally accepted and consistent means and methods for planning and conducting underwater and diving activities to minimize the potential hazards associated with these activities. To efficiently manage the EPA Diving Safety Program, the Diving Safety Board (DSB) will create, revise, and delete SOPs using this document, the program's *Diving Safety Manual.* This manual is considered separable from the EPA Safety and Sustainability Division (SSD) Policy and Program document and is outside of the revision process for that document. SOPs will be reviewed at the DSB annual meeting, as necessary, and the SSD will be informed of the board's action in their annual report.

1.2 Background

The EPA Diving Safety Program and its associated SOPs address various aspects of Agency workers' protection from job-related hazards such as might typically be found at land-based EPA work sites as well as those specific to the underwater environment (such as immersion in chemically and/or biologically contaminated waters) and hyperbaric illnesses (such as DCS or AGE) in accordance with the Diving Safety Manual. A Memorandum of Agreement (MOA) (see EPA Diving Safety Manual, Appendix N) provides for management of the program by the Office of Administration (OA) and Resources Management Safety and Sustainability Division and daily administration by the Chairperson of the DSB. The MOA affirms the authority of SSD for overall program administration and formalizes the relationship between the DSB and SSD, whereby the SSD has program policy authority and the DSB provides program technical assistance and support but retains some independence to ensure that administrative or technical demands do not unduly influence or require field personnel to perform operations with unreasonable risk.

1.3 Policy

As with any employer, it is the Agency's responsibility to limit its workers' exposure to occupational hazards with reasonable risk. This document focuses attention to the risk of injury or to health in diving and other underwater hazards to fall within the limits prescribed by underwater diving certifying entities for no-decompression diving. It is the policy of the Agency to maintain adequate protection for its employees, property and those for whom it has a responsibility, and to limit occupational exposure to diving-related injuries and other underwater hazards.

The Agency maintains a program that establishes the organizational structure, managerial functions, technical framework, safe dive limits system, and other elements through which this policy is affected. SOPs promulgated under this section establish general approaches and work practices, as well as specific procedures and techniques, to achieve program requirements in all operational settings. It must be explicitly stated here that this document is the policy by which EPA employees conduct all diving operations. By issuing this *Diving Safety Manual,* the DSB reserves the need and right to maintain a set of operating rules, guidelines, procedures and methods as provided in the appendices of this manual. As required by OSHA, this manual is maintained by the DSB for autonomous guidance of its operations.

1.4 Scope

The scope of this manual applies to all EPA employees engaged in underwater activities using compressed gas as the breathing medium in the self-contained or surface-supplied mode and shall be administered following the guidance of EPA's basic policies. This document is the policy by which EPA employees* conduct diving operations. The term "employees" includes full-time, part-time, temporary, and permanent EPA employees. In addition, this manual applies to contractors, who are at a minimum, EPA-certified Divers and who routinely participate as members of an EPA dive unit or contractors and other organizations conducting diving operations at EPA-controlled sites or conducting dives under EPA supervision in accordance with EPA policy.

1.4.1 Federal Regulations.

The directives set forth here are not intended to apply to other federal, state or local governmental agencies or contractor personnel. However, the employees or agents of such agencies, when performing duties at EPA facilities or at EPA-controlled sites working as members of an EPA dive unit, are required to comply with:

a. The more conservative of the employee's organization dive regulations or the EPA Diving Safety Policy and Program.
b. Other sections of the program as directed by the Unit Diving Officer (UDO) or local Safety, Health and Environmental Management Program (SHEMP) Manager.
c. Submission of the dive plan and scope of work, approved by the employee's office, to the office of EPA that hired the employee (the local UDO may review the dive plan if requested).

Employees or agents of other government agencies conducting diving operations with EPA, unless covered under a specific reciprocity agreement between that agency and EPA, must follow the policy and procedures required by their own organization. The employees of contractors, grantees and other organizations having agreements with EPA are required to comply with OSHA regulations for commercial diving or with the scientific diving exemption (provided below) under the auspices of their own organization. The diver's direct employer is required by OSHA to have a written program ensuring compliance under either qualification.

**Contractors whose work is clearly of a commercial nature (e.g., drum search and recovery) shall conduct their dives in accordance with the OSHA Commercial Diving Standard. In any case, the Agency has the responsibility for imposing and enforcing appropriate safety standards for all personnel at a multi-employer work site under its control, such as a Superfund remediation site.*

Contractors, grantees and organizations with which EPA has agreements other than by reciprocating must comply with applicable federal, state and local laws and regulations pertaining to underwater diving unless otherwise covered under this manual. Among other requirements are those mandated in the sections below. Two principal federal agencies regulate and govern diving operations: OSHA and the U.S. Coast Guard, as indicated below:

OSHA: Title 29 — Labor; Subtitle B; Chapter XVII; Part 1910 — Occupational Safety and Health Standards; Subpart T — Commercial Diving Operations and Appendix B to Subpart T — Guidelines for Scientific Diving.

U.S. Coast Guard: Title 46 — Shipping; Chapter I; Subchapter V — Marine Occupational Safety and Health Standards; Part 197; Subpart B — Commercial Diving Operations.

1.4.2 Scientific Diving Requirements/Prohibitions.

Both federal regulations have exemptions for diving operations conducted solely for scientific purposes. The standards indicated below allow diving for observation or research and exclude any operation that might require strenuous activity or activities usually associated with commercial diving operations.

OSHA 29 CFR Part 1910 exempts scientific diving under the following conditions:

§ 1910.401 Scope and Application.

(2) ... However, this standard does not apply to any diving operation: ...

(iv) Defined as scientific diving and which is under the direction and control of a diving program containing at least the following elements:

> *(A) Diving safety manual which includes at a minimum: procedures covering all diving operations specific to the program; procedures for emergency care, including recompression and evacuation; and criteria for diver training and certification.*
>
> *(B) Diving control (safety) board, with the majority of its members being active divers, which shall at a minimum have the authority to: approve and monitor diving projects; review and revise the diving safety manual; assure compliance with the manual; certify the depths to which a diver has been trained; take disciplinary action for unsafe practices; and, assure adherence to the buddy system (a diver is accompanied by and is in continuous contact with another diver in the water) for SCUBA diving. ...*

§ 1910.402 Definitions. ...

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

This appendix contains guidelines that will be used in conjunction with §1910.401(a)(2)(iv) to determine those scientific diving programs which are exempt from the requirements for commercial diving. The guidelines are as follows:

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

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

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

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

1.4.3 Light Working Dives. In addition to performing scientific dives, the EPA allows for divers to conduct light working dives in support of its mission. The UDO must determine and document in the dive plan whether a dive meets the OSHA standard to be a scientific dive and if not, it will be conducted as a light working dive (see EPA Diving Safety Manual, Appendix G and H for requirements and restrictions).

2.0 DIVE PROGRAM ORGANIZATION

2.1 Diving Safety Board

2.1.1 Policies/Procedures

a. The EPA DSB shall be composed of the UDOs from each diving unit and the DSB Chairman as voting members, and a representative from SSD as an ex-officio member.

b. Non-voting consultants, where necessary, may be invited to provide essential expertise on matters relating to the EPA Diving Program.

c. All recommendations for revisions of the policy, diving rules or other requirements associated with this program must be agreed upon by consensus of the DSB voting members.

d. The dealings and recommendations of the DSB may be represented by its officers (i.e., Chairperson, Training Director, and Technical Director) with concurrence of the majority of the DSB.

e. As determined by the DSB Chairperson, all voting members of the DSB will be polled if the business at hand can be delayed and the absent vote(s) would determine the decision.

2.1.2 Responsibilities

The DSB shall make recommendations and be responsible for:

a. Meeting annually at a time and place to be designated by the DSB Chairperson.

b. Recommending policy and changes in operating procedures within EPA that will ensure a safe and efficient diving program.

c. Reviewing existing policies, procedures and training needs to ensure a continually high level of technical skills and knowledge throughout the EPA Diving Program.

d. Planning, programming and directing policy pertaining to the initial certification of new Divers and refresher training of experienced Divers in cooperation with the EPA Diving Program's Technical and Training Directors.

e. Recommending changes in operating policy to SSD through the DSB Chairperson.

f. Serving as an appeals board in cases where a Diver's certification has been suspended.

g. Planning, programming, and directing Diver workshops, seminars, and other activities considered essential to maintaining a high level of competency among Divers.

h. Reviewing EPA diving accidents or potentially dangerous incidents and reporting on preventive measures to ensure safe diving.

i. Reviewing all budgeted advanced diving projects or directing the DSB Chairperson to establish and chair an approved review committee for such projects.

j. Advising SSD directly of any policies, procedures or actions that affect the safety or efficiency of EPA diving activities.

k. Reviewing EPA contracts and cooperative agreements that involve diving, as necessary.

l. Reviewing diving reciprocity agreements, and when necessary, dive plans for non-EPA divers when funded and supervised by EPA.

m. Submitting comments on these activities to SSD.

n. Electing officers by a majority vote of board members.

2.2 Diving Safety Board Chairperson

2.2.1 Policies/Procedures

a. The DSB Chairperson shall be the principal contact within EPA for diving operational policy and safety procedures.

b. The DSB Chairperson shall be a Diver with a wide range of experience and be:

i. A currently certified EPA Divemaster.
ii. Capable of carrying out the responsibilities listed below.

c. The DSB Chairperson will be elected by a majority from among the DSB members to nominally serve a term of five years.

2.2.2 Responsibilities

The DSB Chairperson shall make recommendations to allocate sufficient resources to provide technical assistance and support to SSD, regions, laboratories and other operating units to ensure implementation, management and maintenance of program policies, standards, protocols, priorities and evaluation activities in accordance with the MOA between SSD and the DSB and the statutes, regulations and guidelines identified below. The DSB Chairperson, nominated from the DSB membership and confirmed by the DSB, shall be responsible for:

a. Conducting an annual meeting of the DSB.

b. Conducting an annual review with the EPA DSB of all EPA diving operations during the preceding calendar year and submitting an annual report at the end of the calendar year to SSD.

c. Establishing procedures for the UDOs to conduct safety reviews/inspections of each diving unit on an annual basis.

d. Ensuring that such inspections of each diving unit are accomplished.

f. Reviewing and taking appropriate action on recommendations for changes in operating policy formulated by the EPA DSB and/or SSD.

g. Leading a review of all EPA diving accidents or potentially dangerous incidents and issuing reports on preventive measures to ensure safe diving.

h. Approving the use of specialized types of diving apparatus or gas mixtures, other than open circuit self-contained underwater breathing apparatus (SCUBA) with air or oxygen-enriched air after consultation with the appropriate technical experts.

i. Developing diving reciprocity agreements between EPA and other federal and state agencies, colleges/universities, private institutions, or any other entity (See EPA Diving Safety Manual, Appendix P).

j. Remaining abreast of new diving techniques and innovations.

k. Establishing and chairing such budgeted advanced diving project review committees as may be directed and approved by SSD.

2.3 Diving Safety Board Technical Director

2.3.1 Policies/Procedures

a. The DSB shall elect an EPA DSB Technical Director who will be the principal contact with the DSB Chairperson for safety, equipment and technical matters.

b. The DSB Technical Director shall be a currently certified EPA Divemaster capable of carrying out the responsibilities listed below. This requires the Technical Director to remain current in the knowledge and understanding of industry standards, practices and concerns; diving medicine to the extent necessary to provide guidance on safe diving practices; and diving technology (e.g., by attending the annual diving technology show or other technical meetings).

c. The DSB Technical Director will be elected by a majority from among the DSB members to serve a nominal five-year term.

2.3.2 Responsibilities

The Technical Director shall be responsible to the DSB Chairperson for:

a. Coordinating diving accident reporting with appropriate EPA Safety Managers.

b Reviewing new technologies that may be incorporated into the EPA Diving Program.

c. Working with the DSB Chairperson in reviewing all EPA diving accidents or potentially dangerous incidents and issuing reports on preventive measures to ensure safe diving.

d. Actively researching new diving equipment, techniques and innovations.

2.4 Diving Safety Board Training Director

2.4.1 Policies/Procedures

a. The DSB shall elect an EPA Training Director from its membership who will be the principal contact with the DSB Chairperson for training, certification and Diver qualification. In addition, the Training Director will be an additional resource on issues of safety, equipment, and technical diving matters.

b. The Training Director shall be a currently certified EPA Divemaster capable of carrying out the responsibilities listed below. The Training Director shall be experienced in the areas of instruction, as required by the duties involved in the EPA Diving Program and/or as recommended by the DSB. The Training Director shall be capable of coordinating the training activities for the Diver qualification, certification and safety training programs.

c. The DSB Training Director will be elected by a majority from the DSB membership to serve a nominal five-year term.

2.4.2 Responsibilities

The Training Director shall be responsible to the Chairperson of the DSB for:

a. Providing and coordinating all EPA Diver and Divemaster Training Courses for EPA employees, certifying individuals to the EPA Diver and Divemaster levels, maintaining training records, and issuing Letters of Certification (See EPA Diving Safety Manual, Appendix O) in accordance with this manual.

b. Managing these courses with the advice and assistance of the EPA DSB by discussing possible private (contract) sources of trainers and by delegating various training course responsibilities to the EPA UDOs whom are able to participate in the course.

c. Coordinating contracting activities with SSD for the purpose of providing appropriate trainers for these courses.

d. Remaining abreast of new diving equipment, techniques and innovations.

e. Provide training opportunities for the use of specialized types of diving apparatus or gas mixtures, other than open circuit SCUBA with air or oxygen-enriched air after consultation with the appropriate technical specialists.

f. Providing a written summary of all dives conducted during EPA National Diver Training to the DSB Chairperson for inclusion in the DSB's annual report to SSD.

g. Acting on behalf of the DSB Chairperson if they are unavailable.

2.5 Diving Safety Board Special Operations Director

2.5.1 Policies/Procedures

a. The DSB shall elect a Special Operations Director from its membership, who will be the principal contact with the DSB Chairperson related to special non-routine technical issues or dive support that may be associated with significant national events.

b. The Special Operations Director and DSB Chairperson shall be the lead contacts within the EPA Dive Program for major homeland security or hazardous materials incidents, national disaster response, and coordination of EPA Dive Unit response actions during significant national events.

c. The DSB Special Operations Director shall be a currently certified EPA Divemaster capable of carrying out the responsibilities listed below. The Special Operations Director should be experienced in:

   i. Emergency response to oil/chemical spills or terrorist threats.

   ii. Contaminated water diving procedures and equipment.

   iii. Providing EPA technical support during hazardous material incidents.

   iv. Coordination with local, state and federal agencies.

d. The DSB Special Operations Director will be elected by a majority from the DSB membership to serve a nominal five-year term.

e. If EPA personnel are requested to dive on a special mission, and the proposed activity falls outside of the scope of routine scientific diving, the DSB Chairperson and Special Operations Director will identify and brief key Agency personnel on the nature of the operation prior to committing Agency resources.

2.5.2 Responsibilities

The Special Operations Director shall be responsible to the DSB Chairperson for:

a. As requested, coordinating EPA diving projects with On-Scene Coordinators (OSCs) and Remedial Project Managers (RPMs) at Superfund sites or spills of oil or hazardous substances.

b. Providing technical support or diving capability at national or significant events that involve homeland security, waterborne terrorist threats, major oil or chemical spills to water, or other situations warranting the use of EPA divers.

c. Coordinating EPA diving resources at a significant national event. The Special Operations Director will assess the situation and work in consultation with the DSB Chairperson. Based on the hazards involved, the Director and Chairperson will consult with UDOs and select the most qualified Divers.

2.6 Unit Diving Officer

2.6.1 Policies/Procedures

a. The UDO must be capable of managing the unit's diving assignments, personnel, and equipment resources along with the reporting functions indicated in this policy section. The Director or appropriate manager in each region, Headquarters office, or laboratory, as appropriate, that conducts diving operations shall recommend to the EPA DSB Chairperson a UDO for appointment. The UDO candidate nomination shall be made in consultation with and approved by members of the DSB, who may have a better understanding of a candidate's capabilities to meet the functional requirements.

b. The UDO shall be a currently certified EPA Divemaster capable of carrying out the responsibilities listed below. This requires the UDO to be knowledgeable of industry standards, practices and concerns; diving medicine to the extent necessary to provide guidance on safe diving practices; and diving technology.

c. The UDO is responsible for annually reporting to the DSB a summary of all diving activities, accidents, incidents and other information as requested by the DSB Chairperson.

2.6.2 Responsibilities

The UDOs shall compose EPA's DSB, representing the regional, Headquarters offices, and laboratories, and shall be responsible within the unit for:

a. Reviewing and acting on (i.e., approve or request amendment to) requests for dive plan approval. Reviewing and maintaining copies of all dive training and qualification records for all EPA-certified divers within their unit.

b. Maintaining current generic diving safety policies, plans and procedures.

c. Providing technical support locally in the development of site safety plans (e.g. Health and Safety Plans [HASPs]).

d. Providing managerial and technical resources for diving programs to the unit managers and supervisors.

e. Providing, if possible, onsite logistical and supervisory support to the EPA Training Director for Diver training courses.

f. Investigating and reporting each diving accident/incident and employee diving-related illnesses that occur within the unit, in conformance with Subsection 3.1.8, "Reporting, Investigating and Reviewing Diving Accidents," in concert with the SHEMP Manager.

g. Planning, programming, directing and reviewing the diving activities within the unit to ensure compliance with EPA policies, procedures and standards relating to diving operations.

h. Maintaining familiarity with all diving activities within the unit.

i. Complete the diving portion of the safety self-assessment tool (See EPA Divining Safety Manual, Appendix M) in coordination with the SHEMP Manager annually and pursue corrections as needed. Coordinate with SSD to conduct in-person audits as needed.

j. Recommending Divers for advancement in the EPA Diver Training Program.

k. Advising and assisting the Training Director in planning and coordinating Diver training programs leading to certification of Divers to meet the various research and technical diving requirements of EPA.

l. Establishing requalification criteria within the unit for Divers whose proficiency requirements have lapsed.

m. Submitting an annual report of all diving activities and accidents, as required, to the DSB Chairperson.

n. Ensuring that all diving gear and accessory equipment is maintained in a safe operating condition.

o. Ensuring the maintenance of equipment files for the unit. To include type, brand name, serial number and repairs completed on compressors, tanks, regulators, depth gauges, submersible pressure gauges (SPG) and decompression meters and/or dive computers.

p. Ensuring that a competent Divemaster is in charge of the diving operations conducted by the unit.

q. Maintaining records on each Diver in their unit or delegating this responsibility to an Alternate UDO. The records maintained on each Diver shall include, but not be limited to: a copy of the Diver's most recent Medical Qualification Form; a copy of the Diver's Letter of Certification; copies of the Diver's training records and qualification requirements; and copies of the unit's dive log. (*Note:* The individual Diver should be responsible for maintaining a copy of his/her own completed Medical Evaluation Form, as submitted for Diver qualification.)

r. Ensuring that all Divers demonstrate their ability to meet basic physical fitness standards by successfully completing the swim test requirements of the EPA Diver Training Program. This test should be conducted at least every two years, and at any time the UDO deems necessary (e.g., following a long hiatus of not diving).

s. Ensuring that all Divers use breathing gas meeting standards found in EPA Divining Safety Manual, Appendix A, Section 25.

t. Ensuring Divers in their unit meet and maintain qualification requirements including:

   i. Training/Requalification Dives
   ii. Cardiopulmonary Resuscitation (CPR) Training
   iii. Automated External Defibrillator (AED) Training
   iv. First Aid Training
   v. Oxygen Administration Training
   vi. Medical Monitoring

u. Providing an annual rescue drill opportunity for their dive unit.

v. Determining whether dive operations are to be conducted as scientific dives or light working dives, and for documenting this determination in the dive and project plans, dive logs and reports per EPA Diving Safety Manual, Appendix G.

2.7 Alternate Unit Dive Officer

2.7.1 Policies/Procedures

An Alternate UDO will be designated at the discretion of the UDO by internal memorandum to the Office Director (or equivalent level), the DSB Chairperson, and the UDO's appropriate supervisor, to temporarily assume the duties of the UDO in his/her absence. The primary responsibility is to provide coverage for administrative responsibilities in the UDO's absence.

2.7.2 Responsibilities

(See UDO Responsibilities above)

2.8 Divemaster

2.8.1 Policies/Procedures

a. The Divemaster designation is an assigned function for each diving project, similar to a site supervisor. Depending on the unit organization, a Divemaster shall be assigned for each ship/work party by the UDO for all diving operations. In the UDO's or Alternate UDO's absence, the EPA DSB Chair, Technical Director or Training Director may assign the Divemaster.

b. The project Divemaster shall be a currently certified EPA Diver experienced in that specific type of diving and must have successfully completed the EPA or NOAA Divemaster Training Course.

c. The Divemaster or UDO may designate an Acting Divemaster who may not have completed the EPA or NOAA Divemaster Training Course or met all requirements in Subsection 4.5.5, "Certification." The Acting Divemaster should be a fully qualified Diver experienced with the type of dive operation being conducted.

2.8.2 Responsibilities

Designated Divemasters are responsible for:

a. Supervising employees and Divers, as appropriate, and in a manner so as to ensure that their health is protected through the application of this program and all related guidance and directives.

b. Through observation of Divers' performance in the field, identifying those who may be eligible for enrollment, advancement or discharge from the program.

c. If requested by the UDO, overseeing the proper handling and use and timely replacement of critical diving equipment.

d. Jointly reviewing diving-related incidences involving their subordinates in consultation with the SHEMP Manager and UDO.

e. Being aware of their Divers and other workers who are diving profiles that approach the no-decompression limits (or oxygen toxicity limits for Oxygen Enriched Air [Nitrox] or mixed-gas profiles) and monitoring those individuals for neurological or toxic effects (see EPA Diving Safety Manual, Appendix D for EPA Dive Tables)

f. The Divemaster, or their designee, shall be in complete charge of all diving operations conducted by the ship/work party and shall be responsible for ensuring that: Ensuring Divers in their unit meet and maintain qualification requirements including:

   i. All diving operations are conducted safely in accordance with prescribed EPA diving safety rules and regulations.

   ii. All Divers are certified, properly trained and physically fit to perform the required diving and that the prescribed files are maintained if responsibility has been delegated by the UDO.

   iii. All equipment is in a safe operating condition and that the required maintenance records are maintained as directed by the UDO.

   iv. Emergency procedures are understood by all personnel before diving.

v. An accurate log of all diving activities is maintained (e.g., times in/out of water, tank pressures) as required in Subsection 3.1.7, "Diving Plans, Reports and Logs."

vi. All Divers are monitored after each dive for symptoms of Decompression Illness (DCI) (e.g., DCS or AGE).

vii. Reporting immediately all diving-related accidents/incidents within their unit in conformance with Subsection 3.1.8, "Reporting, Investigating and Reviewing Diving Accidents."

2.9 Diving Safety Supervisor

On hazardous waste sites, EPA OSC and/or RPM are ultimately responsible for the health and safety of all site workers per the National Contingency Plan Section 300.150. In diving operations at hazardous waste sites, the designated EPA Diving Safety Supervisor, as the Divemaster, is immediately responsible for the health and safety of Divers under his/her control. The EPA Divemaster should make recommendations to the EPA OSC and RPM for commercial diving subcontractors. Because of the shared responsibilities, both parties shall ensure implementation of this program and all related guidance and directives at reporting units, establishments, or workplaces.

2.9.1 Designation

A Diving Safety Supervisor will be approved by the EPA DSB with written concurrence of the regional or laboratory office in which the candidate is located.

2.9.2 Qualifications

The Diving Safety Supervisor shall:

a. Be a currently certified EPA Divemaster.

b. Complete 40 hours of OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) Training and be current with their annual 8-hour OSHA HAZWOPER Refresher Training.

c. Be knowledgeable of all regulations (e.g., EPA, OSHA, AAUS) affecting the diving operations.

d. Have at least three years of experience with the EPA Diving Program.

2.9.3 Responsibilities

The Diving Safety Supervisor shall be responsible for:

a. Ensuring that all diving operations are conducted in compliance with the EPA Diving Safety Policy.

b. Ensuring that all diving operations are conducted in accordance with OSHA requirements.

c. Protecting the Agency's interest in the project and adhering to all applicable criteria for sample collection and recordkeeping (including chain-of-custody).

d. Remaining abreast of new field techniques, procedures, equipment and regulations.

2.10 Scientific/Light Working and Trainee Divers

2.10.1 Policies/Procedures

a. Individual Divers shall be certified by the EPA DSB Training Director and the DSB Chairperson in accordance with the provisions of Subsection 4.5, "EPA Diver Certification."

b. Divers shall be sufficiently trained to undertake the assigned diving tasks.

2.10.2 Responsibilities

The individual Divers (including the Dive Tender, as the specific dive plan requires) are responsible for:

a. Comply with the requirements established by this program and following all directives, SOPs, and related guidance in the performance of their work.

b. Adhere to dive safe practices in all underwater work-related activities.

c. The proper handling, use and timely replacement of critical diving apparatus and breathing gases.

d. Maintain a high level of diving proficiency.

e. Maintain diving fitness. Diving can be physically demanding and requires that each Diver be physically fit in order to conduct operations safely and effectively. To facilitate the maintenance of good physical conditioning, all Divers may request and be granted up to three hours per week during work hours to exercise, subject to their supervisor's approval and the Diver's adherence to EPA policy. The ability to establish programs to promote and maintain physical fitness of federal employees is provided under Section 7901(a) of Title 5 of the United States Code (U.S.C.).

All Divers will be required to demonstrate their ability to meet basic physical fitness standards by successfully completing the swim test requirements of the EPA Diver Training Program. This test should be conducted at least every two years, and at any time the UDO deems necessary (e.g., following a long hiatus of not diving).

f. Maintain all personal dive equipment in safe operating condition.

g. Ensure diving conditions are safe.

h. Not violating the dictates of training or diving regulations.

i. Maintain a current individual dive log of all EPA-related dives, including training and proficiency dives. Divers will report to their UDO any dives conducted with EPA issued dive gear, including those done on the Diver's own time.

j. Maintain current CPR/AED, Emergency Oxygen Administration, First Aid certifications, and participate in an emergency rescue drill at least every two years and complete hazmat materials cylinder handling and transportation training every three years.

k. Divers are required to notify the UDO if there are any potential issues regarding their physical and/or psychological fitness that could affect their ability to dive.

2.10.3 Refusal to Dive (All Levels)

Each Diver has the responsibility and right to refuse to dive in any of the following cases:

a. If diving conditions appear to be unsafe or unfavorable.

b. If at any specific time the Diver feels that they are not in good physical or mental condition for diving.

c. If, by diving, the Diver would exceed their level of training or applicable regulations. The conditions and reasons for refusing to dive may be required to be documented. If requested, the incident will be reviewed by the UDO, and appropriate action may be taken. Any action resulting from this review may be appealed to the EPA DSB.

2.11 Dive Tender

2.11.1 Policies/Procedures

A Dive Tender, designated by the Divemaster or UDO, shall accompany all EPA sanctioned dive operations. Except for low-risk dive operations, the Dive Tender shall be a fully qualified Diver having knowledge and experience with the dive operation. For low-risk dives, the Dive Tender may be a non-Diver, but must be currently certified in CPR/AED and First Aid and be familiar with dive operations.

2.11.2 Responsibilities

The Dive Tender is responsible for:

a. Assisting in donning the Divers.

b. Assisting in tracking each Diver's location in the water.

c. Recording each Diver's tank pressure before and after each dive, their bottom time and maximum water depth.

d. Alerting Divers, when necessary, on the status of their bottom time via the Diver Recall Unit.

e. Advising other vessels of the diving operation and warning off boat traffic that might pose a hazard to the Divers.

f. Assisting the Divers in exiting the water and doffing their equipment.

2.12 EPA Diving Medicine Specialist

2.12.1 Policies/Procedures

a. The SSD Operations Branch Chief will be responsible for appointing the EPA Diving Medical Specialist (DMS). Nominations may be considered from both the DSB and SSD. Upon the advice of the EPA DSB Chairperson, the EPA DMS must perform or fulfill the following roles:

   i. Be a qualified hyperbaric/diving medicine physician.

   ii. Serve as a consultant to provide essential expertise on matters relating to the medical qualifications of Divers.

b. The EPA DMS will receive overall policy guidance, except for medical policy, from SSD, and shall make recommendations to the EPA DSB or to its Chairperson, as appropriate.

c. The credentials of the EPA DMS must include:

i. Certification as a physician licensed to practice medicine in the United States of America.

ii. Board Certification in an established primary care specialty such as Internal Medicine, Family Practice, or Emergency Medicine.

iii. Qualification as a hyperbaric/diving medicine physician, as evidenced by specific certification as a Navy Diving Medical Officer licensed in hyperbaric medicine or holding a certificate of additional qualification for hyperbaric/diving medicine (Board of Preventative Medicine, Division of Occupational Medicine) and attending courses and seminars, for continuing education, in hyperbaric/diving medicine accredited by the Undersea and Hyperbaric Medical Society (UHMS).

d. The EPA DMS will be provided by agreement (i.e., contract or memorandum of understanding through another department of the government) to be available for consultation to the DSB and/or SSD.

2.12.2 <u>Responsibilities</u>

An EPA DMS, appointed by (and/or under contract to) SSD, shall be responsible for:

a. Providing medical input and recommendations for policies, procedures (e.g., medical evaluation criteria), and other issues that relate to the safety and health matters of Divers.

b. Serving as a professional liaison with EPA contractors providing routine medical examinations on EPA Divers.

c. Reviewing all physical examinations, making final determinations regarding the ability of Divers to perform their diving-related duties, and submitting these determinations, using the current EPA Medical Evaluation Form for Divers, to the respective UDOs as well as the DSB Chairperson.

d. Reviewing or performing special consultations, disability evaluations, independent medical evaluations and other activities and rendering an expert opinion concerning the fitness of Divers.

e. Reviewing medical records pertinent to any diving-related medical emergency, incident or fatality.

f. If requested by the DSB and resources allow, compile medical data related to diving and report the conclusions of the compiled medical data to SSD and the DSB.

g. Responding to specific medical inquiries from SSD or the DSB.

h. Recommending changes in the medical criteria for Divers summarizing and reviewing results of the medical examinations and providing recommendations to the DSB based on the analysis.

i. Reviewing the appeals of individual Divers who have been disqualified, permanently or temporarily, due to their medical qualifications.

j. Provide an annual blanket oxygen prescription to SSD and the DSB for the purpose of maintaining and filling oxygen cylinders.

2.13 SSD Representative

2.13.1 Policies/Procedures

a. The Director of SSD will be responsible for appointing the SSD Representative. Nominations may be considered from both the DSB and SSD.

b. Upon advice of the EPA DSB Chairperson, the SSD Representative is requested to perform or fulfill the following roles:

   i. Attend or participate in DSB meetings as an ex-officio member.

   ii. Act as a liaison to the SSD and the DSB to:

   - Assist with preparation and presentation of Diving Safety Program budget issues to SSD.
   - Act as the advocate for the Diving Safety Program at SSD.
   - Act as the lead for independent audits of the Diving Safety Program.

c. The SSD Representative will ensure a valid MOA is in effect providing autonomy of the DSB, as required by OSHA under the Scientific Diving Exemption (29 CFR Part 1910.401).

2.13.2 Responsibilities

The SSD Representative shall make recommendations and be responsible for:

a. Attending or participating in annual DSB meetings.

b. Assisting with annual budget funding requests to various Program Managers who use the Diving Program's services.

c. Maintaining Headquarters records of the Diving Safety Program including:

   i. DSB Annual Reports
   ii. Audit Report

3.0 DIVE PROGRAM ELEMENTS

3.1 General Operations

3.1.1 Project Review

Proposed diving projects involving systems or modes other than open-circuit SCUBA, and not addressed elsewhere in this manual, must receive the approval of the EPA DSB, or its designee, before proposed diving activities can begin. The EPA DSB, or its designee, in reviewing and considering operational and safety-related aspects of the project, shall review and consider:

a. Diver qualifications, certification and physical condition.

c. The availability of equipment and personnel required to complete the project.

d. Specific SOPs regarding safety, methodology and emergency procedures.

e. Support staffing.

In the case of long-term programs other than standard SCUBA not covered elsewhere in these regulations, an EPA DSB review shall be conducted annually or when major personnel or diving system changes occur.

3.1.2 SCUBA Diving Teams

Except under emergency conditions and/or using the Tethered Diving SOP (EPA Diving Safety Manual, Appendix J), the buddy system of at least two Divers shall always be required. When conditions are such that the probability of Diver separation is high, such as with low visibility, some form of direct contact, physical or visual, between Divers shall be maintained. At all times, Divers (especially Trainee Divers) shall be in physical, visual or auditory contact with other qualified members of the dive team so that assistance can be easily rendered in the event trouble occurs (e.g., entanglement, out-of-air emergency). In the event that diving is shallow within a restricted area, and as water conditions allow, the buddy Diver may remain at the surface fully equipped while maintaining contact (e.g., line tending, visual or underwater communication audio) with the Diver at all times.

A Dive Tender shall always be present to assist Divers in and out of the water. Depending on conditions, and at the Divemaster's discretion, a fully suited, equipment-ready standby Diver might also be required.

3.1.3 Diving by Non-EPA-Certified Personnel

Persons not included in a reciprocity agreement must submit, in advance, evidence of diving training and full medical qualifications, as described in Subsection 4.4, "Physical Examination," to the UDO, or their designee, who will evaluate this evidence along with the standards required for EPA certification to determine equivalence with a level of EPA certification. Where sufficient doubt exists, this evidence shall be forwarded to the DSB Training Director for a decision. In all cases following medical approval, a checkout dive shall be observed by the UDO or his/her designee before the beginning of diving operations. Volunteers (if covered by workers comp) may be accepted under a reciprocal agreement if they are certified by NOAA. Reciprocity agreements with other State or Federal agencies and AAUS may be accepted with the approval of the DSB Chairperson (also see Subsection 3.7.2, "Planned Deviations – Diving by Non-EPA divers as Observers").

3.1.4 Diver Proficiency

EPA-certified divers should log an average of two dives per month. Any time six weeks or more elapse without a dive, the Diver should complete a requalifying program. Any time three months or more elapse without a dive, the Diver **must** be requalified before resuming EPA dives (as specified by the UDO). This requirement may be waived by the UDO only during emergency conditions. A report of such waiver must be submitted to the DSB Chairperson by the UDO for review by the EPA DSB. Supervisors shall authorize the necessary time and payment for qualifying dives if diving is required for official program activities.

3.1.5 Equipment Availability During Off-Duty Hours

Due to the high level of proficiency required and in recognition of the important benefits of regular dive training with a uniform set of diving equipment, EPA divers may use EPA-issued diving equipment during off-duty dives for the purpose of maintaining diving proficiency. Such training helps maintain familiarity with the controls and function of the equipment, develops muscle memory needed to react automatically during emergencies, and promotes physical fitness.

a. In order to use EPA-issued dive equipment during off-duty hours, EPA Divers must be currently authorized to dive in the U.S. EPA Scientific Diving Program. Divers whose diving proficiency has lapsed may participate in off-duty dives for the purpose of obtaining requalification, with UDO approval.

b. Prior to using EPA-issued diving equipment during off-duty dives, each diver must sign and comply with the Agreement, Liability Release and Express Assumption of Risk form for EPA Divers Using EPA Supplied Equipment During Off-Duty Hours (Diving Safety Manual, Appendix F). Liability Release waivers are valid for the duration of one's tenure as an EPA Diver. Copies of these documents, with original signatures, will be maintained at the Diving Unit by the UDO.

c. Since Divers using EPA-issued equipment during off-duty dives will receive credit for training/proficiency, they must complete at least two of the following skills, or other skills as appropriate, during each incidence of use:

- Ditch and don Buoyancy Compensation Device (BCD)
- Weight belt/pouch removal/replacement
- Disconnect/reconnect inflators (BCD/drysuit)
- Dry suit roll outs and venting
- Out of air scenario using Emergency Gas Supply (EGS) and/or backup regulator
- Unconscious diver tow/recovery
- Mask removal, replace, and clear
- Maintain neutral buoyancy for 2 minutes
- Control descent/ascent rate
- Underwater (U/W) communication (hand signals)
- U/W navigation and orientation
- Regulator recovery
- Surface Marker Buoy (SMB) deployment
- U/W photography/videography
- Other skills (List - ____________________________)

d. Completion of requirements in Subsection, 3.1.5.c (above) should be documented following an off-duty dive with EPA-issued dive gear and a copy of the documented skills kept on file by the UDO at the unit for a minimum of one year.

e. All off-duty dives using EPA-issued gear should be logged as “Proficiency” and “off-duty” in the diver’s log and reported to the UDO per Subsection 2.10.2.i under Responsibilities for Scientific/Light Working and Trainee Divers.

f. Divers using EPA-issued dive gear during off duty hours are required to dive within standard recreational dive limits, i.e., maximum depth of 130 feet of seawater (FSW), no decompression diving, no solo diving, surfacing with at least 500 psi.

g. Working or commercial diving is not allowed with EPA-issued dive gear during off-duty hours.

3.1.6 Non-EPA Diving

a. EPA-certified divers may participate in non-EPA programs in an official capacity, provided each EPA diver abides by the provisions of this manual and that the other divers meet minimum EPA diver requirements as determined through a reciprocity agreement, by the UDO or higher authority. Dives conducted as sanctioned activities may be included in the Diver's proficiency/qualification records.

b. EPA divers participating in non-EPA activities and not representing the Agency will not be held to the standards contained herein. However, such dives may not be sanctioned by EPA. EPA divers are prohibited from conducting dives that fall outside the standards provided in this document, when the Diver is in pay or authorized travel status by the Agency.

c. Non-EPA dives may be considered for inclusion in the Diver's proficiency/qualification records only upon approval of the Diver's UDO, the DSB Chairperson or the Training Director.

d. When using EPA equipment, Divers should comport with recreational dive standards of safety.

3.1.7 Diving Plans, Reports and Logs

Divers are required to log and report all dives using EPA equipment. The logged information must indicate the dive location, purpose or function, maximum water depth, and bottom times as indicated in EPA Diving Safety Manual, Appendix A, Section 6.

Recordkeeping

For EPA dives, the following procedures should be followed:

a. The original project's dive plans, Dive Tender's logs, and dive reports will be maintained by the UDO. Dive Plans should be prepared by the Divemaster for the project and receive written approval by the UDO, and if required, by local management (see EPA Diving Safety Manual, Appendix E). Divers must indicate in writing that they have read and understand the dive plan. Dive reports will be prepared by the project Divemaster and sent to the UDO for signature. The reports should be submitted to the UDO within a timely manner after completion of the dive project authorized by the dive plan.

b. Dive logs for each dive unit will be maintained by the UDO. The Divers will provide the UDO with their dive log summaries on an annual basis. The annual reports of the diving activities of each unit will be provided to the Chairperson and the DSB. Topics to be addressed in the unit reports are listed in EPA Diving Safety Manual, Appendix Q. The DSB Chairperson will ensure that an overall report of all dive unit operations is forwarded to SSD annually.

3.1.8 Reporting, Investigating and Reviewing Diving Accidents

It is the responsibility of the Regional, Office, or Laboratory Director, SHEMP Manager and the UDO to ensure that any diving accident within the unit is promptly and properly reported in accordance with EPA regulations. Additional reports must be filed if necessary, as required by OSHA and/or under agreement by organizational membership in the AAUS. The following details describe the investigation, reporting and reviewing requirements to EPA authorities.

a. *All Accidents or Occupational Illnesses* must be reported to the SHEMP Manager and by completion of the appropriate report form (see forms CA-1, CA-2, CA-16, CA-17, OSHA and EPA 301 and HCFA 1500) available through the Human Resources department.

b. *Fatal Accident or Critical Injury* shall be reported immediately by telephone or other rapid means to the following:

   i. UDO
   ii. Immediate Supervisors
   iii. Regional, Office, or Laboratory Director and SHEM
   iv. DSB Chairperson
   v. Director of SSD

c. *All Diving Accidents and Incidents*, including any potential cases of DCI (e.g., DCS or AGE), significant equipment malfunctions, and diving emergencies shall be reported immediately. The report routing sequence for incidences indicated as noncritical should be as follows:

   i. The Divemaster shall report immediately to the UDO.

   ii. The UDO, upon observing a diving accident or receiving the divemaster's report of a diving accident, shall ensure that the divemaster has prepared and forwarded the necessary reports. In addition, the UDO shall prepare a detailed analysis and written report to the DSB Chairperson within 10 days after the date of the accident. Included in this report shall be the nature of the operation, existing conditions, personnel involved, type of equipment used, nature of injury or equipment failure, causal analysis, recommendations for prevention of a similar future accident, and any other pertinent facts.

   iii. The UDO shall work with the Regional, Office, or Laboratory Directors or their designee to report immediately to the EPA DSB Chairperson by telephone or other rapid means and conduct a complete fact-finding investigation of each diving accident/incident, coordinate the reporting, and submit a written report within 30 days to the EPA DSB Chairperson.

iv. The EPA DSB Chairperson, EPA Technical Director, EPA DMS, and EPA DSB shall review all diving accidents and incidents and report on preventive measures to ensure safe diving. If the circumstances warrant such action, they may convene a special investigation. Recommendations for changes in operating policies or procedures shall be reported to SSD. In the event of a serious accident or a fatality, the Agency maintains the right and shall pursue drug testing of all key operation personnel under the Agency's drug testing protocols, as applicable.

3.2 Special Equipment and Operations

3.2.1 High Altitude Diving (> 1,000 ft.) (see EPA Diving Safety Manual, Appendix A, Section 9)

3.2.2 Blue Water (Over-Bottom) Diving (see EPA Diving Safety Manual, Appendix A, Section 11)

3.2.3 Diver Propulsion Vehicles (DPVs) (see EPA Diving Safety Manual, Appendix A, Section 12)

3.2.4 Swift Water (Strong Current) Diving (see EPA Diving Safety Manual, Appendix A, Section 13)

3.2.5 Nitrox (Oxygen Enriched Air) Diving (see EPA Diving Safety Manual, Appendix B)

3.2.6 Surface Supplied Diving (see EPA Diving Safety Manual, Appendix I)

3.2.7 Tethered Diving (see EPA Diving Safety Manual, Appendix J)

3.2.8 Equipment Decontamination (see EPA Diving Safety Manual, Appendix K)

3.2.9 Biohazards Protection (see EPA Diving Safety Manual, Appendix Q)

3.3 EPA Diving Safety

3.3.1 Rules

The EPA Diving Safety Rules shall be adhered to on all diving operations (see EPA Diving Safety Manual, Appendix A).

3.3.2 Safety Audits

Diving units shall periodically be subjected to safety quality assurance reviews. Reviews, inspections or audits shall be conducted as both an internal function and by the SSD Safety Audit Department. UDOs shall maintain knowledge and records of the unit's diving equipment maintenance, compressor systems and air quality, Diver records, and emergency equipment.

Program audits, involving planning, implementation, assessment, reporting and quality improvement, shall ensure that the program management and operations functions are established, monitored and continuously improved to limit EPA divers' occupational exposure to hyperbaric illnesses. The audit system includes specific activities for collecting and analyzing information to indicate levels of success and effectiveness of individual program functions. The audit activities focus on process and outcomes, and include:

a. Program audits and self-assessments
b. Dive incident reporting
c. Quality control activities
d. Operating data and reports
e. Performance standards and indicators

SSD will be responsible for conducting periodic audits of the various diving unit programs. All audits will be conducted following procedures outlined in the audit checklist in EPA Diving Safety Manual, Appendix M.

3.3.3 Maritime Safety
(Refer to the EPA Vessel Safety Manual.)

3.4 Recordkeeping

3.4.1 Diver Training

The EPA Training Director shall maintain complete files on all Divers that have completed EPA Diver Certification. This includes written tests, logs of water work, classwork, and homework. The records will be maintained by EPA for a minimum of 5 years following cessation of diving in the program.

3.4.2 Diver Medical Reviews and Records

Physical evaluation and qualification for diving will be conducted in accordance with Subsection 4.3, "Physical Examination." Completed forms are maintained by the EPA DMS at the Public Health Service. A copy of the completed evaluation form may be requested by the Diver. The Medical Surveillance Clearance Statement is forwarded from the EPA DMS to the local SHEMP Manager and UDO. For those candidates applying for the EPA Diver Training Course, the Medical Clearance Form will be forwarded to the Chairperson of the DSB, and to the Training Director.

3.4.3 Dive Logs

Maintenance of an individual Diver's personal log is the responsibility of that Diver. The Diver's UDO is responsible for maintaining the official dive records, including the original Dive Tender's logs (see EPA Diving Safety Manual, Appendix E).

3.4.4 Accident/Incident Reports

Standard EPA procedures apply for reporting and recordkeeping of any work-related incidents.

3.4.5 Equipment Logs/Maintenance Records

UDOs are required to maintain the following records (or have access to those records that may be prepared by local dive equipment maintenance specialists, such as a local dive shop): tank visual inspection process (VIP) and hydrostatic tests, tank valve and burst disk maintenance, SCUBA regulator system and submersible pressure gauge (annual maintenance and calibration), variable volume dry suit (VVDS) systems, surface supply systems, Full-face Mask (FFM), hard hat/helmet systems, BCD, and compressor maintenance.

3.4.6 Project Dive Requests/Clearances

The UDO is responsible for maintaining the records of approved dive plans and clearances. A dive plan must be prepared for all EPA-sanctioned dive operations and submitted to the UDO for approval. Upon completion of the dive operation, a dive report signed by the Divemaster in charge will be submitted to the UDO, along with all original dive logs. The UDO will maintain complete records of all dive operations for seven years.

3.5 Emergency Planning

3.5.1 Diving Accident Management

a. All EPA divers must complete training in diving accident management.

b. Planning for diving accidents should include transportation and oxygen administration (e.g., backboarding as a potential need). The Divemaster must pass on to emergency responders all known details of the accident but may not insist that the victim be transported to a hyperbaric chamber instead of a hospital. (*Note:* Standard Coast Guard operating procedures do not normally allow for the administration of oxygen en route unless specifically instructed by the patient. The Divemaster may be responsible for providing these instructions.)

c. The choice of treatment location and regime is beyond the typical training of EPA field personnel. Emergency evacuation personnel should be instructed to communicate with the Divers Alert Network (DAN) at 919-684-9111. Non-emergency diving-related inquiries should be made to DAN at 919-684-2948.

3.5.2 Communications

The Divemaster will ensure that there is at least one means of emergency two-way communication with shore support, such as very high frequency (VHF) radio, satellite phone or cellular telephone. In the event of an emergency on site, such as diver injury, sudden adverse weather, or chemical release that might have an impact outside of the immediate area, the Divemaster or his/her alternate is responsible for immediately communicating the emergency to the nearest emergency response unit and the EPA unit from which the operation is based.

3.5.3 Oxygen Administration

For any diving-related injury (e.g., DCS, AGE), providing 100% oxygen is critical to successful treatment and recovery. It is required that all personnel be familiar with how to operate the emergency oxygen equipment and complete training in oxygen administration for diving every two years, such as is available through DAN or other local sources.

3.5.4 Transportation

In the event of injury at a dive site, communication will be established with the closest available emergency response unit (e.g., Coast Guard, local authority via 911, VHF radio, or satellite telephone communication). The ranking dive team member will be responsible for determining the best course of action as to stabilize the diver's condition and await transportation (e.g., for Coast Guard evacuation) or to make best speed toward shore for treatment.

3.6 Reciprocity

To facilitate joint diving operations between EPA and colleges and universities, private institutions, grantees, states or counties, or any other agencies or entities, the UDO may institute a reciprocity agreement that has been approved by the DSB Chairperson and meets the following criteria:

3.6.1 Visiting non-EPA-certified divers accompanying EPA divers on EPA projects, or conducting dive projects for EPA without the presence of EPA divers, shall have or be covered by the following rules:

a. A Scientific Diving Program, as implemented by his/her responsible organization (e.g., employer or institution of learning)

b. Diving training, comparable to EPA's program, for the tasks to be performed.

c. Approved Standards for Scientific Diving.

d. Written approval for diving from the responsible organization's appropriate management level.

e. A reciprocity agreement (See EPA Diving Safety Manual, Appendix P).

f. Evidence of a complete dive medical examination.

g. Completed equipment maintenance logs for equipment used on the subject dives.

h. A brief diver resume.

3.6.2 Any reciprocity agreement shall apply only to divers in the employ of or studying under the sponsoring institution specified in the agreement; additional agreements will be required for divers not directly covered by the sponsoring institution. No third-party agreements are allowed, per Subsection 3.6.6 (below). The visiting diver must have written permission from his/her Diving Safety Officer (or UDO). In addition, the visiting diver must be covered by a comprehensive accident insurance plan by his/her sponsoring institution.

3.6.3 For a non-EPA diving program to be considered comparable to the EPA Diving Program, it must, at a minimum, conform to the OSHA Commercial Diving Standard (29 CFR 1910, Subpart T) or the terms of the Scientific Exemption for that standard. The EPA UDO or his/her designee shall ensure compliance with the terms of the reciprocity agreement; however, some records, such as medical records, may remain in the possession of the sponsoring institution. Compliance with the terms of this reciprocity agreement, as well as the actual diving operations, are subject to on-site inspection by members of the EPA DSB at any time. UDOs may request written verification from the reciprocating organization as to the date of the last medical examination and request that the individually named Diver is cleared and rated for the given diving activities.

3.6.4 The reciprocity agreement may be renewed annually with the consent of all parties to the agreement, or it may be terminated or modified by the DSB Chairperson or the DSB at any time.

3.6.5 An EPA diver may participate in a non-EPA project in an official capacity, provided he/she conforms to the provisions of the EPA *Diving Safety Manual* and the other divers in that diving operation meet the minimum EPA diving safety requirements for the degree of difficulty and complexity for their role in the diving to be performed.

3.6.6 Reciprocity agreements from EPA may not cover third parties to the co-signing organizations. Dive projects that involve three or more organizations may require that each organization interested in participating in an EPA-sponsored project enter into a reciprocity agreement with EPA.

3.6.7 Any EPA regional office or laboratory that does not have an established dive unit and that may have need for occasional diving services, is required to coordinate those operations with the EPA DSB to ensure the adherence to the policies and procedures set forth in the EPA *Diving Safety Manual.* Such units are urged to seek the services of other EPA units that have this capability. Contracted diving service organizations must show proof of operating under OSHA or Coast Guard regulations and have in place their own "Diving Safety Program," even if EPA may have oversight. The OSC or RPM must request assistance from an EPA UDO to review the contractor's operating procedures and safety plans (e.g., HASP) to ensure compliance.

3.7 Exceptions

3.7.1 Unplanned (Emergency) Deviations

Emergency conditions may warrant actions contrary to the dictates of this manual. If this occurs, a detailed written report shall be prepared by the Divemaster for the dive operation. This report shall include a description of all conditions that led to and resulted in the subject condition and actions taken to address the emergency. If an injury occurs, the report will be in accordance with Subsection 3.4, "Accident/Incident Reports."

3.7.2 Planned Deviations – Diving by Non-EPA divers as Observers

At the discretion of the UDO, non-EPA-certified divers may accompany an EPA dive operation as an observer of an EPA program.

EPA program sites may be visited by representatives of other agencies, the media and dignitaries for the purposes of familiarization, evaluation or reporting on EPA programs. Such visits often involve diving activities that are equivalent to recreational diving and can be safely accomplished by persons holding recreational diving credentials. The requirements of EPA diver certification for Divers are substantially more stringent than the standards of the recreational diving industry. The program must ensure that observer divers do not pose a significant hazard to themselves or EPA divers through their lack of experience and/or training.

The policy and standards provided in Subsection 3.6, "Reciprocity," of this manual will allow EPA programs to safely accommodate observing divers who are not EPA certified but meet the requirements stated herein. Personnel not certified by EPA, in accordance with the requirements of this manual, may dive in conjunction with the activities of EPA programs as "observing divers" without obtaining EPA

Diving Certification. This policy applies to EPA employees and non-EPA personnel who have been invited to observe the underwater activities of EPA while using SCUBA equipment. This policy shall only apply when:

a. The observing diver does not participate in work being performed and is accompanied by a fully certified EPA diver who is not performing work.

b. The observing diver is participating in a single dive or a series of dives on a single trip not to exceed six dives per year.

Persons who fall within the scope of this policy must provide to the EPA UDO prior to participating in a dive:

a. Evidence of diving certification by a recognized diver certifying organization (e.g., the U.S. Armed Forces, National Association of Underwater Instructors [NAUI], Professional Association of Diving Instructors [PADI], SCUBA Educators International [SEI], SCUBA Schools International [SSI], Scuba Diving International [SDI]).

b. Evidence of a physical examination conducted by a medical doctor within 12 months of the date of the planned dive (report shall indicate medical fitness to dive), and the observer is willing to complete a medical questionnaire and waiver of liability for the subject dive (e.g. Recreational Scuba Training Council [RSTC] form).

c. Evidence of diving experience indicating the appropriate level of proficiency required for the diving conditions likely to be encountered.

d. Evidence of equipment servicing within the past year.

The UDO shall:

a. Inspect the credentials of the observing diver (including an up-to-date logbook) and determine whether the observing diver has presented evidence establishing certification by an approved organization and has had a physical examination within 12 months prior to the date of the planned dive.

b. Determine if the observing diver's experience level and proficiency are adequate for the conditions likely to be encountered on the dive. The UDO or Divemaster shall conduct an in-water evaluation of the observing diver, if necessary. The observer should show proof of conducting at least one dive to the depth of the planned dive within the past three months or participate in a SCUBA review at the observer's expense.

c. Inspect the observing diver's equipment and service record. (*Note:* Items considered by the Divemaster to be unserviceable will be replaced with appropriate equipment provided by the observing diver.)

d. Ensure that the observing diver is informed of the EPA Diving Safety Rules and that those rules are complied with during the dive. (*Note:* The observer shall sign the dive plan indicating his/her understanding of the EPA Diving Safety Rules, and this shall be countersigned by the UDO or their designee.

e. Maintain a file on each observer diver. The file shall include but not be limited to a dive log, a copy of the diving certification, the physical examination, a copy of equipment servicing record and a signed/countersigned statement of EPA Diving Safety Rules understanding.

f. Retain the authority to suspend the diving operation based on his/her judgment regarding the ability of the observing diver, the adequacy of the diver's equipment, or the conditions at the dive site.

4.0 DIVER TRAINING AND CERTIFICATION

4.1 Need for Divers

Because EPA programs frequently require underwater operations, there is a demonstrated need for employees trained as Divers. The roster of qualified Divers and diving contractors cross-referenced to areas of expertise will be maintained by the Training Director and the UDOs. Where demonstrated needs exist, the DSB Chairperson and UDOs shall aid the various Regional, Office and Laboratory (Unit) Directors in analyzing diving needs. Should circumstances dictate the need for more Divers to fulfill operational requirements, additional personnel may be selected and trained.

4.2 Application for Training

EPA personnel with or without previous training may apply through proper channels to the appropriate UDO to be considered for EPA diver training and certification when the need exists. Diver training may be provided by the EPA Diver Training Center in Gulf Breeze, Florida, or by the NOAA Diving Program.

If slots are available, non-EPA personnel from other Federal, State or local agencies may be trained at the EPA Diver Training Course. The requirements for non-EPA personnel are the same as for EPA personnel. All documentation listed below, including medical approval to dive signed by the approving physician should be submitted by the diver’s Dive Safety Officer (DSO) to the EPA Dive Training Director for review and approval at least 30 days prior to the course.

4.2.1 As part of the application process to the EPA Training Center, each applicant for initial training, as well as those for certification based on past training, must complete the following preliminary actions that may apply:

a. Complete the physical examination as described in Subsection 4.3, “Physical Examination.”

b. Provide evidence of current CPR/AED and First Aid training.

c. Provide evidence of basic SCUBA certification by a nationally recognized organization. All prospective EPA divers must have successfully completed a basic diver training course offered by a recognized certifying agency (e.g., the U.S. Armed Forces, NAUI, PADI, SEI, SSI, SDI) and provide the Training Director with a photocopy of the certification.

d. The candidate must have written supervisor approval to enter the program.

e. Successfully perform the swimming skills described in Subsection 4.5.2, "Swimming Skills."

f. Submit a Diver resume indicating prior experience. Documentation should include copies of dive logs and the types of diving conducted to date.

g. For certification based on prior training and experience (see Subsection 4.3), the applicant shall submit verification of prior training and experience through the UDO to the EPA Training Director and DSB Chairperson for approval. The candidate must also pass the standard EPA SCUBA written examination.

h. An employee who applies for training and/or certification must be willing to commit time to the dive program. The need for the employee's services and the support of their supervisor shall be considered before taking action on certification or training.

4.2.2 Applicants for Diver training with the NOAA Diving Program must fulfill the requirements in the Application for Training and Physical Examination sections of the NOAA Diving Program Administrative and Safety Rules (as currently provided).

4.3 Prior Equivalent Diver Training/Certification

For Divers that have not taken EPA or NOAA training, UDOs may evaluate the credentials of a certified dive candidate with prior non-EPA dive training and experience for application into the EPA Diving Program pending approval from the DSB. After the candidate successfully passes the medical examination for diving and meets other criteria for field work (e.g., CPR/AED and First Aid training) and the written EPA SCUBA examination, the UDO will determine if the applicant sufficiently meets EPA's criteria as a Trainee or Diver. If the candidate does not meet either of these criteria, he/she will be required to take EPA's Diver Training Program as directed by the EPA Training Director. If the candidate meets the Trainee or Diver criteria, the UDO shall:

a. Observe the candidate in demonstrating the required swimming skills (see Subsection 4.5.2, "Swimming Skills.").

b. Observe the dive candidate in a checkout dive.

c. Forward to the EPA Training Director all appropriate documents along with a recommendation for the level of EPA certification to be granted.

4.4 Physical Examination

4.4.1 EPA employees must be medically qualified to perform their diving-related duties. Medical qualification is obtained when the EPA DMS provides a signed qualification statement to the UDO, as provided in the latest Medical Evaluation Form obtained from SSD (non-EPA divers use EPA Diving Safety Manual, Appendix F). Only the EPA DMS or his/her designee can provide this qualification statement.

4.4.2 Full medical examinations are required:

a. Prior to Diver training and certification.

b. At least biennially thereafter while continuing in an EPA diving status, allowing 27 months from the sign-off date, provided the physical examination has been submitted prior to the end of the 24th month. Hazmat (30 days or more per year of exposure) Divers must obtain clearances annually in accordance with OSHA 1910.120. (HAZWOPER). De minimis hazmat diving (i.e., less than 30 days per year), consistent with 1910.120 does not require an annual medical clearance. Since diving is a collateral duty, regional offices and labs may require annual examination due to a Diver's other assigned duties.

c. After a serious accident, injury, or illness at the discretion of the UDO.

d. Upon recommendation of the EPA DMS and approval of the DSB Chairperson and SSD.

e. Upon termination of EPA diving-related duties.

4.4.3 UDOs will make the necessary arrangements to ensure that Diver medical examinations occur in a timely manner. SHEMP Managers or UDOs will provide Divers/candidates with the official EPA Diving Medical Examination Form (gray shaded area for completion by candidate). NOAA Medical Examination Forms (SF-88 and SF-93) are required for submission to NOAA for NOAA training (https://www.gsa.gov/forms-library/medical-record-report-medical-examination and https://www.gsa.gov/forms-library/report-medical-history).

4.4.4 UDOs will ensure that candidates and Divers report to the closest EPA-contracted medical provider for completion of the examination. The Diver/candidate has the responsibility to complete the medical history portion of the evaluation form. Any questions or statements that are unclear to the candidate should be identified to the examining physician for clarification.

4.4.5 UDOs, working with their SHEMP Managers, will ensure that the completed examination and all of the associated diagnostic studies are forwarded to the EPA DMS for review and determination of Diver qualification. The completed examination form, with attached diagnostic tests, should be forwarded to:

Division of Federal Occupational Health

Occupational Medicine Specialist
4350 East-West Highway, Room 3-2A2
Bethesda, MD 20814

Examinations conducted by Federal Occupational Health units will automatically be forwarded to the address above. The UDOs shall ensure that examinations conducted by private providers/personal physicians are completed and forwarded to the indicated address.

4.4.6 Confidential medical evaluation forms should be forwarded as indicated in Subsection 4.4.5 (above) by the examining physician in a double-sealed envelope. The completed evaluation form and supporting information should be placed in an envelope labeled "Confidential Medical Information" and sealed. This envelope should be placed in a second envelope for mailing to the above address. This second envelope should also be labeled "Diving Examination" at the lower left corner.

4.4.7 UDOs will obtain qualification statements for each of their candidates and Divers from the EPA DMS. The UDO shall also forward a copy of the medical qualification statement to the DSB Chairperson and Training Director. Should a quick response be required, a special request can be submitted, allowing for review and qualification to be made by electronic transmission.

4.4.8 When the examination absolutely cannot be conducted by the EPA medical contractor, the private provider should complete the EPA Diving Medical Examination Form and forward it, as detailed above, to the EPA DMS. The private provider is responsible for identifying and describing any abnormal, historical, or physical findings. As the private provider/personal physician may not necessarily be professionally qualified or experienced in diving medicine, the EPA DMS alone will be responsible for determining diving duty medical qualification from the available data.

4.4.9 Applicants with a recommendation of "disqualifying medical conditions" will be ineligible for Diver training. Current EPA divers with such conditions will be recommended for removal from diving-related duties.

4.4.10 Applicants or current Divers with medical conditions that represent a relative disqualification may be recommended for temporary suspension from diving-related duties until a final determination can be made. Some extenuating circumstances, however, may be accommodated. The formal recommendation of the EPA DMS and primary care physician will be considered, but the DSB Chairperson will make the final decision in consultation with the EPA DMS, the DSB, the Diver's UDO, the SHEMP Manager and the Diver's immediate supervisor. The following options are available:

a. In some instances, Divers may have their medical conditions accommodated in a manner that allows them to safely continue the majority of their diving-related duties.

b. In some cases, at the recommendation of the EPA DMS and the approval of the DSB Chairperson, a waiver board may be convened to consider the medical data and offer guidance to the DSB Chairperson.

4.5 EPA Diver Certification

EPA conducts periodic Diver training courses at the EPA Dive Training Center in Gulf Breeze, Florida. A more detailed description of course contents is in the most current version of the EPA Diver Training Curriculum.

4.5.1 Initial Training

For those approved applicants that meet the requirements outlined in Subsection 4.2, "Application for Training", initial EPA diver training shall be taken through one of the following training programs:

a. Regularly scheduled, official EPA courses approved by the EPA Training Director with the advice and assistance of the DSB.

b. Equivalent SCUBA training programs authorized by the EPA Training Director, or his/her designee, plus supplemental training through the Training Director to ensure that the student has satisfactorily completed all elements of the EPA SCUBA training curriculum.

c. Regularly scheduled NOAA Diver training courses announced annually.

4.5.2 Swimming Skills

Following approval of the physical examination, each applicant shall demonstrate the following swimming exercises to the UDO, Training Director, or their designee, showing a noticeable degree of confidence and excellent swimming skills:

a. Swim 250 yards, using any stroke (e.g., the crawl, sidestroke, and/or backstroke) or swim a distance of one-quarter mile (440 yards) on the surface in full SCUBA gear.

b. Swim a horizontal distance of 50 feet at a constant shallow depth underwater without surfacing (alternatively this may be conducted in full SCUBA gear without use of the gas supply).

c. Stay afloat for 15 minutes.

d. Transport another person 25 yards on the surface of the water without the use of swim aids and/or transport another Diver in full SCUBA gear 50 yards.

e. Surface dive to a depth of 10 feet using mask, snorkel and fins to recover a 4-pound weight and clear the snorkel upon returning to the surface.

g. Conduct the following exercises:

   i. Enter the water in full SCUBA gear by giant stride.
   ii. Demonstrate mask clearing.
   iii. Breathe with an alternate air source.
   iv. Use underwater hand signals.
   v. Demonstrate equipment removal/replacement.
   vi. Exit the water using a boat ladder and stow equipment.

4.5.3 Written Examination

All applicants for EPA certification shall pass a standard EPA written examination. The passing score for each part shall be 70%. Applicants failing any part must take a reexamination of the failed part and have a subsequent score of 90% on Sections A and B on the reexamination and 100% on Section C on the reexamination. The candidate is responsible for reviewing any incorrect answers and correcting the errors to confirm a thorough understanding of the material (e.g., achieving a 100% understanding). The Training Director is responsible for preparation, administration and scoring of the examination.

4.5.4 Diving Evaluation

Prospective Divers must demonstrate their proficiency and skill in diving by performing a checkout dive with the appropriate Training Director or designee.

4.5.5 Certification

Upon completion of basic SCUBA training requirements, satisfactory written examination (except for Trainees) and medical examinations, and EPA field diver evaluations appropriate to the situation, the EPA Training Director shall make a final review of all certification requests. EPA employees shall then be considered for certification in one of the following categories.

a. Trainee Diver. An EPA employee or contractor with initial Diver certification by a recognized training agency may be issued a Trainee Diver Certification prior to taking the EPA Diver Training Course. To receive Trainee status, Trainee Divers must possess a basic open water SCUBA certification, pass a physical examination as specified in Subsection 4.4, "Physical Examination" and have current CPR/AED and First Aid training. The UDO should submit a candidate Trainee's information to the EPA Training Director and DSB Chair for review, approval and issuance of an

EPA Diver Trainee Certificate. The EPA written exam is not required for Trainees. At the UDO or designated Divemaster's discretion, trainees may perform simple tasks and is initially authorized to a depth of 60' (see Subsection 4.5.6 for deeper depth authorizations). The UDO will submit the Trainee Diver for attendance to the EPA or NOAA Diver Training Program as soon as the UDO determines they are ready.

b. Diver. An EPA diver who has:

i. Completed a minimum of 25 logged dives.

ii. Demonstrated proficiency to carry out assigned tasks as may be required during EPA's Annual Diver Training Program, such as:

- VVDS use
- FFM use
- Underwater voice communication system use
- Underwater object recovery by use of a lift bag
- Underwater pipe frame object assembly/disassembly
- Underwater pipe flange assembly/disassembly
- Underwater pinger locator use
- Maintain buddy awareness and monitor for signs of DCI

iii. By passing EPA's written examination, demonstrate a proficiency in:

- Dive physics
- Dive physiology
- Decompression table use
- DCI signs/symptoms
- Oxygen administration
- Dive accident management
- Dive equipment

c. Divemaster/Provisional Divemaster. An EPA diver who has:

i. Successfully completed the requirements for an EPA diver (above).

ii. Demonstrated proficiency in conducting the duties of Divemaster as may be conducted during the EPA's Annual Diver Training Program, such as:

- Supervising Divers in conducting assigned tasks
- If available for use, supervising Divers by underwater voice communication
- Maintaining Diver time and activity logs

- Monitoring Divers breathing gas supply
- Monitoring Divers for signs of DCI
- Conducting a simulated unconscious Diver rescue and recovery

iii. Completed 100 logged EPA dives in a variety of conditions and successfully completed the EPA Divemaster (or equivalent) training course, or:

- Divers with less than the requisite 100 logged EPA dives may attend the EPA Divemaster course and receive a Provisional Divemaster Certification. Once they have documented completion of 100 dives or a combination of dives and divemaster credits (see below), the Diver, through their UDO, may request full divemaster status.

- After receiving a Provisional Divemaster Certification, the Diver, at the UDOs discretion and under the mentorship of an onsite Divemaster, may substitute the supervision of dives for logged dives and receive Divemaster credit for up to 35 of the required minimum 100 logged dives. The number of Divemaster dive credits earned will equal the number of dives the candidate supervises. For example, if the divemaster candidate supervises 3 dives in a day that equals 3 Divemaster credits towards the maximum of 35.

4.5.6 Depth Limitations

The EPA Diving Safety Program currently does not provide for formal certification of individual Diver depth limitations. However, the limitations as provided by other programs (e.g., AAUS standards) generally comply with the guidelines based upon EPA diver ratings of Trainee, Diver, and Divemaster and authorizations as provided by the dive plan approval process. Diving is not permitted beyond 190 FSW.

a. Standard Depth Authorization Levels: 0 – 130 FSW.

i. Authorization to 60 FSW: This is the initial permit level, upon approval of a Diver as a Trainee and as an EPA Diver upon successful completion of the EPA Dive Course.

ii. Authorization to 100 and 130 FSW: A Diver authorized to depths of 60 feet may be authorized to depths of 100 and 130 feet, respectively, by logging at least four dives near the maximum depth category. These qualification dives shall be accompanied by the UDO or a DM and validated by the signature (i.e., verifying the Diver's logbook) of authorized individual(s) who are Divers certified to at least the same depth or by authorization of the UDO per dive plan approval. Under these circumstances, the Diver may exceed his/her depth limit by one step. As emphasized in the EPA Diver Training, the Diver will have demonstrated proficiency in the use of the appropriate decompression tables.

b. Authorization to Depths Over 130 FSW: Normally, EPA dives shall not exceed 130 FSW. Proposals and dive plans for depths greater than 130 FSW will require written approval from the DSB Chairperson. A Diver may be authorized to depths of 150 and 190 FSW after the completion of four training dives near each depth. Dives shall be planned and executed under the close supervision of a Diver certified to this depth and the plans approved by the DSB Chairperson. The Diver must also demonstrate knowledge of the special problems associated with deep diving (e.g., decompression diving, mixed gases), and unique safety requirements and equipment (e.g., redundant air supply) required for the specified depths.

4.6 Issuance

4.6.1 An EPA Diver Certification shall be issued by the EPA Training Director based upon the recommendations of the training team (e.g., Training Director, UDOs, Instructors and Divemasters), following final review of each applicant's submitted documents. The EPA Training Director shall issue a Letter of Certification (see EPA Diving Safety Manual, Appendix O) to the Diver and to the diving program file established for the Diver. (*Note:* This file is subject to requirements of the Privacy Act of 1974.)

4.6.2 EPA recognizes and accepts Diver certifications issued by the Director, NOAA Diving Program, for candidates who successfully complete the NOAA Diver Certification process and can issue an EPA Equivalency Certification.

4.7 Requalification

The EPA Training Director, or designee, may requalify a Diver whose qualification has lapsed after the Diver has again completed the requirements for proficiency. A Diver may be required to requalify based upon medical issues, such as following serious accident, injury, or illness, at the discretion of the UDO per Subsections 4.4.2.c and 4.4.10.

A requalification program should be established by each UDO to requalify Divers under his/her jurisdiction. A Diver with more than 12 months lapse without a dive may be required, at the recommendation of the DSB or the UDO, to attend the EPA Diver Certification Course in order to be requalified for diving activities.

4.8 Suspension of a Qualification

An EPA diver qualification may be suspended for cause by the UDO or DSB Chairperson. Violation of any policy in this *Diving Safety Manual* or demonstration of poor judgment may be considered cause. The Diver shall be informed in writing of the reasons for suspension and will be given the opportunity to appeal the suspension in writing to the EPA DSB.

Violations of regulations in this *Diving Safety Manual* include, but are not limited to:

a. Not maintaining one or all of the EPA field safety and health requirements including physical fitness, CPR/AED, First Aid, Oxygen Administration and medical monitoring.

b. Not maintaining diving proficiency per 3.1.3.

c. Violating any requirements in this *Diving Safety Manual* that could endanger themselves or others.

If a Diver is suspended and fails to appeal to the DSB or meet requalification as specified by the UDO or DSB within a year's time, or if a Diver repeatedly lapses in maintaining the requirements listed in this manual or demonstrates poor judgment, possibly endangering themselves or others, then the Diver's EPA certification may be revoked, subject to review by the DSB.

APPENDIX A

EPA Diving Safety Rules

APPENDIX A
EPA DIVING SAFETY RULES

1. Certification. Each Diver must have a valid U.S Environmental Protection Agency (EPA) certification or EPA-approved equivalent.

2. Solo Diving. No one may dive unattended.

3. Depth Limits. A Trainee Diver is authorized to a depth of 60 feet of seawater (FSW). An EPA diver, after successfully completing training per Section 4.0, Diver Training and Certification, is also authorized to a depth of 60 FSW without additional training. Divers may be authorized to depths of 100 and 130 FSW respectively by following the guidelines outlined in Section 4.4.6. Depending upon conditions, and at the recommendation of the divemaster or Unit Dive Officer (UDO), an alternate or redundant air source may be required

   Normally, EPA dives shall not exceed 130 FSW. Proposals and dive plans for dives planned to depths greater than 130 FSW will require written approval from the EPA Diving Safety Board (DSB) Chairperson. Dives to be conducted at depths greater than 130 FSW require additional diver training, and a hyperbaric chamber must be available at the dive site. See Depth Limitations, Section 4.4.6, for specific guidelines, depth limits, and training requirements.

4. No-Decompression Tables. When using dive tables, all no-decompression dives using compressed air and nitrox will be conducted using the EPA dive tables (EPA Diving Safety Manual, Appendix D, "EPA Air and Nitrox I and II Dive Tables"). The EPA dive tables are based on the most recent U.S. Navy Standard No-Decompression Tables.

5. Ascent Rates. The most recent version of the *U.S. Navy Diving Manual Volume 2: Air Diving Operations*, has set the standard ascent rate to 30 FSW per minute for direct ascents to the surface, with an acceptable range of 20 to 40 FSW per minute.

6. Diving Logs. All EPA Divers are required to maintain an EPA dive log. The information logged must include the diver's name, date, dive location, purpose or function, time in/out, maximum water depth, and bottom time. In addition, the dive tender shall also record (on the *Dive Tender's Log*) whether the dive is a scientific or light working dive, the divemaster's name, dive mode, dive conditions and any other information that is needed by the Divemaster or the UDO. The dive tender must also record the Diver's surface interval, residual nitrogen time and bottom time for repetitive dives. Dive tables or the Diver's dive computer may be used for this information. Diver must log his/her bottom (subsurface) time and surface interval time in the case of repetitive dives. A dive is completed when a Diver surfaces with a ten minute or more surface interval.

a. Bottom Time is defined as the total elapsed time rounded up to whole minutes from when a Diver leaves the surface to begin his/her descent until the time the Diver begins a direct ascent to the surface. However, EPA generally uses a conservative, surface to surface time for bottom time. A "dive" is that time and activity spent beneath the surface of the water by a person equipped with diving gear.

b. Safety Stop. Divers should include a safety stop (i.e., time spent to help dissolved nitrogen evolve from tissues) at 15 FSW for 3 minutes to reduce the chance of decompression illnesses on dives deeper than 30 FSW and a stop at one half of the maximum diving depth for one minute, especially for dives below 60 FSW, or as otherwise noted by the dive computer if being used. Safety stop time is not typically added to bottom time, as tissues are in the process of releasing nitrogen.

c. Surface Interval is the time that the Divers have spent on the surface following a dive, beginning as soon as the Divers surface and ending as soon as they begin their next descent. For surface intervals less than ten (10) minutes, add the total bottom time of the previous dive to that of the repetitive dive and choose the decompression schedule for the combined bottom time and the deepest water depth achieved for the sequence.

7. Decompression Dives. Routine working dives shall not exceed the U.S. Navy no-decompression limits. Diving activities that exceed the limits of no-decompression will be permitted only under the following conditions:

a. Proposal. A detailed dive plan has been reviewed and approved by the UDO and the DSB Chairperson.

b. Competence. The project leader must demonstrate to the UDO or his/her designee, that the Divemaster and all members of the diving team have a thorough knowledge of decompression and repetitive dive principles.

c. Dive Team. The team must be composed of no fewer than five people: two Divers in the water, a standby Diver, a dive tender, and a Divemaster.

d. Equipment. Each participating Diver must wear a watch or bottom timer and a depth gauge and have on hand a decompression schedule for the maximum proposed depth of dive or dive computer.

e. Hyperbaric Chamber. Must be on site attended by trained personnel.

8. Decompression Tables. The latest decompression tables should be carried aboard the dive platform, or dive computers capable of completing decompression calculations for exigent circumstances that require an immediate response (See

EPA Diving Safety Manual, Appendix D, “EPA Air and Nitrox I and II Dive Tables”).

9. High Altitude Diving. Decompression tables, depth of stops, rate of ascent, and repetitive dive planning must be altered for safe diving at altitudes above 1,000 FSW. The more conservative of the National Oceanic and Atmospheric Administration (NOAA) Diving Manual (current edition) or the Diver’s computer should be used as a guide for diving at high altitudes.

10. Ascent to Altitude/Flying After Diving. Wait a minimum surface interval of 12 hours prior to flying after diving. When making daily, multiple dives for several days or making a dive requiring an emergency decompression stop, extend the surface interval beyond twelve hours. Whenever possible wait 24 hours before flying. When waiting less than 24 hours, the Diver should adhere to the more conservative of the latest published NOAA Ascent to Altitude table or dive computer recommendations.

11. Over-Bottom “Blue Water” Dives. Dives in water where a Diver could sense a loss of orientation or descend below safe diving depths are to be considered over-bottom dives. No over-bottom dives shall be made unless some direct contact with the surface is maintained, such as net web, a marked line suspended from a surface float. Dive computers or depth gauges are required for all participants, which permit the Divers to determine when ascent or descent occurs.

12. Diver Propulsion Vehicles (DPV). Diver propulsion vehicles are allowed for use on EPA dives providing the following guidelines are followed:

   a. A DPV must never be used for direct ascents or descents.

   b. A relatively constant depth should be maintained while underway. A depth gauge or computer and compass must be in view of the Diver at all times.

   c. DPVs may only be used in good visibility conditions that allow Divers to always maintain contact with their buddy and avoid obstacles that they may hit while underway.

   d. All hoses, second stages or lose items on the Diver must be secured and out of the way prior to operating the DPV. Prop wash from the DPV, through venturi action, can cause a safe second regulator to free flow while underway, resulting in the rapid depletion of the Diver’s air supply.

   e. Divers utilizing a DPV in open water should utilize a surface float to allow the dive boat to follow the Divers, where practical, to track the Divers.

The DPV should be equipped with a short line and carabiner clip to secure the DPV on the bottom if not in use or to clip to the Diver’s BC during the safety stop.

13. Swift Water (Strong Current). EPA dive teams should ~~generally~~ avoid free swimming Self-Contained Underwater Breathing Apparatus (SCUBA) diving in current they cannot swim against. The use of surface supplied, or tethered diving (Appendices O and P) provides the diver the greatest degree of safety when diving in swift water/strong currents. If performing free swimming SCUBA diving in swift water/strong current the following guidelines should be followed:

   a. For the dive boat to safely track and pick up Divers, all Divers should descend and ascend either a fixed anchor line with a surface buoy or a towed line with a surface buoy where practical.

   b. Divers should work upstream to downstream, utilizing a surface buoy or marker where practical which will allow the dive boat to follow and pick up the Divers at the end of the dive.

   c. Divers will always stay in visible distance of each other. It is extremely easy to become separated in strong current, so all Divers must be diligent in keeping track of each other.

   d. In strong current, especially if the bottom cannot be seen from the surface, Divers should follow an anchored or towed line down to the bottom and stay together. If any Diver gets separated or cannot get to the bottom, the dive must be immediately aborted.

   e. All Divers must carry and be proficient in deploying a Surface Marker Buoy (SMB) or "Dive Sausage", a corresponding dive reel, and a whistle or other sound device.

   f. If diving at a fixed location with an anchored surface buoy, Divers should use a tape or reel attached to the anchor line at the bottom to be able to navigate from and back to and ascend the original anchored down line.

   g. If the current is too strong to ascend the anchored line, one Diver, pre-designated before the dive, should deploy their SMB *prior* to releasing the anchored line. Once the SMB is deployed the lead Diver will signal the others to release the anchored line and all Divers should drift together, carefully monitoring their ascent rate and ascend to 15' to conduct the three-minute safety stop. When completed, all Divers should ascend together, staying close to the SMB for pickup by the dive boat. If the SMB is deployed after releasing from the anchored buoy, the Divers will get carried downstream of the dive boat before the SMB gets to the surface and may not be seen by the dive boat.

h. If visibility is too poor to safely maintain contact with a buddy, the Divers must be attached to each other or be surface tended.

i. The dive boat must have a floating line with attached buoy ready to throw to any Divers that may get swept past the boat. The dive boat should also attach lines (dock lines are ideal) from the bow to the stern of the vessel at the waterline level for Divers to hang onto while waiting for each other to board the vessel.

j. If working close to channels or high traffic areas, dives should be planned with the tides or current, such that Divers will be carried away from the channel or high traffic areas on ascent.

k. In high traffic areas, the dive boat must stay very near the Divers, flying the largest red/white dive flag and Alpha flag possible, monitor Very High Frequency (VHF) channel 16, bridge to bridge, and vessel traffic service channels (where applicable) and be ready to position themselves between the marker buoy and any approaching vessel traffic.

14. Boat Tending. During dives beyond swimming distance from shore or those in areas of strong currents, a small boat with a qualified operator will tend the Divers (see item 22.n regarding use of a diving flag).

15. Ship Activities. When appropriate during ship-husbandry related diving activities, the "Dive Safe Ship Operations Checklist" (i.e.., NOAA Form 64-3 or similar) will be completed and used.

16. Hyperbaric Chamber. The location, accessibility, and telephone number of the nearest accessible and operable hyperbaric chambers that treat Divers shall be listed in the dive plan and be available to all participating Divers for each diving operation.

17. Emergency Procedures. The UDOs, or their designee, with the approval of the EPA DSB will prescribe emergency procedures to be used in handling diving-related accidents in the operational area and all Divers shall be familiar with these procedures.

18. Diving Accident Management Training. All Divers shall have Diving Accident Management training, must maintain certifications (refer to EPA Diving Safety Manual 2.10.2.j), and shall complete appropriate refresher training to maintain skills.

19. First Aid Kits. A first-aid kit is required to be available for all dive operations. The First-Aid Kit at a minimum should include:

- Pocket Rescue Mask (for Mouth-to-Mouth)
- Surgical Gloves (disposable)
- Blood Pressure Cuff & Stethoscope
- Digital Thermometer
- Rescue Shears
- Forceps
- Safety Pins
- Adhesive Bandages (e.g., Bandaids®)
- Butterfly Closures
- Tape (e.g., Steri-Strip®, Dermaclear®)
- Sterile Dressings (assorted: 2" x 2", 2" x 3", 4" x 4")
- Cling Bandage Rolls
- Elastic Bandage (Ace type)
- Triangle Bandage
- Sterile Eyewash Solution
- Occlusive Dressing (Vaseline covered)
- Silvidine Ointment (for burns)
- Vinegar (for stings)
- Povidine-Iodine (e.g., Prep-sep, Betadine)
- Triple Antibiotic Ointment (Neosporin, Bacitracin, Polymyxin)
- Tincture of Benzoin (aerosol)
- Q-tips
- Ice Packs
- Alcohol Prep Pads
- Benadryl*
- Aspirin*
- Advil*
- Tylenol*
- First Aid Manual

**The EPA Diving Medicine Specialist (DMS) recommends only non-generic medications to avoid misapplication should be used in conjunction with the SOAP/SAMPLE form.*

20. Emergency Oxygen. An emergency oxygen kit is required to be available for all dive operations and capable of servicing at least two nonbreathing Divers at the same time. Divers and Diver support personnel shall be trained in the use of this equipment. The emergency oxygen kit shall contain:

- Two manual trigger valve (MTV) regulators, two bag valve mask (BVM) or a combination of MTVs and BVMs.

- A single Jumbo D/M22 (640 liters) or size E/M24 (680 liters) oxygen cylinder or two size D/M15 (425 liters each) cylinders or any other combination of oxygen cylinders containing at least 640 liters of oxygen.

21. Automatic External Defibrillator. An Automatic External Defibrillator (AED) shall be present at the dive site.

22. Diving Equipment. Open-circuit SCUBA using compressed air or oxygen-enriched air shall be standard. Other types of equipment (e.g., closed-circuit rebreathers, semi-closed units, or other types of diving apparatus using gas mixtures) may be approved for use by the EPA DSB Chairman, Technical Director, or Training Director. Individuals requesting use of these other types of equipment must have been trained and qualified in their use.

    a. SCUBA Cylinders. Only those cylinders approved for containing compressed air by the U.S. Department of Transportation (DOT) for the purpose of diving may be used in the U.S. EPA Diving Program. Cylinder types currently in use for EPA diving include:

        - 72 cubic foot (cu ft) steel @ 2,250 pounds per square inch (psi) working pressure (wp).

        - 50, 63, 80, 100 cu ft aluminum @ 3,000 psi wp.

        - 50, 65, 80, 100, 120 cu ft high pressure steel @ 3,500 psi wp with appropriate valve and regulator design.

    b. SCUBA Valves. Valve types are matched to the cylinder rating and regulator type. Typical valve types are:

        - K-valve or yoke valve.

        - DIN valve (used with newer high-pressure cylinders).

    c. SCUBA Regulators and Full-Face Mask (FFM) Systems. Most major manufacturer open-circuit (exhaled air exhausted to environment versus being recirculated) regulator systems with demand second stages are appropriate for use in EPA diving. Special considerations may be necessary for contaminated water diving.

    d. Surface Supplied Diving. Please refer to EPA Diving Safety Manual, Appendix I, "Surface Supplied Diving Standard Operating Procedure."

    e. Alternate Air Source. To allow for the eventuality of a termination of a team member's air supply, each free-swimming SCUBA Diver will have available on his/her system an alternate air source. The alternate air source may be any of the following:

- A buddy's spare second stage regulator either independent (e.g., "octopus") or integral to the buoyancy compensator device (BCD) low-pressure inflation system (e.g., Air-2®)

- A redundant air system (e.g., "pony" bottle or dual manifold system)

- "Bail-out" system

- A self-contained scuba unit (e.g., Spare-Air®)

f. Weight Belt, Weight Harness or Backpack. All harnesses, backpacks without flotation, and weight belts must have a quick release.

g. Flotation Device. Each free-swimming SCUBA Diver shall wear an adequate flotation device, such as a BCD, that has two means of inflation: low pressure via tank supply and oral inflation. See Subsection 22.h for additional information on Variable Volume Dry Suits (VVDS).

- A BCD must not obstruct inflation or exhaust valves when worn over VVDS by free-swimming SCUBA Divers.

- A BCD is neither required nor recommended for use in any surface supplied systems.

- When used in chemically, biologically, or radiologically contaminated water environments, the BCD should be capable of being decontaminated (interior as well as exterior) by a method appropriate to the contamination present without degradation of the device or it will need to be considered expendable. It should be noted that the oral inflation device could allow direct oral exposure to harmful materials if used in contaminated environments.

h. Variable Volume Dry Suits (VVDS). Variable volume dry suits are often used on EPA dive projects for thermal and chemical protection. The following guidelines should be followed when using VVDS:

- Variable volume dry suits will only be used after satisfactory training by qualified persons designated by the EPA DSB Training Director, or equivalent prior experience verified by a qualified EPA UDO or designee. The training shall include a minimum of three (3) hours of training in the use of VVDS with at least two (2) hours completed in open water.

- Variable volume dry suits (particularly shell type) manufacturers do not warranty their suits for floatation. Therefore, an appropriate BCD which does not obstruct the inflation or deflation valves should be used when a VVDS is used by a free-swimming SCUBA diver.

- When used in contaminated water environments, the VVDS should be "qualified" for contaminated environment use by manufacturer warranty or suit materials (especially seams, seals, and closures/zippers) should be compatibility tested).

i. Compass. An underwater compass shall be carried by each free-swimming Diver on all dives.

j. Depth Gauge. A depth gauge shall be carried by each Diver on all dives.

k. Dive Computers. Use of dive computers to control dives is allowed. Refer to EPA Diving Safety Manual, Appendix C, "Dive Computer Guidelines."

l. Diving Timer. A diving watch or other suitable timing device shall be worn by each member of a SCUBA diving team. In all cases, an accurate time record of any dive must be kept.

m. Diving Flag. An appropriate diving flag shall be shown at all times while actively diving, following State and/or U.S. Coast Guard regulations.

n. Air Compressor. No person shall operate a diving air compressor without having first read the instructions and/or trained by an operator experienced in its operation. An operational log shall be maintained for all EPA dive compressors. Compressed air, from all active EPA compressors, shall be tested every six (6) months by an approved method.

o. Submersible Pressure Gauge (SPG). Each Diver shall have a SPG capable of directly reading the breathing gas pressure in his/her gas supply as an integral part of his/her SCUBA regulator system.

p. Line Cutter/Dive Knife. Each Diver shall carry at least one line cutter (e.g., dive knife, scissors, or other cutting tool) for use to escape from underwater entanglement/entrapment.

q. Emergency Signaling Device. Each Diver shall carry or have as integral part of his/her dive equipment an emergency signaling device (e.g., whistle, compressed air horn/whistle, mirror, light, or inflatable signal tube).

23. Equipment Maintenance. All diving gear and accessory equipment shall be maintained in a safe operating condition. Manufacturers' recommended servicing policy shall be followed. Equipment in questionable condition shall be tested, repaired, overhauled, or discarded. Life support equipment that is not fit for diving use shall be tagged out and kept separate from operational equipment or properly disposed.

A signed and dated record of the inspection and repair or maintenance will be filed with the UDO.

24. SCUBA Cylinder Inspection and Testing. All SCUBA cylinders must be visually inspected annually by a qualified SCUBA tank inspector, who will attach a dated visual inspection sticker to the cylinder. Cylinders will be hydrostatically tested at least every five (5) years. The dates of the last hydrostatic test must be stamped on the cylinder.

25. Air/Nitrox Standards. SCUBA cylinders shall be filled with air or an oxygen-enriched air mixture (Nitrox) certified as meeting Compressed Gas Association Grade E.

26. Minimum Air Supply. Divers must surface with a minimum of 500 psi in the tank as a safety factor for reaching the shore or boat and to prevent inclusion of water in the cylinder.

APPENDIX B

Oxygen Enriched Air (Nitrox) Diving

MINIMUM EPA STANDARDS FOR THE USE OF OXYGEN ENRICHED AIR (NITROX) FOR DIVING OPERATIONS

Minimum U.S. Environmental Protection Agency (EPA) standards for the use of oxygen enriched air (Nitrox) for EPA sanctioned diving operations are listed below.

1. A dive plan designating a Divemaster, trained and certified in the use of oxygen enriched air, must be approved by the Unit Diving Officer (UDO).

2. All EPA and EPA-sanctioned divers who use oxygen enriched air shall be trained and certified by a nationally recognized organization.

   All EPA and EPA-sanctioned divers who are NITROX certified should complete at least one NITROX dive per year to maintain proficiency. Divers or dive units must re-qualify for NITROX diving if they have not maintained NITROX proficiency but anticipate having to utilize NITROX on an upcoming dive project. The dive unit UDO or their designee overseeing the dive operation shall establish requalification procedures for NITROX use. At a minimum, Divers shall be able to independently determine percent oxygen content of their dive cylinder, determine maximum operating depth, demonstrate an understanding of the limitations of NITROX and be able to set, read and understand NITROX settings and repetitive dive planning on their dive computer and/or appropriate tables.

3. EPA personnel blending or filling high-pressure storage or Self-Contained Underwater Breathing Apparatus (SCUBA) cylinders and operating high pressure gas transfer equipment with oxygen enriched air shall be trained and approved by the UDO or their designee. Gas blending must occur prior to filling SCUBA cylinders or contact with breathing equipment (e.g., an open-circuit regulator). Pre-mixed oxygen enriched air or Nitrox may be purchased from a licensed, commercial supplier that provides breathing quality gas in accordance with nationally recognized consensus standards.

4. All gas blending and transfer equipment and storage cylinders shall be cleaned and maintained for oxygen service in accordance with nationally recognized consensus standards. This is required only for equipment that may be exposed to oxygen concentrations equal to or greater than 40%.

5. All SCUBA cylinders containing oxygen enriched air shall be labeled with a green band around the tank with the words, "Oxygen-Enriched Air " or "Nitrox " in letters appropriate for the size of the cylinder. Cylinders marked in accordance with a nationally or internationally recognized Nitrox association may also be used.

6. The oxygen content of the gas shall be measured twice. The initial measurement should be taken at the gas vendor or supplier after the tank is filled and second measurement shall be taken immediately prior to the use of the cylinder. The Diver using the cylinder must measure the oxygen content and record the measurement and the SCUBA tank number on the Dive tender's log. The Diver will also initial this entry.

7. When diving with oxygen-enriched air, Divers shall use a computer set at the percentage of oxygen in the mix or diving and decompression tables calculated for the specific gas mixture used (e.g., Nitrox I, II, or Equivalent Air Depth Tables). If the percentage of oxygen measured is between whole numbers, the percentage entered into the dive computer should always be rounded down to avoid underestimating the nitrogen load a Diver will accumulate during the dive (See computer user's manual).

8. Oxygen enriched air up to 40% oxygen can be used for EPA dive operations.

9. The partial pressure of oxygen (PO_2) that a diver breathes is only determined by the combination of percentage of oxygen in the diver's tank being used and the diver's current depth. The PO_2 is NOT determined by the computer setting. The PO_2 setting on a diver's computer simply tells the diver what their maximum operating depth (MOD) is for a certain PO_2 setting. The MOD for any given oxygen mix and depth can be found in the Max Depth/ PO_2 and the Nitrox Depth/ PO_2 Determination tables in the EPA Diving Safety Manual, Appendix D, "EPA Dive Tables." EPA divers shall NEVER exceed an actual PO_2 of 1.6 Atmosphere Absolute (ATA). If repetitive deep open circuit dives are required, Divers should limit their depth to work at a maximum PO_2 of 1.4-1.5 ATA or reduce the oxygen percentage in their tank to allow deeper dives while still maintaining a PO_2 of 1.4-1.5 ATA.

<u>References:</u>

Nitrox Manual; Complete Guide to Nitrox Diving -- by: Dick Rutkowski © 1994; Hyperbarics International; 490 Caribbean Drive; Key Largo, FL 33037

Incorporated by reference and with copy: *AAUS Recommendations and Guidelines for Scientific Nitrox Diving and Nitrox Diver Certification, September 1991*

Oxygen toxicity Management in the Field, Alert Diver, DAN periodical May/June 2008, pp 13-14. DAN Recommendation for a maximum oxygen partial pressure of 1.4 ATA for open-circuit scuba using nitrogen-oxygen breathing gas mixtures.

APPENDIX C

Dive Computer Guidelines

DIVE COMPUTER GUIDELINES

1. Any Diver desiring to use a dive computer as a means of determining decompression status must first demonstrate to their Unit Diving Officer (UDO) or designee that they are familiar with use of that particular computer before the Diver uses it to control a dive. Each Diver using a dive computer to plan and/or control dives must have their own unit. On any given dive, both Divers in a buddy pair must follow the more conservative dive computer.

2. If a dive computer fails at any time during a dive, the dive must be terminated and the appropriate surfacing procedures initiated immediately, unless a working backup computer that can serve as the primary is being carried by the Diver.

3. After conducting a dive utilizing the latest DSB-approved US Navy (USN) tables, a Diver should either wait until their residual nitrogen time (RNT) is zero (table-based) before conducting additional dives using a dive computer to control bottom time, or conduct all remaining dives utilizing the USN tables.

4. Backup computers should be the same make and model as the primary, or at a minimum, operate with a more conservative algorithm resulting in a residual nitrogen value that is equal to, or higher than that displayed by the primary. If this cannot be determined, or if switching to a computer that was not a backup on all previous dives, then switching should not take place until the computer(s) have cleared, indicating no residual nitrogen. If a primary computer has ceased operation without a backup, the Divemaster should determine if recreating the dive series with tables is necessary. Any additional dives would require using the latest DSB-approved USN tables (see EPA Diving Safety Manual, Appendix D, "EPA Dive Tables."

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

6. When using a dive computer, non-emergency ascents are to be at a rate specified by the computer being used but should not exceed one foot every two seconds.

7. Divers should include a safety stop (i.e., time spent to help dissolved nitrogen evolve from tissues) at 15 FSW for 3 minutes to reduce the chance of decompression illnesses on dives deeper than 30 FSW and a stop at one half of the maximum diving depth for one minute, especially for dives below 60 FSW, or as otherwise noted by the dive computer being used. Safety stop time is not typically added to bottom time, as tissues are in the process of releasing nitrogen.

8. Multiple deep dives require careful planning regardless of whether dive tables or computers are used.

9. Divers using air integrated computers should be properly equipped and prepared should an air computer component, high pressure hose, or other integrated component fail.

10. Digital air integrated displays may not be appropriate for Divers with limited near vision, or for limited visibility conditions.

11. Special instructions for **Nitrox Dive Computer** use (See EPA Diving Safety Manual, Appendix C, "Dive Computer Guidelines"):

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

    b. Prior to diving with a Nitrox dive computer, users should demonstrate to the UDO or designee a clear understanding of the display, operations, and manipulation of the unit being used.

    c. Dive computers capable of partial pressure of oxygen (PO_2) limit and fraction of oxygen (FO_2) adjustment should be checked by the Diver within 60 minutes prior to the start each dive to assure compatibility with the gas being used.

    d. When diving with oxygen-enriched air, Divers shall use a computer set at the percentage of oxygen in the mix or diving and decompression tables calculated for the specific gas mixture used (e.g. Nitrox I, II, or Equivalent Air Depth Tables). If the percentage of oxygen measured is between whole numbers, the percentage entered into the dive computer should always be rounded down to avoid underestimating the nitrogen load a Diver will accumulate during the dive. For example, Suunto computer models will assume the next higher value for oxygen toxicity, i.e. when reading 31.8 on an oxygen analyzer, the manual states this should be entered as 31. Consult your dive computer manual regarding how to enter the oxygen concentration.

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APPENDIX D

EPA Air and Nitrox I and II Dive Tables*

*Based upon U.S. Navy No Decompression and Decompression Tables
(Rev. 7, December 2016)

US EPA NO-DECOMPRESSION DIVE TABLES - AIR*

DEPTH->	10	15	20	25	30	35	40	45	50	55	60	70	80	90	100	110	120	130	140	SURFACE INTERVAL TABLE					
GROUP																									
A	57	36	26	20	17	14	12	11	9	8	7	6	5	4	4	3	3	2	2	->	->	->	->	A->	0:10 2:20
B	101	60	43	33	27	23	20	17	15	14	12	10	9	7	6	6	5	4	4	->	->	->	B->	0:10 1:16	1:17 3:36
C	158	88	61	47	38	32	27	24	21	19	17	14	12	11	9	8	7	6	6	->	->	C->	0:10 0:55	0:56 2:11	2:12 4:31
D	245	121	82	62	50	42	36	31	28	25	22	19	16	14	12	11	10	9	8	->	D->	0:10 0:52	0:53 1:47	1:48 3:03	3:04 5:23
E	426	163	106	78	62	52	44	39	34	31	28	23	20	17	15	14	12	11	10	E->	0:10 0:52	0:53 1:44	1:45 2:39	2:40 3:55	3:56 6:15
F		217	133	97	76	63	53	46	41	37	33	28	24	21	18	16	15	12	F->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:31	3:32 4:48	4:49 7:08
G		297	165	117	91	74	63	55	48	43	39	32	28	24	21	19	->	G->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:23	4:24 5:40	5:41 8:00
H		449	205	140	107	87	73	63	56	50	45	37	32	28	25	20	H->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:16	5:17 6:32	6:33 8:52
I			256	166	125	100	84	72	63	56	51	42	36	31	->	I->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:08	6:09 7:24	7:25 9:44
J			330	198	145	115	95	82	71	63	57	47	39	33	J->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 7:00	7:01 8:16	8:17 10:36
K			461	236	167	131	108	92	80	71	63	48	->	K->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:52	7:53 9:09	9:10 11:29
L				285	193	148	121	102	89	74	->	->	L->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:44	8:45 10:01	10:02 12:21
M				354	223	168	135	114	92	->	->	M->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:37	9:38 10:53	10:54 13:13
N				469	260	190	151	125	->	->	N->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:29	10:30 11:45	11:46 14:05
O				992	307	215	163	->	->	O->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:27	10:28 11:21	11:22 12:37	12:38 14:58
Z				1102	371	232	->	->	Z->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:27	10:28 11:19	11:20 12:13	12:14 13:30	13:31 15:50
										Z	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A

*Based on USN Tables, Rev. 7, December 2016

[shaded box] - No Deco Limit

US EPA RESIDUAL NITROGEN TABLE FOR AIR*

DEPTH ⇊	Z ⇊	O ⇊	N ⇊	M ⇊	L ⇊	K ⇊	J ⇊	I ⇊	H ⇊	G ⇊	F ⇊	E ⇊	D ⇊	C ⇊	B ⇊	A ⇊	DEPTH ⇊
10												427	246	159	101	58	10
									NO LIMIT								
15									450	298	218	164	122	89	61	37	15
									NO LIMIT								
20						462	331	257	206	166	134	106	83	62	44	27	20
									NO LIMIT								
25			470	354	286	237	198	167	141	118	98	79	63	48	34	21	25
			632	748	816	865	904	935	961	984	1004	1023	1039	1054	1068	1081	
30	372	308	261	224	194	168	146	126	108	92	77	63	51	39	28	18	30
		63	110	147	177	203	225	245	263	279	294	308	320	332	343	353	
35	245	216	191	169	149	132	116	101	88	75	64	53	43	33	24	15	35
		16	41	63	83	100	116	131	144	157	168	179	189	199	208	217	
40	188	169	152	136	122	109	97	85	74	64	55	45	37	29	21	13	40
			11	27	41	54	66	78	89	99	108	118	126	134	142	150	
45	154	140	127	115	104	93	83	73	64	56	48	40	32	25	18	12	45
				10	21	32	42	52	61	69	77	85	93	100	107	113	
50	131	120	109	99	90	81	73	65	57	49	42	35	29	23	17	11	50
					2	11	19	27	35	43	50	57	63	69	75	81	
55	114	105	96	88	80	72	65	58	51	44	38	32	26	20	15	10	55
						2	9	16	23	30	36	42	48	54	59	64	
60	101	93	86	79	72	65	58	52	46	40	35	29	24	19	14	9	60
							5	11	17	23	28	34	39	44	49	54	
70	83	77	71	65	59	54	49	44	39	34	29	25	20	16	12	8	70
								4	9	14	19	23	28	32	36	40	
80	70	65	60	55	51	46	42	38	33	29	25	22	18	14	10	7	80
								1	6	10	14	17	21	25	29	32	
90	61	57	52	48	44	41	37	33	29	26	22	19	16	12	9	6	90
									4	7	11	14	17	21	24	27	
100	54	50	47	43	40	36	33	30	26	23	20	17	14	11	8	5	100
										2	5	8	11	14	17	20	
110	48	45	42	39	36	33	30	27	24	21	18	16	13	10	8	5	110
												4	7	10	12	15	
120	44	41	38	35	32	30	27	24	22	19	17	14	12	9	7	5	120
												1	3	6	8	10	
130	40	37	35	32	30	27	25	22	20	18	15	13	11	9	6	4	130
													1	3	6	8	
140	37	34	32	30	27	25	23	21	19	16	14	12	10	8	6	4	140
														2	4	6	

*Based on USN Tables, Rev. 7, December, 2016

RNT
BT

US EPA NITROX I (32% O_2) DIVE TABLES *

DEPTH->	15	20	25	30	40	45	50	55	60	65	70	80	90	100	110	120	130	SURFACE INTERVAL TABLE								
**EAD->	8	13	17	21	30	34	38	43	47	51	56	64	73	81	90.1	99	107									
A	57	36	26	20	17	14	12	11	9	8	7	6	5	4	4	4	3	->	->	->	->	->	->	->	A->	0:10 2:20
B	101	60	43	33	27	23	20	17	15	14	12	10	9	7	6	6	6	->	->	->	->	->	->	B->	0:10 1:16	1:17 3:36
C	158	88	61	47	38	32	27	24	21	19	17	14	12	11	9	9	8	->	->	->	->	->	C->	0:10 0:55	0:56 2:11	2:12 4:31
D	245	121	82	62	50	42	36	31	28	25	22	19	16	14	12	12	11	->	->	->	->	D->	0:10 0:52	0:53 1:47	1:48 3:03	3:04 5:23
E	426	163	106	78	62	52	44	39	34	31	28	23	20	17	15	15	14	->	->	->	E->	0:10 0:52	0:53 1:44	1:45 2:39	2:40 3:55	3:56 6:15
F		217	133	97	76	63	53	46	41	37	33	28	24	21	18	18	16	->	->	F->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:31	3:32 4:48	4:49 7:08
G		297	165	117	91	74	63	55	48	43	39	32	28	24	21	21	19	->	G->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:23	4:24 5:40	5:41 8:00
H		449	205	140	107	87	73	63	56	50	45	37	32	28	25	25	20	H->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:16	5:17 6:32	6:33 8:52
I		`	256	166	125	100	84	72	63	56	51	42	36	31	->	->	I->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:08	6:09 7:24	7:25 9:44
J			330	198	145	115	95	82	71	63	57	47	39	33	->	J->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 7:00	7:01 8:16	8:17 10:36
K			461	236	167	131	108	92	80	71	63	48	->	->	K->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:52	7:53 9:09	9:10 11:29
L				285	193	148	121	102	89	74	->	->	->	L->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:44	8:45 10:01	10:02 12:21
M				354	223	168	135	114	92	->	->	->	M->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:37	9:38 10:53	10:54 13:13
N				469	260	190	151	125	->	->	->	N->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:29	10:30 11:45	11:46 14:05
O				992	307	215	163	->	->	->	O->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:27	10:28 11:21	11:22 12:37	12:38 14:58
Z				1102	371	232	->	->	->	Z->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:27	10:28 11:19	11:20 12:13	12:14 13:30	13:31 15:50
											Z	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A

*Based on USN Tables, Equivalent Air Depth (EAD), Rev. 7, December, 2016
**EAD=(Decimal % N in mix/.79)*(Depth+33)-33

(shaded) - No Deco Limit

US EPA RESIDUAL NITROGEN TABLE FOR NITROX I*

DEPTH	Z ⇊	O ⇊	N ⇊	M ⇊	L ⇊	K ⇊	J ⇊	I ⇊	H ⇊	G ⇊	F ⇊	E ⇊	D ⇊	C ⇊	B ⇊	A ⇊	DEPTH
15												427	246	159	101	58	15
									NO LIMIT								
20									450	298	218	164	122	89	61	37	20
									NO LIMIT								
25						462	331	257	206	166	134	106	83	62	44	27	25
									NO LIMIT								
30			470	354	286	237	198	167	141	118	98	79	63	48	34	21	30
			632	748	816	865	904	935	961	984	1004	1023	1039	1054	1068	1081	
40	372	308	261	224	194	168	146	126	108	92	77	63	51	39	28	18	40
		63	110	147	177	203	225	245	263	279	294	308	320	332	343	353	
45	245	216	191	169	149	132	116	101	88	75	64	53	43	33	24	15	45
		16	41	63	83	100	116	131	144	157	168	179	189	199	208	217	
50	188	169	152	136	122	109	97	85	74	64	55	45	37	29	21	13	50
			11	27	41	54	66	78	89	99	108	118	126	134	142	150	
55	154	140	127	115	104	93	83	73	64	56	48	40	32	25	18	12	55
				10	21	32	42	52	61	69	77	85	93	100	107	113	
60	131	120	109	99	90	81	73	65	57	49	42	35	29	23	17	11	60
					2	11	19	27	35	43	50	57	63	69	75	81	
65	114	105	96	88	80	72	65	58	51	44	38	32	26	20	15	10	65
						2	9	16	23	30	36	42	48	54	59	64	
70	101	93	86	79	72	65	58	52	46	40	35	29	24	19	14	9	70
							5	11	17	23	28	34	39	44	49	54	
80	83	77	71	65	59	54	49	44	39	34	29	25	20	16	12	8	80
								4	9	14	19	23	28	32	36	40	
90	70	65	60	55	51	46	42	38	33	29	25	22	18	14	10	7	90
								1	6	10	14	17	21	25	29	32	
100	61	57	52	48	44	41	37	33	29	26	22	19	16	12	9	6	100
									4	7	11	14	17	21	24	27	
110	54	50	47	43	40	36	33	30	26	23	20	17	14	11	8	5	110
										2	5	8	11	14	17	20	
120	54	50	47	43	40	36	33	30	26	23	20	17	14	11	8	5	120
										2	5	8	11	14	17	20	
130	48	45	42	39	36	33	30	27	24	21	18	16	13	10	8	5	130
											2	4	7	10	12	15	

*Based on USN Tables Equivalent Air Depth (EAD), Rev. 7, December 2016

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US EPA NITROX II (36% O_2) DIVE TABLES*

DEPTH->	20	25	30	35	40	50	55	60	70	80	90	100	110	SURFACE INTERVAL TABLE										
**EAD->	9.9	14	18	22	26	34	38	42	50.4	59	67	75	83											
A	57	36	26	20	17	14	12	11	8	7	6	5	4	->	->	->	->	->	->	->	->	->	A->	0:10 2:20
B	101	60	43	33	27	23	20	17	14	12	10	9	7	->	->	->	->	->	->	->	->	B->	0:10 1:16	1:17 3:36
C	158	88	61	47	38	32	27	24	19	17	14	12	11	->	->	->	->	->	->	->	C->	0:10 0:55	0:56 2:11	2:12 4:31
D	245	121	82	62	50	42	36	31	25	22	19	16	14	->	->	->	->	->	->	D->	0:10 0:52	0:53 1:47	1:48 3:03	3:04 5:23
E	426	163	106	78	62	52	44	39	31	28	23	20	17	->	->	->	->	->	E->	0:10 0:52	0:53 1:44	1:45 2:39	2:40 3:55	3:56 6:15
F		217	133	97	76	63	53	46	37	33	28	24	21	->	->	->	->	F->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:31	3:32 4:48	4:49 7:08
G		297	165	117	91	74	63	55	43	39	32	28	24	->	->	->	G->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:23	4:24 5:40	5:41 8:00
H		449	205	140	107	87	73	63	50	45	37	32	28	->	->	H->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:16	5:17 6:32	6:33 8:52
I			256	166	125	100	84	72	56	51	42	36	31	->	I->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:08	6:09 7:24	7:25 9:44
J			330	198	145	115	95	82	63	57	47	39	33	J->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 7:00	7:01 8:16	8:17 10:36
K			461	236	167	131	108	92	71	63	48	->	K->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:52	7:53 9:09	9:10 11:29
L				285	193	148	121	102	74	->	->	L->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:44	8:45 10:01	10:02 12:21
M				354	223	168	135	114	->	->	M->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:37	9:38 10:53	10:54 13:13
N				469	260	190	151	125	->	N->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:29	10:30 11:45	11:46 14:05
O				992	307	215	163	->	O->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:27	10:28 11:21	11:22 12:37	12:38 14:58
Z				1102	371	232	->	Z->	0:10 0:52	0:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:27	10:28 11:19	11:20 12:13	12:14 13:30	13:31 15:50
									Z	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A

*Based on USN Tables Equivalent Air Depth (EAD), Rev. 7, Dec., 2016

**EAD=(Decimal % N in mix/.79)*(Depth+33)-33

[shaded] - No Deco Limit

US EPA RESIDUAL NITROGEN TABLE FOR NITROX II*

DEPTH	Z	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A	DEPTH
	⇊	⇊	⇊	⇊	⇊	⇊	⇊	⇊	⇊	⇊	⇊	⇊	⇊	⇊	⇊	⇊	
20												427	246	159	101	58	**20**
									NO LIMIT								
25									450	298	218	164	122	89	61	37	**25**
									NO LIMIT								
30						462	331	257	206	166	134	106	83	62	44	27	**30**
									NO LIMIT								
35			470	354	286	237	198	167	141	118	98	79	63	48	34	21	**35**
			632	748	816	865	904	935	961	984	1004	1023	1039	1054	1068	1081	
40	372	308	261	224	194	168	146	126	108	92	77	63	51	39	28	18	**40**
		63	110	147	177	203	225	245	263	279	294	308	320	332	343	353	
50	245	216	191	169	149	132	116	101	88	75	64	53	43	33	24	15	**50**
		16	41	63	83	100	116	131	144	157	168	179	189	199	208	217	
55	188	169	152	136	122	109	97	85	74	64	55	45	37	29	21	13	**55**
			11	27	41	54	66	78	89	99	108	118	126	134	142	150	
60	154	140	127	115	104	93	83	73	64	56	48	40	32	25	18	12	**60**
				10	21	32	42	52	61	69	77	85	93	100	107	113	
70	114	105	96	88	80	72	65	58	51	44	38	32	26	20	15	10	**70**
							9	16	23	30	36	42	48	54	59	64	
80	101	93	86	79	72	65	58	52	46	40	35	29	24	19	14	9	**80**
							5	11	17	23	28	34	39	44	49	54	
90	83	77	71	65	59	54	49	44	39	34	29	25	20	16	12	8	**90**
								4	9	14	19	23	28	32	36	40	
100	70	65	60	55	51	46	42	38	33	29	25	22	18	14	10	7	**100**
								1	6	10	14	17	21	25	29	32	
110	61	57	52	48	44	41	37	33	29	26	22	19	16	12	9	6	**110**
									4	7	11	14	17	21	24	27	

*Based on USN Tables, Equivalent Air Depth (EAD), Rev. 7, December, 2016

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US EPA MAX DEPTH*/PO2 TABLE

$\%O_2$	DEPTH @ 1.6	DEPTH @ 1.5	DEPTH @ 1.4	DEPTH @ 1.3	DEPTH @ 1.2	DEPTH @ 1.1	DEPTH @ 1.0
21	218	203	187	171	156	140	124
22	207	192	177	162	147	132	117
23	197	182	168	154	139	125	110
24	187	173	160	146	132	118	105
25	178	165	152	139	125	112	99
26	170	157	145	132	119	107	94
27	163	150	138	126	114	101	89
28	156	144	132	120	108	97	85
29	149	138	126	115	104	92	81
30	143	132	121	110	99	88	77
31	137	127	116	105	95	84	73
32	**132**	**122**	**111**	**101**	**91**	**80**	**70**
33	127	117	107	97	87	77	67
34	122	113	103	93	83	74	64
35	118	108	99	90	80	71	61
36	**114**	**105**	**95**	**86**	**77**	**68**	**59**
37	110	101	92	83	74	65	56
38	106	97	89	80	71	63	54
39	102	94	85	77	69	60	52
40	99	91	83	74	66	58	50

***MOD=(P02/Decimal % O_2*33)-33**

NITROX DEPTH/PO2 DETERMINATION TABLE

Depth (Ft.)	PO2 @ 28%	PO2 @ 29%	PO2 @ 30%	PO2 @ 31%	PO2 @ 32%	PO2 @ 33%	PO2 @ 34%	PO2 @ 35%	PO2 @ 36%
0	0.28	0.29	0.30	0.31	0.32	0.33	0.34	0.35	0.36
10	0.36	0.38	0.39	0.40	0.42	0.43	0.44	0.46	0.47
20	0.45	0.47	0.48	0.50	0.51	0.53	0.55	0.56	0.58
30	0.53	0.55	0.57	0.59	0.61	0.63	0.65	0.67	0.69
40	0.62	0.64	0.66	0.69	0.71	0.73	0.75	0.77	0.80
50	0.70	0.73	0.75	0.78	0.80	0.83	0.86	0.88	0.91
60	0.79	0.82	0.85	0.87	0.90	0.93	0.96	0.99	1.01
70	0.87	0.91	0.94	0.97	1.00	1.03	1.06	1.09	1.12
80	0.96	0.99	1.03	1.06	1.10	1.13	1.16	1.20	1.23
90	1.04	1.08	1.12	1.16	1.19	1.23	1.27	1.30	1.34
95	1.09	1.12	1.16	1.20	1.24	1.28	1.32	1.36	1.40
100	1.13	1.17	1.21	1.25	1.29	1.33	1.37	1.41	1.45
105	1.17	1.21	1.25	1.30	1.34	1.38	1.42	1.46	1.51
110	1.21	1.26	1.30	1.34	1.39	1.43	1.47	1.52	1.56
115	1.26	1.30	1.35	1.39	1.44	1.48	1.52	1.57	
120	1.30	1.34	1.39	1.44	1.48	1.53	1.58		
125	1.34	1.39	1.44	1.48	1.53	1.58			
130	1.38	1.43	1.48	1.53	1.58				
135	1.43	1.48	1.53	1.58					
140	1.47	1.52	1.57	1.63					

(yellow) = Max Depth @ 1.4 ATA O_2

(blue) = Max Depth @ 1.5 ATA O_2

(red) = Max Depth @ 1.6 ATA O_2

AIR DECOMPRESSION TABLE (All Stops at 20 Feet)*

Depth	Bottom Time Stop Time/ Grp Out	Bottom Time Stop Time/ Grp Out	Bottom Time Stop Time/ Grp Out	Bottom Time Stop Time/ Grp Out	Bottom Time Stop Time/ Grp Out	Bottom Time Stop Time/ Grp Out	Bottom Time Stop Time/ Grp Out	Bottom Time Stop Time/ Grp Out
30	371	380	420	480	540			
	0/Z	**5/Z**	**22/Z**	**42/Z**	**71/-**			
35	232	240	270	300	330	360		
	0/Z	**4/Z**	**28/Z**	**53/Z**	**71/Z**	**88/-**		
40	163	170	180	190	200	210	220	230
	0/O	**6/O**	**14/Z**	**21/Z**	**27/Z**	**39/Z**	**52/Z**	**64/Z**
45	125	130	140	150	160	170	180	190
	0/N	**2/O**	**14/O**	**25/Z**	**34/Z**	**41/Z**	**59/Z**	**75/Z**
50	92	95	100	110	120	130	140	150
	0/M	**2/M**	**4/N**	**8/O**	**21/O**	**34/Z**	**45/Z**	**56/Z**
55	74	75	80	90	100	110	120	130
	0/L	**1/L**	**4/M**	**10/N**	**17/O**	**34/O**	**48/Z**	**59/Z**
60	63	65	70	80	90	100	110	120
	0/K	**2/L**	**7/L**	**14/N**	**23/O**	**42/Z**	**57/Z**	**75/Z**
70	48	50	55	60	70	80	90	100
	0/K	**2/K**	**9/L**	**14/M**	**24/N**	**44/O**	**64/Z**	**88/Z**
80	39	40	45	50	55	60	70	80
	0/J	**1/J**	**10/K**	**17/M**	**24/M**	**30/N**	**54/O**	**77/Z**
90	33	35	40	45	50	55	60	70
	0/I	**4/J**	**14/L**	**23/M**	**31/N**	**39/O**	**56/O**	**83/Z**
100	25	30	35	40	45	50	55	60
	0/H	**3/J**	**15/L**	**26/M**	**36/N**	**47/O**	**65/Z**	**81/Z**
110	20	25	30	35	40	45	50	
	0/H	**5/I**	**14/K**	**27/M**	**39/N**	**50/O**	**71/Z**	
120	15	20	25	30	35			
	0/F	**4/H**	**9/J**	**24/L**	**38/N**			
130	12	15	20	25				
	0/E	**3/G**	**8/I**	**17/K**				
140	10	15	20					
	0/E	**5/H**	**13/J**					
150	8	10	15					
	0/C	**2/F**	**8/H**					
160	7	10						
	0/C	**4/F**						
170	6	10						
	0/D	**6/G**						
180	6	10						
	0/D	**8/G**						
190	5							
	0/D							

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APPENDIX E

EPA Diving Forms

Example: Dive Plan

DATE OF REQUEST: ___________ DIVE DATES: ______________

DIVEMASTER:_________________ Diver Initials: __________________*I have read and understand this dive plan.*

SURVEY OBJECTIVES: Light Work[1]/ Scientific / Training / Proficiency

____

DIVERS: ____
(Check minimum crew requirements in the EPA Diving Safety Manual, Appendix H, "Checklist for Light Working Diving Operations" and Tether/Surface Supply SOPs as applicable)

LAUNCH SITE/PLATFORM:____

EMERGENCY ASSISTANCE 911 – DAN **919 684 9111 emergency** – DAN 800-326-2822 non-emergency - COAST GUARD CH-16

HOSPITAL: ____

CHAMBER LOCATION: ____

**************** OXYGEN/AED/first aid kit WILL BE ON SITE ****************

ANTICIPATED CONDITIONS: MAX DEPTH ________ AIR/H_2O TEMP________ MAX CURRENT _____
(Work dives in greater than 1 knot of current require the diver(s) to be line tended[1])
TIDAL INFLUENCES __________ VESSEL TRAFFIC __________
POLLUTION SOURCES ____
BIOLOG. HAZARDS ____
VISIBILITY ______ OTHER ____
HAZARDOUS MARINE BIOTA ____
EQUIPMENT:
DRY SUIT ________ FFM ________
SURFACE SUPPLY ______ STANDARD SCUBA ______ TETHER______
Gas: air only for work dives[1] Emergency Gas Supply required for work dive?
OTHER ____
SPECIAL INFORMATION: ____

POST DIVE REPORT
WATER TEMP __________ AIR TEMP/WEATHER __________
CURRENTS __________ VISIBILITY __________
BIOLOGICAL. HAZARD ____
OTHER (TIDES, POLLUTION, VESSEL TRAFFIC,

____
PROCEDURAL NOTES ____
EQUIP. NOTES (REPAIRS(?), ETC.) ____

[1]If conducting a light working dive, complete the checklist in the EPA Diving Safety Manual, Appendix H, "Checklist for Light Working Diving Operations" before/during/after dive.

Example: Divemaster Pre- and Post-Dive Briefing

(Divemaster may elect to use the Safety Audit Checklist for a more thorough briefing)

DIVEMASTER PRE-DIVE BRIEFING

1. Review emergency evacuation procedures.
2. Review emergency equipment & evacuation procedures (e.g., AED, first aid, oxygen kits, radio check with lab)
3. Review dive profile (e.g., times, depths, repetitive calculations)
4. Review communications (e.g., hand signals, diver recall)
5. Review project objective(s)
6. Review potential hazards (physical & pollutant), tides, and current.
7. Review decontamination procedures for contaminated water diving
8. Review specialized equipment to be used
9. Review duties of dive team personnel (e.g., identify divemaster, tender, etc.)
10. All divers check personal dive equipment
11. Record tank pressures
12. Have confidential EPA Field Emergency Forms for all divers in a sealed envelope at the dive site
13. Advise the diver of the location of a hyperbaric chamber which is ready for use; and
14. Notify vessel traffic/Coast Guard if necessary
15. Alert the diver to the potential hazards of flying after diving

POST-DIVE PROCEDURES

1. Monitor divers for symptoms of "bubble trouble"
2. Protect divers from hypothermia or hyperthermia
3. Have drinking water available
4. Record bottom times, tank pressures, and water depths on Tender's Log
5. Record problems, malfunctions, hazards encountered on Tender's Log
6. Follow appropriate decontamination procedures as appropriate
7. Clean up and stow all equipment; wash FFM masks with soap and warm water.
8. Instruct the diver to report any physical problems or adverse physiological effects including symptoms of decompression sickness.
9. Alert the divers to the potential hazards of flying or driving to high altitudes after diving.

Example: EPA Dive Tender's Field Log

EPA DIVE TENDER'S FIELD LOG

PROJECT: TYPE: SCIENTIFIC___LIGHT WORK___
DIVEMASTER: MODE: SCUBA__SS__Tether__
DIVER: NOTES:

DATE/ STATION	SI	GROUP IN	TANK PRESSURE IN	TANK PRESSURE OUT	TIME IN	TIME OUT	BOTTOM TIME (MIN)	MAX DEPTH (FT.)	GROUP OUT
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		

EPA DIVE TENDER'S FIELD LOG

PROJECT:
DIVEMASTER:
DIVER:

TYPE: SCIENTIFIC___LIGHT WORK___
MODE: SCUBA__SS__Tether__
NOTES:

DATE/ STATION	SI	GROUP IN	TANK PRESSURE IN	TANK PRESSURE OUT	TIME IN	TIME OUT	BOTTOM TIME (MIN)	MAX DEPTH (FT.)	GROUP OUT
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		

DIVER:

DATE/ STATION	SI	GROUP IN	TANK PRESSURE IN	TANK PRESSURE OUT	TIME IN	TIME OUT	BOTTOM TIME (MIN)	MAX DEPTH (FT.)	GROUP OUT
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		
							ABT: RNT:______ TBT:		

Example: EPA Field Emergency Form

EPA Field Emergency Form

Name	Date
Date of Birth	Home Address
Office Address	Office Phone / Home Phone
Immediate Supervisor	Supervisor's Phone
Your Blood Type	**Medic Alert Tag** ☐ Yes ☐ No
Typical Blood Pressure	**Wear Contact Lenses?** ☐ Yes ☐ No
Date of Last Tetanus Shot	Allergic to Antibiotics/Anesthesia / Anaphylactic Reactions to Toxins
Current Medications	Other Medical Considerations
Personal Medical Coverage Plan	Personal Physician / Physician's Phone
In Emergency Notify	Relationship
Address/Phone	

See Back Side for More Information

Dive Profile

TP: ____ TP: ____ TP: ____ TP: ____ TP: ____ TP: ____ TP: ____ TP: ____

T: ____ T: ____ T: ____ T: ____ T: ____ T: ____ T: ____ T: ____

Diver:

BT: ____ **D:** ____ | : **SI** | **BT:** ____ **D:** ____ | : **SI** | **BT:** ____ **D:** ____ | : **SI** | **BT:** ____ **D:** ____

Locations: ____ ____ ____ ____

Comments:

Notes: TP = Tank Pressure, T = Clock Time, BT = Bottom Time, D = Maximum Depth, and SI = Surface Interval

Time **Oxygen** Administration **Started**	**Ended**

Further Description of the Accident

APPENDIX F

EPA Liability Release and Express Assumption of Risk Forms

EPA

Name:________________________________

Address:______________________________

City, State, ZIP:_______________________

AGREEMENT, LIABILITY RELEASE AND EXPRESS ASSUMPTION OF RISK for EPA Divers Using EPA Supplied Equipment During Off-Duty Hours

This is a release of your rights to sue. This release may be used against you in a court of law if you sue any release party or person.

Please read carefully, fill in all blanks and initial each paragraph before signing.

I, (PRINT NAME):____, am currently trained and certified to SCUBA dive by the U.S. Environmental Protection Agency (EPA) and am a Diver in good standing in the EPA Diving Program. I hereby affirm that I have been advised and thoroughly informed of the inherent hazards of skin and SCUBA diving.

________In consideration of being allowed to utilize EPA issued dive equipment during off-duty hours, I agree to dive within recreational dive guidelines as follows. I agree to not dive deeper than 130'. I agree to not conduct decompression dives. I agree to not dive solo. I agree to surface with at least 500 psi of air or Nitrox.

________I understand and agree that I am solely responsible for my own actions, decisions and use of EPA owned and maintained dive gear during off duty hours and am financially responsible for all associated expenses, including medical expenses and I agree to compensate EPA within one year for any loss, damage, or destruction of any EPA dive gear in my possession and use under this release.

________Further, I understand that diving with compressed air involves inherent risks, including but not limited to: decompression sickness, embolism, or other hyperbaric injuries which may occur that require treatment in a recompression chamber. I further understand that diving activities may be conducted at sites that are remote, either by time or distance or both, from a recompression chamber, and nonetheless agree to proceed with the diving activity in spite of the possible absence of a recompression chamber in proximity to the site.

________I understand that by signing this Liability Release and Assumption of Risk (Release), I agree to release, waive, discharge and give up any and all claims against EPA, its employees, or any duly appointed staff or crew member of the EPA and the US Government (hereinafter referred to as "Released Parties"), and that none of the Released Parties may be held liable or responsible in any way for any injury, death, or other damages to me or my family, heirs, or assigns that may occur as a result of my use of EPA issued dive gear during off-duty hours or as a result of any cause including the negligence of any party, including the Released Party, whether active or passive.

________I also understand that skin diving and scuba diving are physically strenuous activities and that I will be exerting myself during such activity, and that if I am injured as a result of a heart attack, panic hyperventilation, etc., that I expressly assume all of the risk of said injuries and that I will not hold the above listed Released Parties responsible for the same.

________I further save and hold harmless any and all Released Parties from any claim or lawsuit by me, my family, estate, heirs, or assigns, arising out of my association with, and participation in any diving activity while using EPA issued dive equipment during off-duty hours.

________I hereby personally assume all risks in connection with said activity, for any harm, injury, or damage that may befall me while I am engaged in this activity, including all risks connected therewith, whether foreseen or unforeseen. I understand this Release hereby encompasses and applies to all diving activities in which I choose to participate while using EPA dive equipment during off-duty hours. These may include but are not limited to activities which may be considered specialty diving activities such as: navigation, night, deep, altitude, boat, drift, dry suit, wreck or other overhead environment, underwater naturalist, and underwater photography.

________I also understand that diving from a boat poses additional hazards such as slippery boat decks and movement caused by wave action could cause me to lose my footing, fall and/or be injured, especially while carrying or wearing SCUBA equipment. In consideration of being allowed to use EPA issued dive equipment during off-duty hours, I hereby personally assume all risks in connection with getting to and from said activity, for any harm, injury, or damage that may befall me while I am engaged in such activity, including all risks connected with traveling to and from the dive site, whether foreseen or unseen.

_________I further state that I am of lawful age and legally competent to sign this Release agreement.

_________I hereby state and agree that this Release will be effective and valid for all diving activities as defined above for the duration of my tenure as an EPA Diver from the initial date on which I execute this Release.

_________I understand that the terms herein are contractual and are not a mere recital, and that I have signed this document of my own free will.

SPECIAL OXYGEN ENRICHED AIR (EAN, NITROX) CONSIDERATION, IF APPLICABLE:

_________I understand that diving with oxygen enriched air (EAN, NITROX) involves certain inherent risks of oxygen toxicity and/or improper mixtures of breathing gas. I agree to assume all risks associated with breathing oxygen enriched air under hyperbaric conditions and agree to personally determine the oxygen content of my breathing gas and plan the dive accordingly to include a maximum depth and time.

IT IS THE INTENTION OF (PRINT NAME)____BY THIS INSTRUMENT TO EXEMPT AND RELEASE THE U.S. ENVIRONMENTALPROTECTION AGENCY AND THE U.S. GOVERNMENT, ANY DULY APPOINTED STAFF OR CREW MEMBER, AND ALL RELATED ENTITIES AS DEFINED ABOVE FROM ALL LIABILITY AND RESPONSIBILITY WHATSOEVER FOR PERSONAL INJURY, PROPERTY DAMAGE OR WRONGFUL DEATH HOWEVER CAUSED, INCLUDING, BUT NOT LIMITED TO, THE NEGLIGENCE OF THE RELEASED PARTIES, WHETHER PASSIVE OR ACTIVE.

I HAVE FULLY INFORMED MYSELF OF THE CONTENTS OF THIS LIABILITY RELEASE AND EXPRESS ASSUMPTION OF RISK BY READING IT BEFORE I SIGNED IT ON BEHALF OF MYSELF AND MY HEIRS. I FURTHER UNDERSTAND AND AGREE THAT THIS RELEASE IS EFFECTIVE AND VALID FOR THE DURATION OF MY TENURE AS AN EPA DIVER FROM THE DATE ON WHICH I EXECUTE THIS RELEASE.

____

Your Signature *Date*

____

Signature of Unit Dive Officer (UDO) or Witness *Date*

EPA

Name:________________________________

Address:______________________________

City, State, ZIP:________________________

LIABILITY RELEASE AND EXPRESS ASSUMPTION OF RISK for Non-EPA Divers Participating in EPA Dive Activities

This is a release of your rights to sue. This release may be used against you in a court of law if you sue any release party or person.

Please read carefully, fill in all blanks and initial each paragraph before signing.

I, (PRINT NAME):____, am currently certified to scuba dive by (PRINT AGENCY)__________________________ as provided by the assigned certification number (PRINT Certification Number) ________________, Do hereby affirm that I have been advised and thoroughly informed of the inherent hazards of skin and SCUBA diving.

________Further, I understand that diving with compressed air involves inherent risks, including but not limited to: decompression sickness, embolism, or other hyperbaric in juries which may occur that require treatment in a recompression chamber. I further understand that the diving activities which the U.S. Environmental Protection Agency (EPA) engages in from time to time, may be conducted at a site that is remote, either by time or distance or both, from a recompression chamber, and nonetheless agree to proceed with the diving activity in spite of the possible absence of a recompression chamber in proximity to the site.

_________I understand and agree that the EPA and its employees, nor any duly appointed staff or crew member of EPA or property owner of the site dived, (hereinafter referred to as "Released Party"), may be held liable or responsible in any way for any injury, death, or other damages to me or my family, heirs, or assigns that may occur a s a result of my participation in this diving activity or as a result of any cause including the negligence of any party, including the Released Party, whether active or passive.

_________In consideration of being allowed to participate in this diving activity, I agree to dive within the dive guidelines as defined by the "EPA Diving Safety Manual". I hereby personally assume all risks in connection with said activity, for any harm, injury, or damage that may befall me while I am engaged in this activity, including all risks connected therewith, whether foreseen or unforeseen. I understand this Liability Release and Assumption of Risk (Release) hereby encompasses and applies to all diving activities in which I choose to participate as part of EPA diving activities. These may include but are not limited to activities which may be considered specialty diving activities such as: navigation, night, deep, altitude, boat, drift, dry suit, wreck or other overhead environment, underwater naturalist, and underwater photography.

_________I further save and hold harmless any and all Released Parties from any claim or lawsuit by me, my family, estate, heirs, or assigns, arising out of my association with, and participation in this EPA diving activity.

_________I also understand that skin diving and scuba diving are physically strenuous activities and that I will be exerting myself during such activity, and that if I am injured as a result of a heart attack, panic hyperventilation, etc., that I expressly assume the risk of said injuries and that I will not hold the above listed Released Parties responsible for the same.

_________I also understand that diving from a boat poses additional hazard s such a s slippery boat decks and movement caused by wave action could cause me to lose my footing, fall and/or be injured, especially while carrying or wearing SCUBA equipment. In consideration of being allowed to participate in this diving activity, I hereby personally assume all risks in connection with getting to and from said activity, for any harm, injury, or damage that may befall me while I am engaged in such activity, including all risks connected with travelling to and from the dive site, whether foreseen or unseen.

_________I further state that I am of lawful age and legally competent to sign this liability and release.

_________I hereby state and agree that this Release will be effective and valid for all specialized diving activities as defined above for a period of one year from the initial date on which I execute this Release.

_________I understand that the terms herein are contractual and are not a mere recital, and that I have signed this document of my own free will.

SPECIAL OXYGEN ENRICHED AIR (EAN, NITROX) CONSIDERATION, IF APPLICABLE:

________I understand that diving with oxygen enriched air involves certain inherent risks of oxygen toxicity and/or improper mixtures of breathing gas. I agree to assume all risks associated with breathing oxygen enriched air under hyperbaric conditions and agree to personally determine the oxygen content of my breathing gas and plan the dive accordingly to include a maximum depth and time.

IT IS THE INTENTION OF (PRINT NAME)____BY THIS INSTRUMENT TO EXEMPT AND RELEASE THE U.S. ENVIRONMENTAL PROTECTION AGENCY AND THE U.S. GOVERNMENT, ANY PROPERTY OWNER I MMEDIATELY ASSOCIATED WITH ACCESSING THE DIVING ACTIVITY, ANY DULY APPOINTED STAFF OR CREW MEMBER, AND ALL RELATED ENTITIES AS DEFINED ABOVE FROM ALL LIABILITY AND RESPONSIBILITY WHATSOEVER FOR PERSONAL INJURY, PROPERTY DAMAGE OR WRONGFUL DEATH HOWEVER CAUSED, INCLUDING, BUT NOT LIMITED TO, THE NEGLIGENCE OF THE RELEASED PARTIES, WHETHER PASSIVE OR ACTIVE.

I HAVE FULLY INFORMED MYSELF OF THE CONTENTS OF THIS LIABILITY RELEASE AND EXPRESS ASSUMPTION OF RISK BY READING IT BEFORE I SIGNED IT ON BEHALF OF MYSELF AND MY HEIRS. I FURTHER UNDERSTAND AND AGREE THAT THIS RELEASE IS EFFECTIVE AND VALID FOR A PERIOD OF ONE YEAR FROM THE DATE ON WHICH I EXECUTE THIS RELEASE.

____

Your Signature *Date*

____

Signature of Unit Dive Officer (UDO) or Witness *Date*

APPENDIX G

Determination and Requirements for Scientific and Light Working Diving

Background

The purpose of this Appendix is to help to determine whether a dive is classified as a light working or scientific dive and to highlight the differences between the two. As per OSHA regulation, a scientific dive is defined as any 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, but does not include performing any tasks usually associated with commercial diving such as but not limited to: placing or removing heavy objects underwater; inspection of pipelines and similar objects; construction; demolition; cutting or welding; or the use of explosives. Dives which are arguably ambiguous and do not clearly meet the OSHA definition of a working dive or a scientific dive, but support research/collection of data and allow EPA to carry out its mission to study and protect the environment would be classified as a scientific dive as long as they don't specifically fall into OSHA's definition of a working dive (e.g., use of heavy tools, placing or removing heavy objects inspection of pipelines etc.)[1]. Scientific tasks are usually light and short in duration and if tools are used, they are simple ones like a hammer, collecting jars, measuring devices, hand nets, suction fish collector, camera, or slate pencil. The diver must be a scientist or scientist in training. Individual tasks (e.g., laying transects, installing/deploying/retrieving scientific equipment/instruments) conducted as part of a scientific project are considered within the scope of scientific diving.

Scientific objectives and/or data collected during the dives must be documented in the dive plan, dive logs and/or the project QAPP/Work Plan/Sampling Plans and/or communicated through formal or informal informational reports. Without this documentation tasks that are not clearly within the realm of data collection would likely be considered outside the realm of the scientific diving exemption by OSHA.

Unit Diving Officers (UDO) shall be responsible for determining whether dive operations are to be conducted as scientific dives or light working dives, and for documenting this determination in the dive and project plans, dive logs, and reports.

Light Working Diving

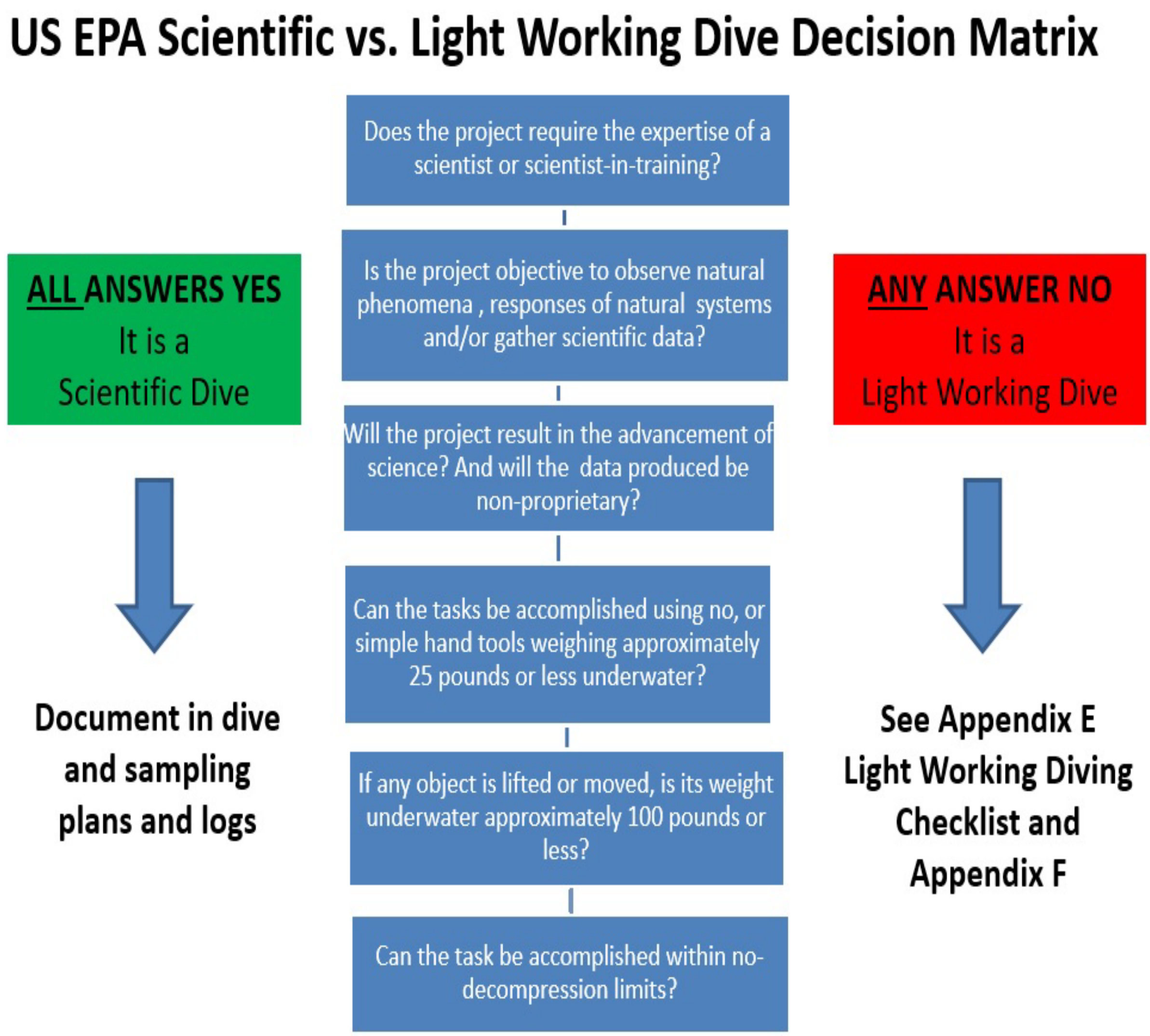
Construction and trouble-shooting tasks traditionally associated with commercial diving, such as using heavy tools powered by pneumatics or hydraulics from the surface, explosives, welding equipment, or burning equipment are clearly heavy duty or commercial type tasks and are outside the scope of what can be considered an EPA light working dive.

However, EPA may need to perform light working dives as part of their dive program. For example, as part of a scientific project the EPA may need to lower a large object (heavier than approximately 100 pounds underwater) into the water, or the EPA may need to perform tasks involving ship husbandry (e.g., clearing a sea strainer or un-fouling a ship's propeller). The EPA

[1] Supported by United States Court of Appeals for the Fifth Circuit No. 19-60245, Houston Aquarium.

recognizes these tasks cannot be conducted under the scientific exemption and will conducted these dive operations as light working dives as per this manual and OSHA 29 CFR Part 1910, Subpart T - Commercial Diving Operations.

The diagram below can help to determine whether a dive falls under the scientific diving exemption or the light working diving (OSHA Commercial) standard.



The following table illustrates the differences in requirements for a scientific dive vs. a light working dive:

Item/Topic	Scientific Diving	Light Working Diving
Flags/Warning Signals	Dive flags are often regulated by the State or municipality where the dive operation is conducted. A code flag "Alpha" and/or the red/white "Diver down flag" 20" x 24" meets many of these requirements, but this should be verified by the Divemaster prior to dive operations. The dive flag should be displayed in a manner which allows all-round visibility and shall be illuminated during night diving operations.	Dive flags are often regulated by the State or municipality where the dive operation is conducted. A code flag "Alpha" and/or the red/white "Diver down flag" 20" x 24" meets many of these requirements, but this should be verified by the Divemaster prior to dive operations. The dive flag should be displayed in a manner which allows all-round visibility and shall be illuminated during night diving operations.
Hyperbaric Chamber	No hyperbaric chamber is required on site if operating to depths less than 130 FSW and within the no decompression limits. Dives deeper than 130 feet require written approval from the EPA DSB Chairman, appropriate training and possibly a hyperbaric chamber on-site. The location, accessibility, and telephone number of the nearest accessible and operable hyperbaric chambers that treat divers shall be listed in the dive plan and be available to all participating Divers for each diving operation.	Air Dives >100 FSW or outside the no-decompression limits require access to a chamber (6 ATA) within 5 minutes of the dive site. All Nitrox (mixed-gas) dives require a chamber available at the dive location.

Item/Topic	Scientific Diving	Light Working Diving
Emergency Gas Supply (EGS) Systems that may be used include a SpareAir®, pony bottle with an independent second stage or rigged directly to a full face mask or helmet using a manifold block or similar mechanism, or a Reserve Air Supply System (RASS) kit. If you are using a manifold without a safe second connected, this would require an overpressure relief valve to avoid inadvertent hose rupture during first stage failure. An independent pressure gauge is required for scientific and light working dives below 30 FSW.	The need an independent EGS for SCUBA diving operations would be at the Divemaster's discretion based on mode of diving, dive profile and dive site characteristics. An independent EGS is required for all surface supplied dives. An EGS may consist of a: a. Pony Bottle b. SpareAir® c. RASS	A diver-carried reserve breathing gas supply consisting of an independent reserve cylinder with a separate regulator (and pressure gauge for depths >30 FSW) or a manually operated J Valve shall be carried with the Diver for all working dives regardless of mode of diving (SCUBA, surface supplied air, or line tended). The reserve supply should be enough quantity to allow the Diver to reach the surface while maintaining an ascent rate of 30 feet per minute and kept in a closed position when not in use during the dive. SpareAir® is acceptable per OSHA regulations if it is attached the Diver and has a sufficient volume of air. **It is recommended you have least 1 cu. ft. per 10 foot of depth** for open circuit mouthpiece SCUBA. Two to 3 cu. ft. per 10 foot of depth is recommended when wearing a FFM or helmet.
Dive Profile	Documentation in addition to normal dive logs are not required (Some information such as dive purpose or dive conditions may be documented in the Dive Plan or Dive Report).	A written record called a depth-time profile must be maintained for each Diver during the dive, including decompression. (See Record of Dive below for clarification) 29 CFR 1910.423(d).

Item/Topic	Scientific Diving	Light Working Diving
Swift Water (Strong Current)	1) No SCUBA operations conducted in currents > 3 knots 2) For dive operations in 1 to 3 knots (see EPA Diving Safety Manual, Appendix A, Diving Safety Rules" for additional details): a. Line Reels with Surface Mark Buoys (SMB) b. Dives planned to minimize swimming into current c. A vessel used for live boating Divers d. Divers must be briefed on importance of gas management and buddy communication.	SCUBA divers must be line tended when currents > 1 knot.
Standby Diver	For SCUBA, at the Divemaster's discretion, a fully suited, equipment-ready standby Diver might be required. All tethered diving operations require a standby Diver ready to enter the water within several minutes (crew of 3). For surface supplied operations a standby Diver is always required and ready to enter the water promptly in case of an emergency unless there are two surface supplied Divers in the same area and are able to render aid to each other within 3 minutes throughout the dive (crew of 4).	A standby Diver is required for all modes of light working dives. For dives in an enclosed or physically confined space, a standby Diver must be stationed at the underwater point of entry.
Item/Topic	Scientific Diving	Light Working Diving

Pre-dive procedures	The dive plan must contain: 1) Nearest medical facility (hospital or clinic) and a method of communication must be established and documented. 2) Nearest operational hyperbaric chamber and a method of communication must be established and documented. 3) Method of emergency evacuation 4) Method of communication with means of emergency transportation. 5) DAN's emergency and non-emergency phone numbers. 6) A copy of the EPA DSM.	At the dive site a list of phone numbers or call signs for: • An operational hyperbaric chamber (if not at the dive location) • Accessible hospitals • Available physicians (DAN is acceptable) • Available means of transportation • The nearest U.S. Coast Guard Rescue Coordination Center
Post-dive procedures	Monitoring Divers post dive: 1) Divemaster or tender monitor each Diver exiting the water for symptoms of DCS or other dive related medical issues. 2) Post dive report. 3) Decontamination performed if required. 4) Gear cleaned and stored after dive operations have been completed.	At the completion of a dive, the employer must: thoroughly check the physical condition of the Diver; instruct the Diver to report any physical problems or adverse physiological reactions (including decompression sickness symptoms); advise the Diver of the location of the nearest hyperbaric chamber; and alert the Diver to the hazards of flying too soon after the dive. After a dive deeper than 100 fsw, a dive that requires decompression, or after any dive using a mixed-gas breathing mixture, the employer is required to instruct the Diver to remain awake and in the vicinity of the hyperbaric chamber at the dive location for at least one hour after the dive, including one hour after any hyperbaric or diving medical treatment
Item/Topic	Scientific Diving	Light Working Diving

Record of dive	The record maintained for each diving operation must include: 1) Names of dive-team members 2) Divemaster 3) Date/Time/Location of the dive 4) Maximum Depth & Bottom Time for each Diver 5) Dive mode (In dive plan or dive logs) 6) Purpose or function of dive (In Dive Plan or dive logs) 7) Dive Conditions (In Dive Report or dive logs) 8) For repetitive diving, the elapsed time since the last pressure exposure (if less than 24 hours) or the repetitive dive designation for each Diver	The record maintained for each diving operation must include: 1) Names of the dive-team members 2) Divemaster (DPIC) 3) Date/Time/Location of the dive 4) Maximum Depth & Bottom Time for each Diver 5) Dive mode (In dive plan or dive logs) 6) Purpose or function of dive (In Dive Plan or dive logs) 7) Dive Conditions (In Dive Report or dive logs) 8) For repetitive diving, the elapsed time since the last pressure exposure (if less than 24 hours) or the repetitive dive designation for each Diver 9) Depth-Time and breathing-gas profiles must be maintained for dives outside the no-decompression limits, deeper than 100 FSW or using mixed-gas.
Enclosed or physically confining space	N/A	SCUBA Divers to be line-tended when they are in an enclosed or physically confining space, and a Diver must be stationed at the underwater point of entry to the enclosed or physically confining space.
First Aid Kit	Refer to EPA Diving Safety Manual, Appendix A, Diving Safety Rules" for minimum First-Aid Kit contents.	The first aid kit (including a bag valve mask) specified in the EPA Diving Safety Manual, Appendix A, Diving Safety Rules" meet both light working and scientific diving requirements.

Team Make-up		
Item/Topic	Scientific Diving	Light Working Diving
SCUBA (air)	1) Divemaster 2) Diver 3) Buddy Diver 4) Standby Diver (at discretion of Divemaster)	1) Divemaster (DPIC) 2) Diver 3) Buddy Diver 4) Standby Diver
SCUBA (nitrox)*	1) Divemaster 2) Diver 3) Buddy Diver 4) Standby Diver (at discretion of Divemaster)	1) Divemaster (DPIC) 2) Diver 3) Buddy Diver 4) Standby Diver Note: For enclosed or physically confined space, another Diver must be stationed at the underwater point of entry. Note: 29 CFR 1910.426(c)(1)
Line Tended SCUBA*	1) Tender/Divemaster* 2) Line-tended Diver 3) Standby Diver *If qualified to perform both duties a single person may serve as Divemaster and tender.	1) Divemaster (DPIC) 2) Line-tended Diver 3) Standby Diver The standby Diver can be the DPIC provided that they are a qualified Diver, and that the third dive team member is trained and capable of performing all necessary functions of the DPIC while the DPIC is in the water as the standby Diver. The standby Diver can also be the tender provided that they are a qualified Diver; in this case, the DPIC would assume tending duties when the standby Diver is in the water
Surface Supplied Air	1) Divemaster 2) Line-tended Diver* 3) Tender 4) Standby Diver or second line-tended Diver* *If two line-tended Divers are in the water and both are able to render assistance to each other in less than 3 minutes than a standby diver is not required	For consistency, EPA surface supplied diving crew requirements will match between light working and scientific dives.

Item/Topic	Scientific Diving	Light Working Diving
Hookah	1) Divemaster 2) Line-tended Diver* 3) Tender 4) Standby Diver or second line-tended Diver*	Not an acceptable mode of diving for working dive operations
Dive Tender	Dive Tender is required for all dive operations and should be a fully qualified EPA-certified diver. For low-risk dive operations the tender may be a non-diver but must be certified in CPR/First Aid and familiar with dive operations.	Responsibilities and duties are specified in Appendix E of OSHA Guidelines for 29 CFR Part 1910, Subpart T (https://www.osha.gov/OshDoc/Directive_pdf/CPL_02-00-151.pdf), but are generally similar to the requirements for a tender during scientific dive operations. The tender does not have to be a diver nor have any specific certifications other than training to perform duties as a tender.

APPENDIX H

Checklist for Light Working Diving Operations

The checklist below consists of the 29 Code of Federal Regulations (CFR) Part 1910, Subpart T standards (verbatim) in a matrix format as updated by Occupational Safety and Health Administration (OSHA) interpretation. The checklist can be used “as is” or tailored for a specific dive plan by deleting unnecessary paragraphs. See requirements, restrictions, and consultation requirements for light work during EPA operations in the table below excerpted from 29 CFR 1910.

	1910.410 ***QUALIFICATIONS OF DIVE TEAM.***	**Comments/ Remarks/Notes**
	(a) ***General.***	
	(1) Each dive-team member shall have the experience or training necessary to perform assigned tasks in a safe and healthful manner.	
	(2) Each dive-team member shall have experience or training in the following: (i) The use of tools, equipment and systems relevant to assigned tasks. (ii) Techniques of the assigned diving mode. (iii) Diving operations and emergency procedures.	
	(3) All dive-team members shall be trained in cardiopulmonary resuscitation and first aid (American Red Cross standard course or equivalent).	
	(4) Dive-team members who are exposed to or control the exposure of others to hyperbaric conditions shall be trained in diving-related physics and physiology.	
	(b) ***Assignments.***	
	(1) Each dive-team member shall be assigned tasks in accordance with the employee’s experience or training, except those limited additional tasks may be assigned to an employee undergoing training provided that these tasks are performed under the direct supervision of an experienced dive-team member.	
	(2) The employer shall not require a dive-team member to be exposed to hyperbaric conditions against the employee’s will, except when necessary to complete decompression or treatment procedures.	
	(3) The employer shall not permit a dive-team member to dive or be otherwise exposed to hyperbaric conditions for the duration of any temporary physical impairment or condition which is known to the employer and is likely to affect adversely the safety or health of a dive-team member.	

	(c) ***Designated person-in-charge.***	
	(1) The employer or an employee designated by the employer shall be at the dive location in charge of all aspects of the diving operation affecting the safety and health of dive-team members.	
	(2) The designated person-in-charge shall have experience and training in the conduct of the assigned diving operation.	

	1910.420 ***SAFE PRACTICES MANUAL.***	**Comments/ Remarks/Notes**
	(a) ***General.*** The employer shall develop and maintain a safe practices manual which shall be made available at the dive location to each dive-team member (this manual).	
	(1) The safe practices manual shall contain a copy of this standard and the employer's policies for implementing the requirements of this standard [29 CFR Part 1910, Subpart T]. Section 7.1 BASIC EMERGENCY PROCEDURES GUIDELINES/ ADCI are incorporated by reference to this safe work practices manual.	
	(2) For each diving mode engaged in, the safe practices manual shall include: (i) Safety procedures and checklists for diving operations. (ii) Assignments and responsibilities of the dive-team members. (iii) Equipment procedures and checklists. (iv) Emergency procedures for fire, equipment failure, adverse environmental conditions, and medical illness and injury.	

	1910.421 ***PRE-DIVE PROCEDURES.***	**Comments/ Remarks/Notes**
	(a) ***General.*** The employer shall comply with the following requirements prior to each diving operation, unless otherwise specified.	
	(b) ***Emergency aid.*** A list shall be kept at the dive location of the telephone or call numbers of the following:	
	(1) An operational decompression chamber (if not at the dive location);	
	(2) Accessible hospitals;	
	(3) Available physicians;	
	(4) Available means of transportation; and	
	(5) The nearest U.S. Coast Guard Rescue Coordination Center.	

	1910.421 ***PRE-DIVE PROCEDURES.***	**Comments/ Remarks/Notes**
	(c) ***First aid supplies.***	
	(1) A first aid kit appropriate for the diving operation and approved by a physician shall be available at the dive location.	
	(2) When used in a decompression chamber or bell, the first aid kit shall be suitable for use under hyperbaric conditions.	
	(3) In addition to any other first aid supplies, an American Red Cross standard first aid handbook or equivalent, and a bag-type manual resuscitator with transparent mask and tubing shall be available at the dive location.	
	(d) ***Planning and assessment.*** Planning of a diving operation shall include an assessment of the safety and health aspects of the following:	
	(1) Diving mode;	
	(2) Surface and underwater conditions and hazards;	
	(3) Breathing-gas supply (including reserves);	
	(4) Thermal protection;	
	(5) Diving equipment and systems;	
	(6) Dive-team assignments and physical fitness of dive-team members (including any impairments known to the employer); For non-scientific SCUBA dives, a designated person in charge (DPIC) and standby diver are required to be part of the four-person dive team, which also includes two divers in the water. The two divers must be in continuous visual contact with each other or line-tended from the surface. A three-person team is also acceptable consisting of a DPIC, standby diver/tender and diver that is line-tended from the surface.	When referring to Divemaster throughout this manual, this is equivalent to DPIC for light working dives.
	(7) Repetitive dive designation or residual inert-gas status of dive-team members;	
	(8) Decompression and treatment procedures (including altitude corrections); and	
	(9) Emergency procedures.	
	(e) ***Hazardous activities.*** To minimize hazards to the dive-team, diving operations shall be coordinated with other activities in the vicinity which are likely to interfere with the diving operation.	

	1910.421 *PRE-DIVE PROCEDURES.*	**Comments/ Remarks/Notes**
	(f) ***Employee briefing.*** (1) Dive-team members shall be briefed on: (i) The tasks to be undertaken. (ii) Safety procedures for the diving mode. (iii) Any unusual hazards or environmental conditions likely to affect the safety of the diving operation. (iv) Any modifications to operating procedures necessitated by the specific diving operation.	
	(2) Prior to making individual dive-team member assignments, the employer shall inquire into the dive-team member's current state of physical fitness and indicate to the dive-team member the procedure for reporting physical problems or adverse physiological effects during and after the dive.	
	(g) ***Equipment inspection.*** The breathing-gas supply system including reserve breathing-gas supplies, masks, helmets, thermal protection, and bell handling mechanism (when appropriate) shall be inspected prior to each dive.	
	(h) ***Warning signal*. When diving from surfaces other than vessels *[emphasis added]*** in areas capable of supporting marine traffic, a rigid replica of the international code flag "A" at least one meter in height shall be displayed at the dive location in a manner which allows all-round visibility, and shall be illuminated during night diving operations.	

	1910.422 *PROCEDURES DURING DIVE.*	**Comments/ Remarks/Notes**
	(a) ***General.*** The employer shall comply with the following requirements which are applicable to each diving operation unless otherwise specified.	
	(b) ***Water entry and exit.***	
	(1) A means capable of supporting the diver shall be provided for entering and exiting the water.	
	(2) The means provided for exiting the water shall extend below the water surface.	
	(3) A means shall be provided to assist an injured diver from the water or into a bell.	Use of bells for light commercial work is outside the scope of EPA diving.

	1910.422 ***PROCEDURES DURING DIVE.***	**Comments/ Remarks/Notes**
	(c) Communications. (1) An operational two-way voice communication system shall be used between: (i) Each surface-supplied air or mixed-gas diver and a dive-team member at the dive location or bell (when provided or required). (ii) The bell and the dive location.	
	(2) An operational, two-way communication system shall be available at the dive location to obtain emergency assistance.	
	(d) ***Decompression tables.*** Decompression, repetitive, and no-decompression tables (as appropriate) shall be at the dive location.	
	(e) ***Dive profiles.*** A depth-time profile, including when appropriate any breathing-gas changes, shall be maintained for each diver during the dive including decompression (See 1910.423(d) Record of Dive below).	
	(f) ***Hand-held power tools and equipment.***	
	(1) Hand-held electrical tools and equipment shall be de-energized before being placed into or retrieved from the water.	
	(2) Hand-held power tools shall not be supplied with power from the dive location until requested by the diver.	
	(g) ***Welding and burning.***	Outside the scope of EPA diving.
	(1) A current supply switch to interrupt the current flow to the welding or burning electrode shall be: (i) Tended by a dive-team member in voice communication with the diver performing the welding or burning. (ii) Kept in the open position except when the diver is welding or burning.	
	(2) The welding machine frame shall be grounded.	
	(3) Welding and burning cables, electrode holders, and connections shall be capable of carrying the maximum current required by the work and shall be properly insulated.	
	(4) Insulated gloves shall be provided to divers performing welding and burning operations.	
	(5) Prior to welding or burning on closed compartments, structures or pipes, which contain a flammable vapor or in which a flammable vapor may be generated by the work, they shall be vented, flooded, or purged with a mixture of gases which will not support combustion.	

	1910.422 ***PROCEDURES DURING DIVE.***	**Comments/ Remarks/Notes**
	(h) ***Explosives.***	Use of explosives is outside the scope of EPA diving.
	(1) Employers shall transport, store, and use explosives in accordance with this section and the applicable provisions of 29 CFR 1910.109 and 29 CFR 1926.912.	
	(2) Electrical continuity of explosive circuits shall not be tested until the diver is out of the water.	
	(3) Explosives shall not be detonated while the diver is in the water.	
	(i) ***Termination of dive.*** The working interval of a dive shall be terminated when:	
	(1) A diver requests termination;	
	(2) A diver fails to respond correctly to communications or signals from a dive-team member;	
	(3) Communications are lost and cannot be quickly re-established between the diver and a dive-team member at the dive location, and between the designated person-in-charge and the person controlling the vessel in liveboating operations; or	
	(4) A diver begins to use diver-carried reserve breathing gas or the dive- location reserve breathing gas.	

	1910.423 ***POST-DIVE PROCEDURES.***	**Comments/ Remarks/Notes**
	(a) ***General.*** The employer shall comply with the following requirements which are applicable after each diving operation, unless otherwise specified.	
	(b) ***Precautions.***	
	(1) After the completion of any dive, the employer shall: (i) Check the physical condition of the diver. (ii) Instruct the diver to report any physical problems or adverse physiological effects including symptoms of decompression sickness. (iii) Advise the diver of the location of a decompression chamber which is ready for use. (iv) Alert the diver to the potential hazards of flying after diving.	

	1910.423 *POST-DIVE PROCEDURES.*	Comments/ Remarks/Notes
	(2) For any dive outside the no-decompression limits, deeper than 100 feet of seawater (fsw) or using mixed-gas as a breathing mixture, the employer shall instruct the diver to remain awake and in the vicinity of the decompression chamber which is at the dive location for at least one hour after the dive (including decompression or treatment as appropriate).	
	(c) *Recompression capability.*	
	(1) A decompression chamber capable of recompressing the diver at the surface to a minimum of 165 fsw (6 Atmosphere Absolute [ATA]) shall be available at the dive location for: (i) SCUBA and Surface-supplied (SS) air diving to depths deeper than 100 fsw and SS dives shallower than 220 fsw. (ii) Mixed-gas diving shallower than 300 fsw. (iii) Diving outside the no-decompression limits shallower than 300 fsw.	Use of an onsite chamber requires EPA Dive Safety Board approval.
	(2) A decompression chamber capable of recompressing the diver at the surface to the maximum depth of the dive shall be available at the dive location for dives deeper than 300 fsw.	
	(3) The decompression chamber shall be: (i) Dual-lock. (ii) Multi-place. (iii) Located within 5 minutes of the dive location.	
	(4) The decompression chamber shall be equipped with: (i) A pressure gauge for each pressurized compartment designed for human occupancy. (ii) A built-in-breathing-system with a minimum of one mask per occupant. (iii) A two-way voice communication system between occupants and a dive-team member at the dive location. (iv) A viewport. (v) Illumination capability to light the interior.	
	(5) Treatment tables, treatment gas appropriate to the diving mode, and sufficient gas to conduct treatment shall be available at the dive location.	
	(6) A dive-team member shall be available at the dive location during and for at least one hour after the dive to operate the decompression chamber (when required or provided).	
	(d) *Record of dive.*	

	1910.423 ***POST-DIVE PROCEDURES.***	**Comments/ Remarks/Notes**
	(1) The following information shall be recorded and maintained for each diving operation: (i) Names of dive-team members including the designated person-in- charge. (ii) Date, time, and location. (iii) Diving modes used. (iv) General nature of work performed. (v) Approximate underwater and surface conditions (visibility, water temperature and current). (vi) Maximum depth and bottom time for each diver. (vii) Elapsed time since last pressure exposure if less than 24 hours or repetitive dive designation for each diver.	
	(2) For each dive outside the no-decompression limits, deeper than 100 fsw or using mixed-gas, the following additional information shall be recorded and maintained: (i) Depth-time and breathing-gas profiles. (ii) Decompression table designation (including modification).	
	(3) For each dive in which decompression sickness is suspected or symptoms are evident, the following additional information shall be recorded and maintained: (i) Description of decompression sickness symptoms (including depth and time of onset). (ii) Description and results of treatment.	
	(e) ***Decompression procedure assessment.*** The employer shall:	
	(1) Investigate and evaluate each incident of decompression sickness based on the recorded information, consideration of the past performance of the decompression table used, and individual susceptibility;	
	(2) Take appropriate corrective action to reduce the probability of recurrence of decompression sickness; and	
	(3) Prepare a written evaluation of the decompression procedure assessment, including any corrective action taken, within 45 days of the incident of decompression sickness.	

	1910.424 ***SCUBA DIVING.***	**Comments/ Remarks/Notes**
	(a) ***General.*** Employers engaged in SCUBA diving shall comply with the following requirements, unless otherwise specified.	
	(b) ***Limits.*** SCUBA diving shall not be conducted:	
	(1) At depths deeper than 130 fsw;	

	(2) At depths deeper than 100 fsw or outside the no-decompression limits unless a decompression chamber is ready for use;	
	(3) Against currents exceeding one (1) knot unless line-tended; or	
	(4) In enclosed or physically confining spaces unless line-tended.	
	(c) *Procedures.*	
	(1) A standby diver shall be available while a diver is in the water.	
	(2) A diver shall be line-tended from the surface, or accompanied by another diver in the water in continuous visual contact during the diving operation.	
	(3) A diver shall be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.	
	(4) A diver-carried reserve breathing-gas supply shall be provided for each diver consisting of either a: (i) A manual reserve (J-valve). (ii) An independent reserve cylinder with a separate regulator or connected to the underwater breathing apparatus.	
	(5) The valve of the reserve breathing-gas supply shall be in the closed position prior to the dive. [For a J-valve, this is the up position.]	J-valves while OSHA compliant are generally discouraged as an EGS for light work dives.

	1910.425 *SURFACE-SUPPLIED AIR DIVING.*	**Comments /Remarks/Notes**
	(a) *General.* Employers engaged in surface-supplied air diving shall comply with the following requirements, unless otherwise specified.	
	(b) *Limits.*	
	(1) Surface-supplied air diving shall not be conducted at depths deeper than 190 fsw, except that dives with bottom times of 30 minutes or less may be conducted to depths of 220 fsw.	See also Appendix A depth restrictions and requirements.
	(2) A decompression chamber shall be ready for use at the dive location for any dive outside the no-decompression limits or deeper than 100 fsw.	

	1910.425 *SURFACE-SUPPLIED AIR DIVING.*	**Comments /Remarks/Notes**
	(3) A bell shall be used for dives with an inwater decompression time greater than 120 minutes, except when heavy gear is worn or diving is conducted in physically confining spaces.	Use of bells for light commercial work is outside the scope of EPA diving.
	(c) ***Procedures.***	
	(1) Each diver shall be continuously tended while in the water.	
	(2) A diver shall be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.	
	(3) Each diving operation shall have a primary breathing-gas supply sufficient to support divers for the duration of the planned dive including decompression.	
	(4) For dives deeper than 100 fsw or outside the no-decompression limits: (i) A separate dive-team member shall tend each diver in the water. (ii) A standby diver shall be available while a diver is in the water. (iii) A diver-carried reserve breathing-gas supply shall be provided for each diver except when heavy gear is worn. (iv) A dive-location reserve breathing-gas supply shall be provided.	Requires EPA Dive Safety Board approval.
	(5) For heavy gear diving deeper than 100 fsw or outside the no-decompression limits: (i) An extra breathing-gas hose capable of supplying breathing gas to the diver in the water shall be available to the standby diver. (ii) An inwater stage shall be provided to divers in the water.	Requires EPA Dive Safety Board approval.
	(6) Except when heavy gear is worn or where physical space does not permit, a diver-carried reserve breathing-gas supply shall be provided whenever the diver is prevented by the configuration of the dive area from ascending directly to the surface.	

	1910.426 *MIXED-GAS DIVING.*	**Comments/ Remarks/Notes**
	(a) ***General.*** Employers engaged in mixed-gas diving shall comply with the following requirements, unless otherwise specified.	

	(b) *Limits.* Mixed-gas diving shall be conducted only when:	
	(1) A decompression chamber is ready for use at the dive location; and (i) A bell is used at depths greater than 220 fsw or when the dive involves inwater decompression time of greater than 120 minutes, except when heavy gear is worn or when diving in physically confining spaces. or (ii) A closed bell is used at depths greater than 300 fsw, except when diving is conducted in physically confining spaces.	Use of bells for light commercial work is outside the scope of EPA diving.
	1910.426 *MIXED-GAS DIVING.*	**Comments/ Remarks/Notes**
	(c) *Procedures.*	
	(1) A separate dive-team member shall tend each diver in the water.	
	(2) A standby diver shall be available while a diver is in the water.	
	(3) A diver shall be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.	
	(4) Each diving operation shall have a primary breathing-gas supply sufficient to support divers for the duration of the planned dive including decompression.	
	(5) Each diving operation shall have a dive-location reserve breathing- gas supply.	
	(6) When heavy gear is worn: (i) An extra breathing-gas hose capable of supplying breathing gas to the diver in the water shall be available to the standby diver. (ii) An inwater stage shall be provided to divers in the water.	
	(7) An inwater stage shall be provided for divers without access to a bell for dives deeper than 100 fsw or outside the no-decompression limits.	
	(8) When a closed bell is used, one dive-team member in the bell shall be available and tend the diver in the water.	
	(9) Except when heavy gear is worn or where physical space does not permit, a diver-carried reserve breathing-gas supply shall be provided for each diver: (i) Diving deeper than 100 fsw or outside the no-decompression limits or (ii) Prevented by the configuration of the dive area from directly ascending to the surface.	

	1910.427 ***LIVEBOATING.***	**Comments /Remarks/Notes**
	(a) ***General.*** Employers engaged in diving operations involving liveboating shall comply with the following requirements.	
	(b) ***Limits.*** Diving operations involving liveboating shall not be conducted:	
	(1) With an in-water decompression time of greater than 120 minutes;	
	(2) Using surface-supplied air at depths deeper than 190 fsw, except that dives with bottom times of 30 minutes or less may be conducted to depths of 220 fsw;	
	(3) Using mixed-gas at depths greater than 220 fsw;	
	(4) In rough seas which significantly impede diver mobility or work function; or	
	(5) In other than daylight hours.	
	(c) ***Procedures.***	
	(1) The propeller of the vessel shall be stopped before the diver enters or exits the water.	
	(2) A device shall be used which minimizes the possibility of entanglement of the diver's hose in the propeller of the vessel.	
	(3) Two-way voice communication between the designated person-in-charge and the person controlling the vessel shall be available while the diver is in the water.	
	(4) A standby diver shall be available while a diver is in the water.	
	(5) A diver-carried reserve breathing-gas supply shall be carried by each diver engaged in liveboating operations.	

	1910.430 ***EQUIPMENT.***	**Comments/ Remarks/Notes**
	(a) ***General.***	
	(1) All employers shall comply with the following requirements, unless otherwise specified.	
	(2) Each equipment modification, repair, test, calibration or maintenance service shall be recorded by means of a tagging or logging system, and include the date and nature of work performed, and the name or initials of the person performing the work.	
	(b) ***Air compressor system.***	

	1910.430 *EQUIPMENT.*	**Comments/ Remarks/Notes**
	(1) Compressors used to supply air to the diver shall be equipped with a volume tank with a check valve on the inlet side, a pressure gauge, a relief valve, and a drain valve.	
	(2) Air compressor intakes shall be located away from areas containing exhaust or other contaminants.	
	(3) Respirable air supplied to a diver shall not contain: (i) A level of carbon monoxide (CO) greater than 20 ppm. (ii) A level of carbon dioxide (CO_2) greater than 1,000 ppm. (iii) A level of oil mist greater than 5 milligrams per cubic meter; or (iv) A noxious or pronounced odor.	
	(4) The output of air compressor systems shall be tested for air purity every 6 months by means of samples taken at the connection to the distribution system, except that non-oil lubricated compressors need not be tested for oil mist.	
	(c) *Breathing-gas supply hoses.*	
	(1) Breathing-gas supply hoses shall: (i) Have a working pressure at least equal to the working pressure of the total breathing-gas system. (ii) Have a rated bursting pressure at least equal to 4 times the working pressure. (iii) Be tested at least annually to 1.5 times their working pressure. (iv) Have their open ends taped, capped or plugged when not in use.	
	(2) Breathing-gas supply hose connectors shall: (i) Be made of corrosion-resistant materials. (ii) Have a working pressure at least equal to the working pressure of the hose to which they are attached. (iii) Be resistant to accidental disengagement.	
	(3) Umbilicals shall: (i) Be marked in 10-foot increments to 100 feet beginning at the diver's end, and in 50-foot increments thereafter. (ii) Be made of kink-resistant materials. (iii) Have a working pressure greater than the pressure equivalent to the maximum depth of the dive (relative to the supply source) plus 100 psi.	

	1910.430 *EQUIPMENT.*	**Comments/ Remarks/Notes**
	(d) *Buoyancy control.*	
	(1) Helmets or masks connected directly to the dry suit or other buoyancy-changing equipment shall be equipped with an exhaust valve.	
	(2) A dry suit or other buoyancy-changing equipment not directly connected to the helmet or mask shall be equipped with an exhaust valve.	
	(3) When used for SCUBA diving, a buoyancy compensator shall have an inflation source separate from the breathing-gas supply.	OSHA is not enforcing this subsection of the standard. (Dry Tortugas incident report, 2008)
	(4) An inflatable flotation device capable of maintaining the diver at the surface in a face-up position, having a manually activated inflation source independent of the breathing supply, an oral inflation device, and an exhaust valve shall be used for SCUBA diving.	
	(e) *Compressed gas cylinders.* Compressed gas cylinders shall:	
	(1) Be designed, constructed and maintained in accordance with the applicable provisions of 29 CFR 1910.101 and 1910.169 through 1910.171;	
	(2) Be stored in a ventilated area and protected from excessive heat;	
	(3) Be secured from falling; and	
	(4) Have shut-off valves recessed into the cylinder or protected by a cap, except when in use or manifolded, or when used for SCUBA diving.	

	1910.430 ***EQUIPMENT.***	**Comments/ Remarks/Notes**
	(f) ***Decompression chambers.***	Use of recompression chambers on vessel or on site requires EPA Dive Safety Board approval.
	(1) Each decompression chamber manufactured after the effective date of this standard, shall be built and maintained in accordance with the American Society of Mechanical Engineers (ASME) Code or equivalent.	
	(2) Each decompression chamber manufactured prior to the effective date of this standard shall be maintained in conformity with the code requirements to which it was built, or equivalent.	
	(3) Each decompression chamber shall be equipped with: (i) Means to maintain the atmosphere below a level of 25 percent oxygen by volume. (ii) Mufflers on intake and exhaust lines, which shall be regularly inspected and maintained. (iii) Suction guards on exhaust line openings. (iv) A means for extinguishing fire and shall be maintained to minimize sources of ignition and combustible material.	
	(g) ***Gauges and timekeeping devices.***	
	(1) Gauges indicating diver depth which can be read at the dive location shall be used for all dives except SCUBA.	
	(2) Each depth gauge shall be dead-weight tested or calibrated against a master reference gauge every 6 months, and when there is a discrepancy greater than two percent (2 percent) of full scale between any two equivalent gauges.	
	(3) A cylinder pressure gauge capable of being monitored by the diver during the dive shall be worn by each SCUBA diver.	
	(4) A timekeeping device shall be available at each dive location.	

	1910.430 ***EQUIPMENT.***	**Comments/ Remarks/Notes**
	(h) ***Masks and helmets.***	
	(1) Surface-supplied air and mixed-gas masks and helmets shall have: (i) A non-return valve at the attachment point between helmet or mask and hose which shall close readily and positively. (ii) An exhaust valve.	
	(2) Surface-supplied air masks and helmets shall have a minimum ventilation rate capability of 4.5 Actual Cubic Feet per Minute (acfm) at any depth at which they are operated or the capability of maintaining the diver's inspired carbon dioxide partial pressure below 0.02 ATA when the diver is producing carbon dioxide at the rate of 1.6 standard liters per minute.	
	(i) ***Oxygen safety.***	
	(1) Equipment used with oxygen or mixtures containing over forty percent (40%) by volume oxygen shall be designed for oxygen service.	
	(2) Components (except umbilicals) exposed to oxygen or mixtures containing over forty percent (40%) by volume oxygen shall be cleaned of flammable materials before use.	
	(3) Oxygen systems over 125 psi and compressed air systems over 500 psi shall have slow-opening shut-off valves.	
	(j) ***Weights and harnesses.***	
	(1) Except when heavy gear is worn, divers shall be equipped with a weight belt or assembly capable of quick release.	
	(2) Except when heavy gear is worn or in SCUBA diving, each diver shall wear a safety harness with: (i) A positive buckling device. (ii) An attachment point for the umbilical to prevent strain on the mask or helmet. (iii) A lifting point to distribute the pull force of the line over the diver's body.	

	1910.440 ***RECORDKEEPING REQUIREMENTS.***	**Comments/ Remarks/Notes**
	(a) ***Recording diving-related injuries and illnesses.***	
	(1) [Reserved]	
	(2) The employer shall record the occurrence of any diving-related injury or illness which requires any dive-team member to be hospitalized for 24 hours or more, specifying the circumstances of the incident and the extent of any injuries or illnesses.	
	(b) ***Availability of records.***	
	(1) Upon the request of the Assistant Secretary of Labor [for OSHA], or the Director, National Institute for Occupational Safety and Health, Department of Health and Human Services or their designees, the employer shall make available for inspection and copying any record or document required by this standard.	
	(2) Records and documents required by this standard shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.1020 (a)-(e) and (g)-(i) (in 1996, 29 CFR 1910.20 was re-designated as 29 CFR 1910.1020). Safe practices manuals (29 CFR 1910.420), depth-time profiles (29 CFR 1910.422), decompression procedure assessment evaluations (29 CFR 1910.423), and records of hospitalizations (29 CFR 1910.440) shall be provided in the same manner as employee exposure records or analyses using exposure or medical records. Equipment inspections and testing records which pertain to employees (29 CFR 1910.430) shall also be provided upon request to employees and their designated representatives.	

	1910.430 ***EQUIPMENT.***	**Comments /Remarks/Notes**
	(3) Records and documents required by this standard shall be retained by the employer for the following period: (i) Dive-team member medical records (physician's reports) (29 CFR 1910.411) – 5 years; [NOTE: No longer required since 29 CFR 1910.411 was deleted from the standard]. (ii) Safe practices manual (29 CFR 1910.420) – current document only (iii) Depth-time profile (29 CFR 1910.422) – until completion of the recording of the dive, or until completion of decompression procedure assessment where there has been an incident of decompression sickness. (iv) Recording of dive (29 CFR 1910.423) – 1 year, except 5 years where there has been an incident of decompression sickness. (v) Decompression procedure assessment evaluations (29 CFR 1910.423) – 5 years. (vi) Equipment inspections and testing records (29 CFR 1910.430) – current entry or tag, or until equipment is withdrawn from service. (vii) Records of hospitalizations (29 CFR 1910.440) – 5 years.	
	(4) After the expiration of the retention period of any record required to be kept for 5 years, the employer shall forward such records to the National Institute for Occupational Safety and Health, Department of Health and Human Services. The employer shall also comply with any additional requirements set forth at 29 CFR 1910.1020(h) (in 1996, 29 CFR 1910.20 was re-designated as 29 CFR 1910.1020).	
	(5) In the event the employer ceases to do business: (i) The successor employer shall receive and retain all dive and employee medical records required by this standard or (ii) If there is no successor employer, dive and employee medical records shall be forwarded to the National Institute for Occupational Safety and Health, Department of Health and Human Services.	

APPENDIX I

Surface Supplied Diving Standard Operating Procedure

SURFACE SUPPLIED DIVING STANDARD OPERATING PROCEDURE

Credits: US EPA Environmental Response Team developed this SOP.

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SURFACE SUPPLIED DIVING STANDARD OPERATING PROCEDURE

1.0 OBJECTIVES

This standard operating procedure (SOP) states the U.S. Environmental Protection Agency (EPA) policy concerning surface supplied diving operations. Procedures for general dive operations are specified the EPA *Diving Safety Manual*. This SOP in not intended to be a substitute for actual hands-on training. See EPA Diving Safety Manual, Appendix H, "Checklist for Light Working Diving" for light working requirements that apply to this diving mode.

2.0 APPLICABILITY

Surface supplied diving applies to diving operations during which Divers are supplied with breathing gas through an umbilical hose from the surface. These procedures apply to EPA employees and contractors working directly for EPA, that are engaged in surface supplied diving operations. This SOP presumes and requires prior training and experience with surface supplied diving.

3.0 DESCRIPTION

3.1 Certification and Physical Examinations

All Divers must be dive certified and medically qualified to perform their diving duties, as specified in EPA *Diving Safety Manual*.

3.2 General Dive Equipment and Safety Equipment

Each component of a Diver's equipment shall be maintained in a safe operating condition, and shall be inspected, tested, serviced and logged as specified in the EPAEPA *Diving Safety Manual*. All appropriate safety equipment shall be available at the dive site as specified in the Dive Safety Plan and EPA *Diving Safety Manual*.

3.3 Documentation

Project-specific Dive Plans and Dive Safety Plans shall be issued prior to performing dive operations, and all dives shall be logged as specified in the EPA *Diving Safety Manual*. The Unit Dive Officer (UDO) shall maintain logs of each Diver's certifications, medical clearance to dive, and all health and safety training (e.g., Cardiopulmonary Resuscitation [CPR], first aid and oxygen administration) as specified in the EPA Diving Safety Manual.

3.4 Surface Supplied Diving Equipment

3.4.1 Breathing Gas

The breathing gas may be air or enriched air (e.g., nitrox up to 40%

oxygen) depending on the planned dive profile, if the control box and umbilicals are approved by the manufacturer for that usage and/or have been oxygen cleaned. Gas may be supplied by means of pressurized tanks, low pressure/high volume compressors or a compressor/tank system. Breathing gases may be either generated on-site with a compressor or from tank fills purchased through a reputable dive shop or commercial gas supplier or from tank fills from an EPA, National Oceanic and Atmospheric Administration (NOAA) or other trusted partner owned compressor. Dive shops and commercial suppliers are required to have their breathing gas analyzed for impurities regularly. Compressor-generated breathing gas is also required to be analyzed to Compressed Gas Association (CGA) grade E standards at least once every six months. Dive operations shall not be initiated unless there is a sufficient supply of breathing gas for all Divers, including stand-by Divers and emergency reserve.

3.4.1.1 Compressed Gas Cylinders

All self-contained underwater breathing apparatus (SCUBA) tanks or other pressurized vessels used for breathing gases must be properly maintained and undergo hydrostatic testing at a qualified facility at least every five years and have an internal visual inspection by a qualified technician annually. The Divemaster or designee shall check that each tank intended for dive operations has markings for current inspection and test dates. Prior to use, the yokes on all gas cylinders should be inspected for damage to the seat or O-rings. Gas pressure must not exceed the rated working pressure for any of the components of the entire diving gas supply system.

3.4.1.2 Compressors

All breathing gas compressors must be properly maintained, with regularly logged maintenance records. Compressors must be capable of supplying breathing gas at a satisfactory volume (at least double the volume required) and pressure (at least 25% greater than the maximum pressure requirement anticipated) for the number of Divers potentially supplied at the deepest depth potentially encountered at a work site.

3.4.2 Surface Supplied Control Box

Surface supplied control boxes are capable of running two Divers simultaneously on separate umbilicals, and can accept breathing gas either from compressed gas cylinders (working pressure can range from 3,000 pounds per square inch [psi] to 3,500 psi; check the manufacturer specifications for details) or from a low pressure/high volume compressor. Air is the only breathing gas approved by some manufacturers for use with their control boxes without special cleaning, while other manufacturers allow the use of Nitrox mixes up to 40%. One should check the specifications of their control box before using Nitrox.

These boxes typically have an internal rechargeable 12-volt gel cell battery that must be charged prior to dive operations, and indicator lights that indicate the battery charge level. The box requires very little power, and a fully charged battery should last for up to 20 hours of continuous service. If the unit does not show full charge (all indicator lights lit) after an overnight charge, the battery may need to be replaced.

While using the control box plugged into an electrical source is possible, some manufacturers cautions the user to never connect the charger during a dive due to the potential of electrical shock to the Diver.

The surface supplied control box must be operated by a qualified technician. When there are one or more Divers in the water on surface supplied air, the box operator can have no duties other than monitoring the breathing gas supply to the Diver, maintaining communications with the Diver, and logging the Diver's bottom time and depth.

3.4.3 Diving Umbilicals

Surface supply umbilicals provide breathing gas, communications, the Diver's depth and a strength member between the tender and the Diver. Diving umbilicals may either be the sinking or floating type. The sinking type is negatively buoyant and more likely to snag on bottom obstructions or disturb contaminated sediments. The floating type is positively buoyant and more likely to be affected by surface current or vessel traffic. The buoyancy of the umbilical can be modified in the field by adding floats or weights as required.

Decontamination compatible floating umbilicals, ranging in length from 150 to 300 feet are typically used. The umbilicals are typically comprised of three separate spiral-wound hoses, although straight (not spiral wound) hoses may be utilized as well in order to use components separately if needed. This smooth polyurethane umbilical and twists, rather than tape, is ideal for operations in potentially contaminated water because it can be effectively decontaminated.

The primary hose is the Diver's breathing gas supply hose, which runs between the surface supply control box and the Diver's emergency manifold block (see Section 3.4.4).

The breathing gas supply hose should be rated to a working pressure of at least 300 psi. The hose is typically 3/8 inch inside diameter, but some lightweight systems may utilize a 1/4 inch diameter breathing gas hose. To ensure a sufficient air supply, users should be aware that the diameter of the breathing gas supply hose may restrict the safe operation of the system at greater depths, umbilical lengths, or breathing rates. The manufacturer should be consulted to identify any possible limitations of the breathing gas system (Dive Lab Surface Supply Breathing Requirements and Recommendations for Kirby Morgan Helmets and Band Masks, 2008).

The second component of the umbilical is the Diver's hard-wired communication line (com line), which allows open, two-way communication between the Diver and surface support personnel. The com line runs between the surface supply box and the Diver's mask-integrated communication system (microphone and earphones). The com line is usually also equipped with a strength member capable of towing or lifting many times the Diver's weight. The hard-wired umbilical may be eliminated if using a reliable wireless comm. system, although a strength member is still required.

The third component of the umbilical is the pneumofathometer (pneumo) hose, a gas line that is open on the Diver's end. The 1/4 inch inner diameter pneumo runs from the surface supply control box down to the Diver, with its open end attached in the area of the Diver's chest. The pneumo line is a simple capillary tube type of depth gauge, which allows surface personnel to monitor the Diver's depth. The control box operator can open the pneumo valve to blow gas through the pneumo hose, and when the valve is closed, the water pressure will back up the hose allowing the pneumo gauge to read depth. In some instances, the Diver can also use the pneumo as a tool to inflate a lift bag or to blow sediment out of a small work area. In the event of an emergency, some manufacturers suggest the Diver can also use the pneumo as an alternative breathing gas supply. The pneumo hose may be eliminated in situations where the Diver monitors and controls their own depth and dive profile with a depth gauge or dive computer.

For polluted water diving, configuration of the umbilical on the vessel should allow for easy decontamination of the hose in the "hot zone." Moving the umbilical into the contamination reduction zone should be avoided.

3.4.4 Gas Supply Manifold Block

The Diver's harness-mounted manifold block typically has two ports for attachment of incoming gas supply, one port for the dry suit inflator hose, one port for attachment of the breathing regulator, and two low pressure ports for auxiliary equipment. The primary incoming port is for attachment of the umbilical breathing gas line. This port must have a functioning non-return valve to ensure that a loss of umbilical line pressure, combined with depth pressure, won't suck the gas out of the Diver's lungs or out of the emergency gas supply tank. This ensures that in the event of umbilical air supply loss, the Diver will receive air from the emergency gas supply (EGS). Prior to attaching the umbilical hose to the manifold block, the non-return valve should be tested by pressurizing the EGS and checking for any air leakage past the non-return.

The second incoming port on the manifold block is for attachment of the emergency gas supply (A"bail-out" bottle).

In the event of a loss of air from the surface, the manifold block has a knob that the Diver turns to open the EGS. At the start of the dive, the knob must be in the closed position (fully turned clockwise). During the dive the Diver should periodically confirm the knob is fully closed and the submerged pressure gauge (SPG) for the EGS is full. It should be noted that as little as a quarter turn may begin depleting the EGS. All Divers must be aware of the operation and placement of the manifold block, so they can find it in an emergency. No other equipment may block the Diver's access to the knob.

3.4.5 Emergency Gas Supply

While dive planning must involve provision of sufficient air for the dive operation including ascent and exigencies, independent emergency breathing gas (EGS) must also be provided for all surface supplied diving operations. The size of the bail-out bottle is determined based upon the type of water, i.e. contaminated vs. non-contaminated, working depth, type of equipment, i.e. FFM vs. helmet and the air consumption rate of the individual Diver. The bail-out bottle is typically mounted with the valve down which allows the Diver to turn the tank valve on, should the knob be inadvertently closed. The larger the bail-out bottle, the longer the Diver has to surface in the event of a loss of surface supplied gas. The deeper the Diver is working and the more potential hazards present, the larger the bail-out bottle required. A SPG for the EGS must be accessible to the Diver at all times. The first-stage regulator on the pony bottle must have an over-pressure relief valve unless otherwise equipped to relieve pressure created by first stage failure.

Sometimes it is necessary to fill the bail-out bottle in the field. In those instances, a filling whip (a length of high pressure air hose with tank yoke fittings on both ends) is used to connect the bail-out bottle to a full SCUBA tank. The empty bail-out bottle valve should be completely opened, and then the full SCUBA tank valve should be opened very slowly so that the bail-out bottle does not heat up. Depending on the size of the bail-out bottle, it may be necessary to use several SCUBA tanks to get a satisfactory fill (greater than 2500 psi).

3.4.6 Breathing Regulator

EPA divers typically wear a full face mask (FFM) when using surface supplied gas, but diving helmets may also be used. Both the FFM and the helmet are equipped with communication equipment (microphones and earphones).

The decision to use either a helmet or full face mask depends on the resources and training available to each dive team, the dive objective, pollution/contamination level, or other environmental factors.

3.4.7 Diver Harness

A harness should be worn by the Diver for all surface supplied dive operations. The harness is used as an attachment point for both the umbilical line and the Diver's emergency breathing gas supply. The communications line must be clipped to the Diver's harness prior to the start of the dive. This safety feature allows the Diver to pull the umbilical along or for the Diver to be towed back to the point of entry without straining any vital gas or communication links.

3.5 Surface Supplied Diving Operations

3.5.1 Surface Supplied Control Box Operations

The control box should be secured in an area where its presence, and that of the operator, will not impede operations of the surface support crew. The box should be held open and secured to a fixed object (e.g., boat rail or a dock piling). The breathing gas source should be within easy reach of the operator. In inclement weather, the box should be set up in an area out of the rain (e.g., in the boat cabin or under a tarp).

When the surface supply control box is set up, the main power switch should be turned on and the battery power checked. The gas outlets should be uncapped and the breathing gas line and the pneumo line should be attached. Since the two lines are different diameters, they can only be attached to their respective outlets. The control box has gas outlets for two sets of umbilical lines, typically marked with different colors, typically red/white, red/blue or orange/blue. The control box operator must be sure to attach both lines (breathing gas and pneumo, if used) from one umbilical to the matching colors for each diver. Many control box umbilical lines (breathing gas and pneumo) have a bronze Joint Industrial Conference (JIC) hose fitting which screws onto its gas outlet. These fittings should be lightly tightened with a wrench to prevent gas leaks, but not tight enough to put torque on the fittings. Both of the Diver gas supplies have a gate lever that can be opened or closed to allow gas flow to the outlets.

SCUBA tanks can be used as a source of breathing gas for surface supplied diving. The control box has a selector valve handle that is used to switch between two incoming gas lines. While the incoming lines are typically each attached to a single SCUBA tank, the team may opt to use a manifold block to attach several tanks to each incoming line. The tanks on both incoming lines must be open. After the gas tanks are attached to the system, the operator should blow out the breathing gas line by briefly opening the outlet gate to allow gas to blow out any dust or particles. The end of breathing gas line can then be attached to the Diver's gas supply manifold block.

3.5.2 Communications

3.5.2.1 Voice Communications

The control box communications system can be operated either with a microphone and the built-in speaker so all surface personnel can hear the Diver or the box operator can wear headphones to block out external noise (e.g., machinery, wind, extraneous conversation). When using headphones, the operator may turn off the speaker switch so that only the box operator can hear the Diver. When in this mode, the operator must relay information to dive tender and other surface personnel. The set up should be close enough to the dive operation and tenders to allow clear communication between the Communications Box Operator and dive tender.

Prior to donning the helmet or FFM, the Diver and control box operator must perform a communications check. The surface end of the com line is wired with connectors for attachment to the control box, and the Diver end of the com line is wired to attach to the Diver's communication line (microphone and earphones). The control box has adjustment knobs for surface-to-Diver and for Diver-to-surface volume. Proper two-way communications should be established prior to initiating dive operations.

3.5.2.2 "Line-pull" Communications

In the event of loss of voice communications, the dive unit should practice backup line signals to ensure the dive can be safely and efficiently aborted. Example standard line-pull signals are included below from the US Navy Dive Manual, revision 6, Table 8-3.

Example Emergency Line-pull Signals

Primary Diver to Tender:

2-2-2	*I am in a difficulty but I am OK, I need assistance, send the backup Diver.*
3-3-3	*I am entangled and OK, I am stopping to handle it myself but ready the backup Diver.*
4-4-4	*I am not OK, I need immediate assistance.*

Primary Diver to Standby Diver:

Big Circular Motion: *I am entangled here (indicate where the entanglement is by putting the backup Diver hands on it).*

Tap Standby's Hand on Primary Divers Chest:
I am injured here (indicate the injury location).

Tap Standby's Hand to Primary Divers Second Stage:
I am running low on air.

Standby Diver to Primary Diver:

Place primary's hand back on his carabineer and give three squeezes:
I am leaving now but will be back. The standby Diver goes back to return with additional air to allow more time to deal with the problem.

USN Revision 6 Full Set of Line Pull Signals:

Table 8-3. *Line-Pull Signals.*

From Tender to Diver		Searching Signals (Without Circling Line)	
1 Pull	"Are you all right?" When diver is descending, one pull means "Stop."	7 Pulls	"Go on (or off) searching signals."
2 Pulls	"Going Down." During ascent, two pulls mean "You have come up too far; go back down until we stop you."	1 Pull	"Stop and search where you are."
3 Pulls	"Stand by to come up."	2 Pulls	"Move directly away from the tender if given slack; move toward the tender if strain is taken on the life line."
4 Pulls	"Come up."	3 Pulls	"Face your umbilical, take a strain, move right."
2-1 Pulls	"I understand" or "Talk to me."	4 Pulls	"Face your umbilical, take a strain, move left."
3-2 Pulls	"Ventilate."		
4-3 Pulls	"Circulate."		
From Diver to Tender		**Searching Signals (With Circling Line)**	
1 Pull	"I am all right." When descending, one pull means "Stop" or "I am on the bottom."	7 Pulls	"Go on (or off) searching signals."
2 Pulls	"Lower" or "Give me slack."	1 Pull	"Stop and search where you are."
3 Pulls	"Take up my slack."	2 Pulls	"Move away from the weight."
4 Pulls	"Haul me up."	3 Pulls	"Face the weight and go right."
2-1 Pulls	"I understand" or "Talk to me."	4 Pulls	"Face the weight and go left."
3-2 Pulls	"More air."		
4-3 Pulls	"Less air."		
Special Signals From the Diver		**Emergency Signals From the Diver**	
1-2-3 Pulls	"Send me a square mark."	2-2-2 Pulls	"I am fouled and need the assistance of another diver."
5 Pulls	"Send me a line."	3-3-3 Pulls	"I am fouled but can clear myself."
2-1-2 Pulls	"Send me a slate."	4-4-4 Pulls	"Haul me up immediately."
ALL EMERGENCY SIGNALS SHALL BE ANSWERED AS GIVEN EXCEPT 4-4-4			

3.5.3 Pre-Dive Operations

The area in which the Diver dresses and then uses for access to the water should be kept clear of all debris and items that could present slip, trip or fall hazards to the Diver. The tender should always be available to physically assist the fully dressed Diver.

The tender should assist the Diver in donning all equipment and ensure all belts, clips and harnesses are securely fastened. The dive tender and/or the box operator should ensure that all air systems and communications are functioning properly. The tender should complete all predive checks as specified in the Surface Supplied Air Checklist (Attachment 1).

3.5.4 Entering the Water

The tender should assist the Diver with entering the water and always maintain a grip on the umbilical. If the Diver jumps into the water, it is the tender's responsibility to ensure that there are no obstacles in the Diver's landing area. The tender should also give the Diver enough slack in the umbilical to get into the water just below the surface. Immediately after the Diver has entered the water, the tender should pull the Diver back to the surface. Once back at the surface, the Diver should ensure that he or she is properly weighted, do another communication check, and the tender and the Diver should assess the Diver for leaks (bubbling, particularly around the mask). Once the Diver is ready to submerge, the tender should give the Diver enough slack to descend. Since the tender is usually in the best position to witness the Diver submerging, the tender should also call out to the box operator and/or divemaster when the Diver has submerged so the submergence time can be recorded.

3.5.5 Depth Monitoring

When a Diver is in the water, the box operator must maintain regular, open communication. Once the Diver has descended to the work site, the operator should monitor the Diver's depth using the pneumo. Using the correct pneumo gauge for the Diver's umbilical, the operator should open the pneumo valve below the gauge by turning it in a counter clockwise direction until the depth gauge reads a depth that is known to be deeper than the Diver, or until the Diver reports bubbles coming from the open end of the pneumo hose. The operator should then close the valve, monitor the depth gauge and record the Diver's depth, measured in feet of sea water (FSW), when the gauge needle stabilizes. The operator should monitor the Diver's depth frequently, especially when the Diver is moving around. The Divemaster or designee records this information on the tending form during the dive. The Diver may also choose to use a computer or depth gauge to monitor their depth in lieu of using a pneumo hose.

3.5.6 Umbilical Pressure

The control box operator should ensure that the Diver is getting sufficient breathing gas pressure at depth. The umbilical pressure gauge on the control box should read between 115 psi and 225 psi depending upon the specifications of the mask or dive helmet being utilized, bottom depth, and particular control box instructions. Lower umbilical pressure results in more effort required on the Diver's part to breathe. The EPA typically maintains umbilical pressure at 150 psi for light to moderate workloads. If the Diver is performing manual labor (e.g., pounding sediment cores or moving heavy objects) and is breathing hard, it may be necessary to increase the umbilical pressure by turning the umbilical pressure knob until the Diver reports that gas flow is comfortable.

3.5.7 Breathing Gas Supply

The control box operator must maintain careful watch over the pressure gauge on the line that is supplying gas to the Diver. When the gauge reads approximately 500 psi, the operator should flip the selector handle to the other incoming gas line. The selector handle must be turned all the way to its stop for breathing gas to flow properly. As soon as is practical, the operator, or designee, should replace the spent gas cylinder with a full cylinder. When using SCUBA tanks, the spent tank valve should be closed, and the pressure should be bled out of the hose between the tank and the control box using the bleed valve on the yoke. Upon removing the spent tank and replacing it with a full tank, the bleed valve should be closed and the tank valve should slowly be fully opened. The operator should ensure that the pressure gauge on the control box indicates a full tank. This procedure should be followed each time a spent tank is replaced. It is the responsibility of the control box operator to ensure that a sufficient gas supply is readily available for all diving.

Prior to switching the gas source, the operator should notify the Diver to suspend the current activity, locate the EGS manifold block and be ready to switch to emergency gas. Once the Diver has responded to the operator and has put a hand on the manifold block, the operator can switch the gas source. In the event that a gas line or a seal (O-ring or fitting) should fail upon changing pressure, the Diver will be prepared to immediately switch to emergency breathing gas. If a seal should fail and gas pressure to the system is lost, the operator must switch back to the previous tank and inform the Diver to be ready to switch to the EGS. The box operator should replace the failed tank with a new tank as quickly as possible and switch to the replacement tank. Once the situation has been resolved, it is the divemaster's decision to either continue or terminate the mission.

3.5.8 Emergency Gas Supply

It is the responsibility of the Divemaster, the Diver and the tender to each ensure that the valve of the bail-out bottle is opened after it is connected to the manifold block and that the manifold block knob is closed. The bail-out bottle pressure should be checked and recorded prior to every working dive. The EGS should be mounted upside down, and the divemaster should verify that the Diver can reach the tank valve to re-open it, should it become closed.

3.5.9 Ending a Dive

At the termination of each dive, the operator should notify the surface support crew that the Diver is ready to ascend. If conditions permit the Diver to control the ascent, the tender should slowly pull in the slack from the umbilical as it becomes available. The umbilical should be coiled neatly in a pile either in its shipping box, on the deck/dock/ground, or on a rack behind the tender. The umbilical should be coiled in alternating over-under loops to facilitate the next deployment. If conditions do not permit the Diver to control the ascent (e.g., low visibility or mid-water current), the tender should gently pull in all slack umbilical and the operator should have the Diver swim on the bottom in the direction of the umbilical. Once the Diver is close to or below the boat/platform, the Diver should exhaust air in their suit to become negatively buoyant and the tender should use the umbilical to lift the Diver up to the surface. The tender must maintain an ascent rate of no more than 30 feet per minute, and the operator must continually communicate with the Diver to ensure that the ascent rate is not causing discomfort (e.g., reverse squeeze). The box operator can monitor the Diver's rate of ascent simply by watching the pneumo gauge. The operator should warn Diver if any surface hazards are present.

Once the Diver is on the surface, the tender should call out to the Divemaster or box operator who should record surface time on the dive log. Once at the dive platform, the tender should assist the Diver exiting the water. When diving in contaminated water, proper decontamination methods should be utilized prior to undressing the Diver.

3.5.10 Switching Divers

When switching Divers, the same harness rig is typically worn but the next Diver's personal FFM should be used. To switch FFMs, the box operator should close the gate on the umbilical gas outlet, and the tender should push the purge button on the first Diver's FFM to bleed the pressure out of the breathing gas hose. The FFM should then be removed and the next Divers mask put on the system. Dive computers must not be shared.

3.5.11 Termination of Dive Operations

When the day's dive operations have been completed, the control box should be properly stowed. The main power switch should be turned off, and the battery power should be checked. If the battery is low, the box should be charged overnight prior to the next dive operation. The microphone should be disconnected and stowed in the battery compartment, and the com line connectors should be gently pulled. The gas supply tank valves should be closed and the bleed valves on the tank yokes should be opened to depressurize the supply hoses. The SCUBA tanks should be taken off the system, and any tanks that have not been exhausted should be capped for use on future dives. Tanks that have been exhausted should not be capped and should be kept separate from the full tanks so that they can be refilled. The FFM purge button should be pushed to bleed the gas out of the umbilical. The gas supply gate should then be closed. Using a wrench, the umbilical lines (both breathing gas and pneumo) should be removed from the box. The breathing gas hose should be capped immediately upon being disconnected from the box.

The gas outlets should then be capped, finger-tight, with their brass caps. The control box should then be closed and latched so that the o-ring seal on the lid makes the control box water-tight.

After decontamination, the umbilical should be coiled neatly in its shipping box. The harness should be disconnected by unclipping the umbilical and using a wrench to disconnect the breathing gas supply hose. The supply hose should be capped immediately after being disconnected. The pony bottle valve should be closed, and the valve on the manifold block should be briefly opened to bleed the hose pressure so that the regulator first stage can be removed from the bottle and capped. After all gear has dried, the umbilical, harness, pony bottle and regulator should be stowed in the umbilical shipping case, and all of the latches should be tightened. Prior to shipping the case by air, the pony bottle must either be removed or emptied.

3.6 Surface Supplied Air Equipment Maintenance and Storage

At the conclusion of daily dive operations, the panels of the control box should be wiped with a damp cloth. After the project is completed all equipment should be allowed to air dry prior to being stored.

The control box should be serviced by a qualified technician on an annual basis. All batteries used in the control box, should be maintained according to the manufacturer's recommendations. When batteries no longer take a full charge or the battery life is diminished, they should be replaced according to the manufacturer's procedures.

The breathing gas hose must be pressure tested to 1.5 times its working pressure by a qualified facility on an annual basis. The breathing gas hose must be kept clean, inside and out. It is important to ensure that both ends of the hose are properly capped when the hose is not in use to prevent dust and particulate contaminants from getting into the breathing system.

4.0 RESPONSIBILITIES

Each member of the surface supplied dive team will have the experience or training necessary to perform the tasks assigned to them in a safe and efficient manner. This experience and training will include the use of tools and equipment needed for the specified tasks and techniques required for surface supplied diving. Each member of the dive team will also have training in the emergency procedures required in the event of a diving accident. Each dive team member will only be assigned tasks in accordance with that person's training and experience.

A simple surface supplied diving operation (a single Diver, shallow, short duration dives) requires a minimum of four people; a Diver, a stand-by Diver, a tender, and control box operator/divemaster. However, dive projects requiring multiple dives, depths greater than 30 feet, and multiple Divers may require a larger minimum crew. If two Divers are in the water simultaneously, the minimum of five people are required; two Divers, two tenders, and a control box operator/divemaster. These minimum numbers assume that all personnel, with the exception of tenders, are qualified Divers who could switch duties from surface support to in-water operations. The responsibilities of the dive team are described in the EPA *Diving Safety Manual*, but those responsibilities specific to surface supplied diving follow:

4.1 Divemaster

The divemaster carries the overall responsibility for the safety and performance of the dive operation. On small operations, the divemaster may also assume the responsibilities of another surface support person or even perform in-water duties if there is a qualified divemaster available to assume the divemaster surface responsibilities.

4.2 Diver

Divers are primarily responsible for performing the in-water work. The Diver is also responsible for ensuring all dive equipment is present, and in working order. While in the water, the Diver is responsible to carry out work duties as instructed, and to maintain open communication with surface personnel. The surface supply control box operator and the Divemaster should be aware of the Diver's status at all times. It is the Diver's responsibility to ensure that they are clear on the objectives of the dive and is aware of all safety equipment and procedures that may be required.

4.3 Stand-by Diver

For all surface supplied diving operations, at least one qualified member of the team will be designated as a stand-by Diver. The stand-by Diver will be ready to enter the water promptly in case of an emergency. Two surface supplied Divers may be in the water conducting work each acting as a standby Diver for the other, if both are able to render the other aid within 3 minutes at all times, allowing for no decompression limits.

4.3 Dive Tender

The primary responsibility of the dive tender is to assist the Diver while preparing for, conducting, and recovering from in-water operations. The dive tender will maintain control of the surface supply air umbilical, ensuring that the Diver has enough umbilical to work freely, but not so much umbilical that an entanglement hazard is posed. The dive tender will also be responsible for visually tracking the Diver's location while in the water. The dive tender and all surface personnel are responsible for advising other vessels of the dive operation and warning off any vessels that may pose a hazard to the Diver. Although the tender does not need to be a certified Diver, the tender must be trained to perform the required duties and have an understanding of the equipment utilized by the Diver.

4.4 Surface Supply Control Box Operator

A qualified and trained person will be dedicated to running the surface supply control box. This person shall have no other duties that may distract them from their primary responsibility of maintaining sufficient breathing gas delivery and communications with the Diver. The dive control box operator in conjunction with the divemaster must be aware of the Diver's profile (maximum allowable depth and bottom time) and actual bottom time and depth to ensure that all diving is performed in a safe manner and the Diver does not exceed the no-decompression limits (NDL) or the dive-specific profile limits. The control box operator is directly responsible for the safety of the Diver. In certain circumstances, at the discretion of the divemaster, the surface supply control box operator may also maintain the dive logs.

4.5 Boat Operator

The boat operator is responsible for all boat operations in support of the dive operation. The boat operator must have experience or training in operating the vessel during dive operations and performing emergency procedures that may be required. During the dive, if the boat is secured in position (anchored or docked), this person may also perform the duties of one of the surface support personnel.

5.0 REFERENCES

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APPENDIX J

Tethered Diving Standard Operating Procedure

TETHERED DIVING STANDARD OPERATING PROCEDURE

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TETHERED DIVING STANDARD OPERATING PROCEDURE

1.0 OBJECTIVE

This standard operating procedure (SOP) states the United States Environmental Protection Agency (EPA) policy concerning tethered diving operations. Procedures for general dive operations are specified the EPA *Diving Safety Manual*. This SOP in not intended to be a substitute for actual hands-on training.

2.0 APPLICABILITY

Tethered SCUBA diving is a tended diving method where one Diver in the water is line tended by surface personnel and directed to perform a variety of underwater tasks, which could include light work or scientific tasks. OSHA also requires that standby Divers for working dives be line tended. This method is much like that of surface supplied diving in many ways other than the virtually unlimited air supply. Typical tethered diving equipment, personnel, and procedure is described below. These procedures apply to EPA employees and contractors working directly for EPA that are engaged in surface supplied diving operations. This SOP presumes and requires prior training and experience with tethered diving.

3.0 DESCRIPTION

3.1 Certification and Physical Examinations

All Divers must be dive certified and medically qualified to perform their diving duties, as specified in EPA Diving Safety Manual.

3.2 General Dive Equipment and Safety Equipment

Each component of a Diver's equipment shall be maintained in a safe operating condition, and shall be inspected, tested, serviced and logged as specified in the EPA *Diving Safety Manual*. All appropriate safety equipment shall be available at the dive site as specified in the Dive Safety Plan and EPA *Diving Safety Manual*.

3.3 Documentation

Project-specific Dive Plans and Dive Safety Plans shall be issued prior to performing dive operations, and all dives shall be logged as specified in the EPA *Diving Safety Manual*. The Unit Dive Officer (UDO) shall maintain logs of each Diver's certifications, medical clearance to dive, and all health and safety training (e.g., CPR, first aid and oxygen administration) as specified in the EPA *Diving Safety Manual*.

3.4 Tethered Diving Equipment

3.4.1 Diver Dress

Tethered SCUBA diving equipment nominally includes standard Diver dress, e.g. wetsuit/drysuit, fins, and weight belt, as well as particular equipment to tethered diving needs. These other items include a full face mask with communications, strength member with quick release snap shackle tether, hardwired or wireless communications, and man-rated safety harness for rated for lifting the Diver from the water. In addition, a cutting device is recommended for the Diver within easy reach, e.g. EMT shears mounted on the harness.

3.4.2 Breathing Regulator

EPA Divers may wear a standard dive mask but will typically wear a full face mask (FFM) to provide VOX communications. The FFM is typically equipped with communication equipment (microphones and earphones) for this application. The FFM allows for hardwired communication and in conjunction with a drysuit with hood and drygloves will give the Diver some protection from polluted water, when using the positive pressure version to minimize leakage. When diving in non-polluted water, a wetsuit may be utilized. Typically, the mask is used with an ear/microphone attachment, such that the Diver may be in constant hardline communication with the surface.

3.4.3 Diver Harness

A Diver harness is necessary to connect the Diver securely to the tether line for all tethered dive operations. This allows the Diver to be towed back to the point of entry. The harness is worn underneath the BCD or backpack on top of the wetsuit or dry suit. The harness should be rated to pull the Diver from the water, in the event of an emergency on the surface or beneath the water. The harness may also allow for an attachment for a hard-wire communication (com) line to prevent straining of the communication links. The com line must be clipped to the Diver’s harness prior to the start of the dive.

Note: Buoyancy compensation device (BCD) D-rings have inadequate strength for connecting the tether line to the Diver, as they cannot support the Diver’s entire weight and dynamic load when the tender needs to quickly retrieve the Diver. Breakage of a BCD D-ring could result in serious injury to the Diver, as the Diver's head is connected to the tether via the communications cable, absent the secure harness connection.

3.4.4 Tether

While any kind of line may be used in conjunction with line signals, typically a com rope is used to allow for constant communications with the Diver. Care must be taken in tending the Diver when moving in arc patterns (discussed below), that the line is not hung up and frayed on sharp underwater objects. The tether should be fitted with a quick release snap-shackle to allow the Diver to egress to the surface should the tether become irreconcilably entangled in bottom debris. The tether may also be marked in intervals for measuring distances used in search patterns, for example. Tethers can be made in most any length, though 200 and 300 foot tethers are typical for dive operations. Generally, the tether required must be the distance from the dive platform added to the depth to the dive site multiplied by 1.5 (NOAA, 2009), e.g. 50 feet from the dive site at a 50 foot depth would be 150 foot of tether. A tether longer than 300 foot can present some span of control problems with a dive platform under anchor, in adequately fending off nearby vessel traffic in a timely fashion. The tether should be stowed in a bucket or bag of some kind, with the tender end going in first, Diver end last, to keep it from being stepped on and damaged, and to avoid tripping/falling hazards on the dive platform. The container should allow for easy decontamination and segregation of contaminated line from other gear.

3.4.5 Emergency Gas Supply

An emergency gas supply (EGS) is necessary for tethered diving operations should the primary air supply be exhausted. The EGS is typically controlled through a manifold block, connected to the BCD. The manifold block should have a one way valve, such that opening the block does not equalize the primary and EGS cylinders. The EGS itself may be a pony bottle connected to a larger primary bottle up to a fully redundant SCUBA bottle, depending on diving depth (Barsky, 1999). The EGS bottle is left open for diving, while the manifold block is in the closed position, such that the Diver is breathing off the primary gas supply, but may access the reserve supply by simply turning the manifold knob, similar to a surface supply configuration. For those configurations without a manifold valve, the EGS tank valve itself is used to control the flow of gas and is kept off until needed. In this configuration, the EGS tank valve should be easily accessible, e.g. sling mounted. The first stage regulator on the pony bottle must have an over-pressure relief valve so that first stage malfunction will not cause a hose failure.

Note: This is different than a non FFM configuration, where the pony bottle is normally left off (e.g. NOAA mouthpiece reserve air supply system) to prevent a free flow from emptying the reserve supply. The size of the bail-out bottle is determined based upon the type of water, i.e. contaminated vs. non-contaminated, working depth, type of equipment, i.e. FFM vs. Helmet, and the air consumption rate of the individual Diver.

The EGS should be mounted upside down such that the Diver can reach the tank valve, should it accidentally be left closed. A submerged pressure gauge must also be in plain view of the Diver so that they may see the current status of their EGS bottle. For example, if the manifold block is bumped, the Diver may start breathing off the EGS without their knowledge. Frequent checking of the primary gas supply SPG, bailout block and EGS SPG will help to ensure that the Diver is continuously breathing off the primary air supply. Also, as tethered diving is often used for low visibility situations, analog gauges should be used as digital gauges cannot be read when pressing the gauge directly against the FFM in true blackout conditions. For diving with a dry suit, the inflator whip should be connected to the manifold block such that suit inflation may still be achieved when using the EGS.

3.5 Tethered Diving Operations

3.5.1 Procedures

The tethered diving operation normally involves at least three Divers. This allows for safe and efficient diving by rotating through the crew of 3, especially for deeper dive profiles. The 3 person rotation allows for ample surface intervals for the Diver who has just dived, and then becomes the Divemaster/Tender, the Diver who has been out of the water for the duration of the last dive, who becomes the standby Diver, and the Diver, who has been out of the water for at least two dives worth of time.

3.5.1.1 Donning Gear and Water Entry/Descent

Both the tender and standby Diver should assist the Diver in donning gear if needed. Special attention is paid to placement and setting of the manifold block/EGS and verification that the Diver can reach the block and EGS valves easily, and without looking, as tethered diving is often used in low visibility environments. The primary and EGS tank pressures are checked and recorded. Comm. checks are performed and volumes/earpiece placement adjusted as needed. The Diver is deployed with an extra loop of line available (to avoid jerking the Diver during descent) and the tender arrests their descent into the water via the tether line and holds them at the surface until they can complete a mask check.

The tender uses both hands to tend the line, so as to ensure that the Diver is firmly held in place. The tether line is never wound around the tender in any way for two reasons: 1) the line may be contaminated, and this could leave polluted water and sediment on the tender, and 2), the tender could be pulled into the water with the line wound around them. The tender should use gloves to prevent chafing, and these should be covered by disposable gloves if there is any chance of contamination in surface water or sediment.

The tether should be managed in a portion of the dive platform considered to be the "hot zone" where it can be appropriately decontaminated and otherwise managed without tracking contamination throughout the vessel during tending at contaminated sites. The Diver controls the rate of descent, including making requests for the amount and rate of slack given by the surface to ensure too much line is not paid into the water column, resulting in entanglements.

3.5.1.2 On the Bottom

Directing the Diver is undertaken in a different manner than in buddy type SCUBA operations, where movements are relative to the tethered line itself. For example, the tender may instruct the Diver to swim "toward the line," "away from the line," "take a 90 right," "take a 90 left," and so on. The Diver trusts that the surface can direct them where they need to go, as in conducting a search pattern, "Hold line tension, and swim with the tether at your left." Surface may ask the Diver to conduct search patterns via an arc, sweep, or out and back methods, using these line signals. Based on whether there is visibility on the bottom, this will determine the distance between Diver sweeps. (Hendrick, 2000). The surface will regularly ask for pressure checks from the Diver, and the Diver should also volunteer these to the surface. If asked during a crucial task for a pressure check, the Diver should ask the surface to "standby." The surface will hold tension at all times, and release tension only when requested by the Diver. Without tension, the surface loses good information on the status of the line, i.e. tangled or untangled, and may actually cause the line to tangle by allowing it to drag on the bottom. Absence of tension also prevents backup communications from happening as discussed in emergency procedures, below. Equipment may be conveyed to a stationary Diver nearby the platform via a loop in the line. If this is done, tension should be maintained in the line should verbal communications fail, and once the tool is conveyed, all slack should be removed.

3.5.1.3 Ascent

The surface may control the Diver's ascent, if the Diver cannot control their own ascent due to weighting, currents, etc. Using the tether, the tender will give at least a 2 second count for every foot of line they pull in. When the Diver nears the platform, the tender will instruct the Diver to put up their hand for the last part of the ascent to protect their head from the hull of the vessel. The tender will remain on com until the Diver is aboard and decontaminated, as needed. The line will be managed in the dive platform's "hot zone" with gloves such that it can be decontaminated at the end of dive operations, and otherwise managed to avoid material tracking throughout the vessel.

3.5.1.4 Doffing Gear

Decontamination, such as a potable water decontamination, will take place as needed before other tasks, focusing on the mask and glove areas when conducting repetitive diving. The tender will ensure that the Diver leaves the bottom with sufficient pressure to undergo whatever type of decontamination deemed necessary.

3.5.2 Communications

3.5.2.1 Voice Communications Unit

The voice communications unit is utilized by the tender while tending the Diver's line to maintain constant verbal communication with the Diver and standby Diver. Communication may be one-way, surface-to-Diver, or two way allowing the Diver to speak with the surface either by hard-wire coupled with the tether or by through-water (e.g., acoustic or sonic) transmission. The voice communications unit may be operated with either a "voice operated switch," also known as VOX (or Voice Operated eXchange) or in a "push-to-talk" mode in which the Diver's and operator's microphone are button activated. The VOX is a switch that operates when sound over a certain threshold is detected. It is used to turn on a transmitter when the Diver speaks and is turned off when they stop speaking. The tender communications unit allows the tender to talk with the Diver via a headset and belt clip communications unit.

The tender unit typically uses replaceable batteries, which should be changed out on a daily basis to ensure constant communications. The vessel should have one set of batteries per day for the dive operation, plus one spare set. Care should also be taken when installing batteries in the unit, as the battery compartment soldering can be quite fragile. All batteries must be removed at the end of the project to prevent corrosion and destruction of the unit. Rechargeable batteries are beneficial for this purpose to minimize waste generation from daily dive operations. When connecting the headset to the belt clip unit, a "squeal" should initially be heard as the unit powers on. Absence of this sound can indicate that the batteries are dead, or that the unit is otherwise not functioning. When the unit is not in use, the headset should be disconnected from the belt clip unit to conserve battery power.

3.5.2.2 Line-Pull Communications

In the event of loss of voice communications, the dive unit should practice backup line signals to ensure the dive can be safely and efficiently aborted. Example standard line-pull signals are included below from the US Navy Dive Manual, revision 6, Table 8-3.

Example Emergency Line-pull Signals

Primary Diver to Tender:

2-2-2 *I am in a difficulty but I am OK, I need assistance, send the backup Diver.*

3-3-3 *I am entangled and OK, I am stopping to handle it myself but ready the backup Diver.*

4-4-4 *I am not OK, I need immediate assistance.*

Primary Diver to Standby Diver:

Big Circular Motion: *I am entangled here (indicate where the entanglement is by putting the backup Diver hands on it).*

Tap Standby's Hand on Primary Divers Chest:
I am injured here (indicate the injury location).

Tap Standby's Hand to Primary Divers Second Stage:
I am running low on air.

Standby Diver to Primary Diver:

Place primary's hand back on his carabineer and give three squeezes:
I am leaving now but will be back. The standby Diver goes back to return with additional air to allow more time to deal with the problem.

USN Revision 6 Full Set of Line Pull Signals:

Table 8-3. *Line-Pull Signals.*

From Tender to Diver		Searching Signals (Without Circling Line)	
1 Pull	"Are you all right?" When diver is descending, one pull means "Stop."	7 Pulls	"Go on (or off) searching signals."
2 Pulls	"Going Down." During ascent, two pulls mean "You have come up too far; go back down until we stop you."	1 Pull	"Stop and search where you are."
3 Pulls	"Stand by to come up."	2 Pulls	"Move directly away from the tender if given slack; move toward the tender if strain is taken on the life line."
4 Pulls	"Come up."	3 Pulls	"Face your umbilical, take a strain, move right."
2-1 Pulls	"I understand" or "Talk to me."	4 Pulls	"Face your umbilical, take a strain, move left."
3-2 Pulls	"Ventilate."		
4-3 Pulls	"Circulate."		
From Diver to Tender		**Searching Signals (With Circling Line)**	
1 Pull	"I am all right." When descending, one pull means "Stop" or "I am on the bottom."	7 Pulls	"Go on (or off) searching signals."
2 Pulls	"Lower" or "Give me slack."	1 Pull	"Stop and search where you are."
3 Pulls	"Take up my slack."	2 Pulls	"Move away from the weight."
4 Pulls	"Haul me up."	3 Pulls	"Face the weight and go right."
2-1 Pulls	"I understand" or "Talk to me."	4 Pulls	"Face the weight and go left."
3-2 Pulls	"More air."		
4-3 Pulls	"Less air."		
Special Signals From the Diver		**Emergency Signals From the Diver**	
1-2-3 Pulls	"Send me a square mark."	2-2-2 Pulls	"I am fouled and need the assistance of another diver."
5 Pulls	"Send me a line."	3-3-3 Pulls	"I am fouled but can clear myself."
2-1-2 Pulls	"Send me a slate."	4-4-4 Pulls	"Haul me up immediately."
ALL EMERGENCY SIGNALS SHALL BE ANSWERED AS GIVEN EXCEPT 4-4-4			

3.5.3 Vessel Operations

Vessel operations necessitate important tethered diving safety procedures, which include:

1. All boat/ship propellers must be deactivated prior to initiating dive operations.
2. A small boat must be on anchor before deploying the tethered diver.
3. Ships do not need to be on anchor for a ship husbandry dive, e.g. clearing a fouled propeller in deep water.
4. A bow and stern line should be available. While it is not required to be at a 2 point or greater anchor configuration, sudden wind changes may necessitate a two point anchoring system to complete a dive safely.
5. If the boat were to swing on its anchor, it is important that sufficient slack is given and/or tension is kept on the Diver to ensure they are not swept away in current or subjected to sudden changes in pressure.
6. When operating near channel, a "Security" call should be made to all concerned traffic over VHF channel 16 and vessel traffic and channel 16 communications should be monitored to determine if large vessels are inbound.
7. An Alpha Flag (blue and white) as well as the standard diver down flag must be flown from the vessel during dive operations.

As the dive platform cannot fend off other boat traffic by means of physical presence, care should be given how far channel ward a tethered Diver is allowed to travel. Consideration of notice to mariners, broadcast of an encumbered vessel status either via VHF and/or automatic identification system (AIS) could also be considered.

3.5.4 Emergency Procedures

Before the tethered Diver undertakes a dive, it is important that they have practiced how to free an entangled line, disconnecting from the tether, unconscious Diver rescue, and clearing a flooded mask in a training situation. During the dive briefing, backup communication line pull signals must be reviewed and memorized by the dive crew. See the US Navy Revision 6 Table 8-3 line pull signal table above.

It is also important that the dive crew review what it sounds like for the communications cable wet connection for the hard line com to become disconnected underwater at the Diver end. Absence of sound for the Diver should indicate that they need to reconnect the plug, and/or begin using line pull signals to communicate their status to the surface. A fresh set of batteries should be on hand topside, in the event of communications loss, to ensure that voice communications can be re-established. A fully redundant tender headset and communications box might be kept on board in the event that these become flooded or cease operating.

A Diver recall could also be kept on hand to supplement line pull signals should hard line communications be lost. The Diver must also be prepared to disconnect from the tether, in consultation with the surface. The Diver should not disconnect from the tether without first telling the surface, "going off com." to ensure that the surface understands that communications will be lost for a period of time. Unplanned loss of communication (voice and line pulls) of the tethered Diver should lead to immediate deployment of the standby Diver unless the divemaster determines that conditions are too hazardous for rescue to be undertaken.

For retrieval of an unconscious Diver on the bottom, the standby Diver would be deployed on tether and follow the primary Diver's tether to the bottom. Once with the unconscious Diver, the victim should be oriented head up, and the surface notified that they may haul the pair up.

For trapped Diver situations, a "rescue bottle" could be maintained for the standby Diver to convey to a trapped primary tethered Diver. The rescue bottle could be outfitted with a quick disconnect coupling (female), so that the bottle may be connected underwater to the trapped Diver's SCUBA bailout block manifold quick disconnect fitting (male), along with a mouthpiece second stage and SPG. The latest decompression tables should be carried aboard the dive platform, or dive computers capable of completing decompression calculations for exigent circumstances that require an immediate response.

4.0 PERSONNEL AND RESPONSIBILITIES

Typically, tethered diving operations consist of a three person team, the Diver, the standby Diver, and the Divemaster/tender.

4.1 Diver

The Diver, unlike in the conventional SCUBA diving buddy system, will likely be diving alone. This takes some adjustment for the Diver, and reminders from their Divemaster that they will be in constant communication with the surface. Taking the dive slowly and not rushing through tasks is key to avoiding panic, but also in minimizing air consumption. While the Diver is still responsible for checking their air supply and reporting this to topside support, unlike surface supplied diving, other adjustments are needed. Often the dive may be controlled from the surface depending upon the task being performed. If the dive is primarily surface controlled, the Diver will need to adjust to not being primarily in control of their dive, i.e. the Divemaster will be in constant communication with them, and will instruct the Diver what to do, and when to do it. As with all dives, the Diver or Divemaster may end the dive for any reason.

4.2 Tender/Divemaster

The Divemaster/tender will assist the Diver in dressing in, tending the line, and doffing gear at the end of the dive. The tender should also be a Diver prepared to dive each day, especially for deeper dive profiles. Divemaster responsibilities are the same as generally defined for buddy type SCUBA operations e.g. the Divemaster continues to be in charge of the overall dive, except that they can hear the Diver throughout the dive and should be monitoring the Diver constantly for signs of anxiety. Breathing rate of the Diver is a clue to their mental status. As needed, the tender should ask the Diver to stop what they are doing, rest, and breathe (e.g. more deeply or slowly). As with all dives, the Divemaster must remain undistracted such that they can monitor the surface for danger from incoming boat traffic and any other hazards.

4.3 Standby Diver

All tethered diving operations require a standby Diver. The standby Diver must be ready to get into the water within several minutes and be dressed in their dry suit or wetsuit either half way or fully at the Divemaster's discretion.

Disclaimer: *This SOP is an illustration of steps to be taken to conduct tethered SCUBA diving operations and minimize the Diver's exposure to polluted water conditions and is not the official view of the EPA. Mention of any specific brand or model instrument or material does not constitute endorsement by the EPA.*

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APPENDIX K

Standard Operating Procedures for Diver Decontamination

STANDARD OPERATING PROCEDURES FOR DIVER DECONTAMINATION

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STANDARD OPERATING PROCEDURES FOR DIVER DECONTAMINATION

1.0 OBJECTIVE

This standard operating procedure (SOP) states the policy concerning decontamination of personnel involved in contaminated water diving. This SOP is not intended as a substitute for actual hands-on training.

2.0 APPLICABILITY

These procedures apply to all personnel, including subcontractors under U.S. Environmental Protection Agency (EPA) supervision, engaged in diving operations. This SOP presumes and requires prior experience with diving and decontamination procedures.

3.0 DESCRIPTION

3.1 Contaminated Water Diving

For this SOP, contaminated water is defined as any body of water that is suspected of containing chemical or biological agents in concentrations that could potentially harm an unprotected diver and/or surface support personnel. Unless a body of water is known to be clean, some degree of contamination must be assumed. The level and type of contamination will determine the decontamination procedure required.

Since a river or a large body of water (e.g., a lake or ocean) has flow or circulation allowing for removal or dilution of suspected contaminants, these are generally of less concern than diving in a closed body of water (e.g., a pond or a flooded quarry) which has no flow and significantly less potential for dilution of contaminants.

In general, most persistent biological and chemical contaminants tend to concentrate in sediment rather than in the water column (Hendrick, *et al.* 2000, Hoffman, *et al.* 2003; US Navy 2004). Therefore, simply remaining above and not coming into contact with the sediment may reduce the diver's potential exposure.

It is the responsibility of the Divemaster in charge, with concurrence of the Unit Dive Officer (UDO), to determine whether sufficient contaminant information is available and whether conditions are appropriate for diving. All contaminated water diving will be performed using appropriate exposure protection. For contaminated water diving, this document assumes all divers will wear, at a minimum, a full-face mask and a dry suit with mating dry gloves. The dry suit material should have a smooth outer surface which does not trap contaminants and is capable of being thoroughly decontaminated. Some dry suit manufacturers have had their suit materials tested against a variety of contaminants in the laboratory using American Society for Testing and Materials (ASTM) methods (Viking 2001, Barsky, 2007).

STANDARD OPERATING PROCEDURES FOR DIVER DECONTAMINATION

To minimize the number of personnel potentially exposed when performing dive operations in contaminated water, it is common EPA practice to use a single diver, on surface supplied gas with hard-wired communications (see SOP *Surface Supplied Diving Operations*). During boat operations, it is easier to decontaminate one diver at a time. Additionally, surface supplied divers can share some dive gear (weight harness, fins, helmet, emergency gas supply (EGS)), limiting the amount of contaminated equipment. It is the Divemaster's responsibility to determine whether surface supplied diving and/or the use of a single diver is the safest/most effective means of completing the dive operation.

3.2 Chemical Contaminants

Chemical contaminants include any chemicals which have leaked, spilled or dumped, or have been otherwise found in a body of water. Lists of the chemical substances most commonly spilled in inland and coastal waterways of the United States are available from a number of sources. The chemical spill lists were summarized for the US Navy's Experimental Diving Unit by Southwest Research Institute (Henkener and Ehlers, 2000). These chemicals may be located in the sediment, on the sediment, on the water surface, dissolved in the water column, or associated with particulates in the water column. Chemicals may pose risk from ingestion, inhalation and/or dermal contact (NIOSH 2005).

3.3 Biological Contaminants

Biological contaminants include harmful algal blooms (e.g., red tide), bacteria (e.g., fecal coliforms), viruses and parasites which could potentially harm an unprotected diver. A summary of potential biological hazards to Navy divers and swimmers was prepared for the US Navy's Experimental Diving Unit by Southwest Research Institute (Henkener and Ehlers, 2000). Biological contaminants may be present in stormwater runoff and pose hazards to divers and to surface support personnel, especially when diving in near shore, urban areas within 36 hours of a storm event.

3.4 Site Area Definitions

Site area definitions are modified from the EPA's Standard Operating Safety Guides (EPA, 1992). Modifications were made to make the definitions applicable to dive operations. Figure 2 shows the flow and procedures at each stage of decontamination.

3.4.1 Exclusion Zone

The Exclusion Zone (EZ), also called the Hot Zone, is the area believed to be contaminated. This is the area in which site work will normally be performed. Each site will require definition of this zone. In some cases when divers are entering the water from the shoreline, performing their duties and returning to the shore, the body of water and a portion of the shoreline may be considered the EZ. In the case of boat operations, the body of water and that portion of the boat that a contaminated diver contacts may be considered the EZ. It is imperative that no personnel enter the EZ without the proper personal protective equipment

(PPE). It is also imperative that no personnel, equipment or samples pass from the EZ to the Support Zone without going through the Contaminant Reduction Zone.

3.4.2 Contamination Reduction Zone

The Contamination Reduction Zone (CRZ), or Contamination Reduction Corridor, is defined as the area through which all personnel leaving the Exclusion Zone must pass through for decontamination. This is the primary working zone for decontamination personnel. All personnel in the CRZ must wear proper PPE for the task they have been assigned. The CRZ is a straight-line operation, divers enter from the EZ and go through the decontamination process until being fully decontaminated and able to enter the Support Zone (SZ) on the other end. All equipment must also be decontaminated before moving into the SZ. All samples must be grossly decontaminated and encapsulated (e.g., placed inside resealable plastic bags) or placed in a sample container before being passed into the SZ.

3.4.3 Support Zone

The SZ is defined as the clean area outside of both the EZ and the Contamination Reduction Zone. No one should be allowed to leave the EZ and enter the SZ without completing the decontamination procedure, except in the event of a diving accident.

3.4.4 Emergency Decontamination Area

A separate area should be set aside between the EZ and SZ for emergency decontamination operations. In the case of a diving accident, it may not be possible to perform the complete decontamination procedure prior to initiating first aid (see Section 5.4).

3.4.5 Contaminant Zones During Boat Operations

When performing dive operations from a boat, the EZ is typically considered to be the water, the swim platform/ladder and a container on the boat used as the equipment drop. The other zones have to either be contained in the limited space available on the boat or completed at another location. It is the responsibility of the Divemaster to determine whether the space available on the boat is sufficient for the level of decontamination required. It is also the Divemaster's responsibility to determine whether conditions are appropriate for decontamination on the boat (e.g., sea state, weather).

For dive operations on a small boat involving low levels of contaminants and a simple decon, it is often the case that Contaminant Reduction is initiated on the dive platform or on the swim ladder and the area of the boat immediately around the platform/ladder. All hand-held equipment must be passed to the dive tender, who sets everything in an area designated for potentially contaminated equipment (e.g., a labeled container). The entire diver decontamination process is then carried out on the platform or ladder, and the dry suit is removed as soon as the diver is on the boat. The diver is considered to be in the SZ as soon as he or she is out of the dry suit and away from the immediate area of the platform/ladder.

It is the Divemaster's responsibility to determine whether contaminant levels and sea state conditions are low enough to perform decontamination on the back of a small boat (or ladder/platform). If the vessel size/sea conditions warrant a decontamination procedure that cannot be done on the ladder or threatens to spread contamination within the vessel, the Divemaster must make alternate arrangements (e.g., using a second vessel or transporting the diver to shore for complete decontamination). Any decontamination process involving multiple steps, or the use of decontamination solutions that cannot be directly discharged into surface water, cannot be safely accomplished on a small, open boat. Additional factors to consider are the diver's gas supply integrity during decontamination, the diver's fatigue and stress levels while holding on to a ladder for several minutes, and the potential for the spread of contamination to other parts of the vessel and personnel.

During some dive operations, a second boat or a barge is available to use as the CRZ. The second vessel should be securely rafted to the primary vessel. Divers may enter the water from the primary vessel, but always exit the water onto the CRZ vessel, and are decontaminated there before re-entering the primary vessel. During such operations, the barge is considered the CRZ and the primary boat is considered the SZ. Additional considerations include surface-supplied air source and placement. Under no circumstances should the supplied gas source be on a different vessel than the diver. This may require a segregated space on the CRZ vessel for the source and operator. Likewise, divers using shared equipment (i.e., harnesses, tools) will both enter and exit the water from the CRZ vessel as these items are considered contaminated and should not enter the SZ until the final dive and complete decontamination. In most cases, when using two adjacent vessels for the dive operation, decontamination washes will be contained and transported off-site for temporary storage, testing, and disposal considerations.

It may not be feasible to perform diver decontamination on some smaller vessels, especially when a more complex decontamination (decon) is required. For these situations the vessel shall be considered part of the EZ throughout the dive operation and the diver can be brought to the shore or a larger vessel for decontamination. If this is the case, the boat must be treated as part of the EZ throughout the entire operation until it has been decontaminated. All equipment and personnel leaving the vessel would also be required to pass through the CRZ before returning to the SZ. On a small boat, sufficient decontamination equipment should be available to remove gross contamination from the diver and the diver's face/neck seal area to allow the diver to safely remove the helmet/mask while returning to shore for full decontamination. If multi-day, repetitive diving is conducted this scenario would not be appropriate.

3.5 Decontamination Plan

Dive personnel shall include a decontamination plan as part of every Dive Plan dealing with contaminated water. The Dive Plan shall be referenced in the site-specific Health and Safety Plan

(HASP). The Dive Plan should detail the steps required to properly decontaminate divers based on the known or suspected site contaminants. Included in the plan will be allowances for gross decontamination, equipment decontamination, and required decontamination solutions. Special concerns and procedures will be outlined in the Dive Plan.

If, during contaminated water dive operations, it is discovered that contamination is more severe than originally believed, it is the Divemaster's responsibility to determine whether appropriate decontamination equipment is available and whether conditions permit safe dive operations.

4.0 REQUIRED EQUIPMENT

Equipment required for decontamination activities will be dependent on the level of decontamination required at each site. The equipment should be chosen from the following list based on need.

Potable water
Decontamination solutions (e.g., soap, water, bleach, etc.)
Soft bristled brushes/sponges
Paper towels
Plastic sheeting
Marking tape
Water collection basins
Pump sprayer
Decontamination shower
Disinfectant wipes
Stools
Hand soap
Emergency breathing gas supply
Chemical/Water resistive suits
Face shields/eye protection
Rubber gloves/boot covers
Rubber boots
Other PPE
Basins/Containers/Buckets

STANDARD OPERATING PROCEDURES FOR DIVER DECONTAMINATION

5.0 DIVING DECONTAMINATION OPERATIONS

5.1 General Decontamination Procedures

Prior to any dive operation, the level of decontamination shall be determined by the Divemaster with concurrence of the UDO and Health and Safety Officer, based on the information available. The anticipated decontamination procedure will be spelled out in the site-specific Dive Plan. During the dive operation, the Divemaster may alter the decontamination procedure, based on site conditions and any additional information available. Since real-time contaminant levels are rarely available, the Divemaster must use professional judgment, weighted on the conservative side of safety.

This SOP addresses decontamination of divers and equipment after operations in moderately contaminated water. Some locations may be contaminated to an extent that makes diving unsafe regardless of the exposure protection available. In those locations, it is the Divemaster's responsibility to ensure that divers do not enter the water, and operations must be performed using remotely operated vehicles (ROV), sonar, remote sampling equipment (e.g., Ponar dredge, Kemmerer bottle, etc.), or other non-diving methods to fulfill the project objectives.

The level of decontamination can range from simply rinsing the diver with clean water to having the diver pass through a formal decontamination corridor. The major variables to consider when decontaminating dive equipment include the nature of the surface (smooth surfaces are easier to clean than porous surfaces) and the type and concentrations of contaminants encountered.

Since many persistent chemical contaminants of concern are present in sediments and most EPA scientific diver studies occur on or near the sediment zone, gross decontamination of a diver or removal of all visual contamination (sediment, mud, vegetation, etc) can be a critical decontamination step. All equipment, especially diver fins, diver boots (including soles), diver dry suits from the thigh downward, and any areas where contaminants may become trapped should be inspected for visual contamination before any gear is moved to a clean area.

In some situations, where the diver's dry suit will likely suffer gross contamination (oil spills) that may not be possible to clean, the diver may wear coveralls, Tyvek or similar PPE over the dry suit. The coveralls must be modified to not interfere with the proper operation of the dry suit (e.g., holes have to be cut for the suit inflator and exhaust valves). While the coveralls will provide only minimal protection to the dry suit, it may be possible to complete a multi-day dive operation before discarding any dive equipment that can't be sufficiently decontaminated. Coveralls may also be worn when diving near potentially sharp or jagged edges to prevent tearing the dry suit. Any PPE materials which become visually contaminated should be removed and replaced between dives.

STANDARD OPERATING PROCEDURES FOR DIVER DECONTAMINATION

5.1.1 Personnel Requirements

Each member of the decontamination team shall have the experience or training necessary (e.g., EPA Diver Training, Occupational Safety and Health Administration 40-hour Hazardous Waste Operations and Emergency Response Training (OSHA 1910.120 40hr HAZWOPER) to perform the tasks assigned to them in a safe and efficient manner. This experience and training shall include the use of tools and equipment required for efficient and effective decontamination. Each member of the decontamination team shall also have training in emergency procedures (first aid and Cardiopulmonary Resuscitation/ Automated External Defibrillator [CPR/AED]) Each decontamination team member shall only be assigned tasks in accordance with that person's training and experience.

5.1.2 Safety Considerations

The duration of the decontamination process is an important consideration during any dive operation. Having the diver remain encapsulated to walk through a decontamination corridor is tiring and stressful. During cold weather, the diver may risk hypothermia walking through a decontamination line. During warm weather the diver may risk hyperthermia the longer he or she is in the dry suit on the surface (particularly if dressed for cold water diving). Additionally, the surface support/decontamination personnel will be exposed to the weather. It is important to get the diver through the decontamination process and out of the dry suit as quickly as possible (NOAA 2001).

There is a high likelihood that the surface support/decontamination personnel will be splashed by surface water, sediment and/or by the decontamination solutions. Surface personnel should wear impermeable, disposable outerwear and face shields or similar PPE as specified in the HASP. Care must be taken when rinsing contaminated sediment from the diver in windy conditions. Wind direction should be a consideration in setup of the decon zones. The EZ should be downwind of the CRZ and support zone.

Choice of PPE for surface support personnel is driven by both the expected site contaminants and by the choice of decontamination solution. Though certain decontamination solutions don't require any special PPE (e.g., soap), the potential for being splashed by site sediment or water mandates proper PPE. Conversely, some decontamination solutions (e.g., bleach) mandate proper PPE regardless of the site contamination (see Attachment 1). The appropriate PPE should be defined in the site-specific Dive Plan.

When assisting the diver donning clean dive gear, the tender needs no PPE. However, as successive divers reuse the same equipment (e.g., weight harness, buoyancy compensation device (BCD), emergency gas supply (EGS) harness, fins), the tender must wear appropriate PPE when handling the equipment that has not been fully decontaminated.

In order to prevent cross-contamination, when the same tender that assisted a contaminated diver from the water is required to assist the next diver into clean gear, the tender must first change out of his/her potentially contaminated PPE (see Section 5.6).

In order to expedite the decontamination process on a small vessel, it is often more efficient to scrub and rinse the diver's decon compatible equipment with sufficient quantities of potable water in order to wash the biological agents off, so equipment can be efficiently removed. Potable water has been shown to effectively remove microbial contaminants from decon compatible material. Non decon compatible equipment can remain in the EZ for later use, and be provided to the next diver or soaked in an antimicrobial soap solution, bleach, or other appropriate decontamination solution if daily operations are completed.

Some decontamination situations may call for covering surrounding areas with plastic sheeting in order to contain contaminants or decontamination solutions. Care must be taken that the sheeting is properly anchored and does not pose a slip, trip and fall hazard to either the diver or the support personnel. Additionally, once the plastic is wet and/or soapy, it may become more slippery. An appropriate number of support personnel are required to steady the diver to prevent accidents.

5.2 Decontamination Solutions

The major considerations when choosing a decontamination solution are; 1) effectiveness against the expected site contaminants; 2) compatibility with dry suit materials and other equipment; 3) safety of exposure to both the diver and the tenders; 4) availability and cost; 5) use of biodegradable decontamination solutions or containment and disposal of used non-biodegradable solutions. Selection of decontamination solutions is at the discretion of the Divemaster, with concurrence of the UDO and the Health and Safety Officer. Decontamination solutions and procedures should be described in the Dive Plan prior to going on-site.

There are numerous decontamination solutions to choose from. Unfortunately, some of the most effective decontamination solutions are very aggressive, corrosive and toxic (LBL 2006). Attachment 1, *DIVER DECONTAMINATION SOLUTIONS* lists some decontamination solutions along with their general effectiveness against biological and chemical contaminants and their safety/compatibility for use on divers and dive equipment.

5.3 Decontamination Stages

The following sections list decontamination steps, some of which may be minimized, combined or omitted at the Divemaster's discretion, based on the contaminants and situation. These steps must be performed in the most efficient, effective manner possible to avoid undue stress on the diver. The planned decontamination stages should be included in the Dive Plan.

STANDARD OPERATING PROCEDURES FOR DIVER DECONTAMINATION

5.3.1 Exclusion Zone

5.3.1.1 Equipment Drop

As the diver exits the water, all non-life support equipment (e.g., tools, cameras, dive lights) should be dropped in the EZ for later use or decontamination. The equipment should be taken by the tender and set aside so that it is out of the way, but available for the next diver or staged for decontamination. If available space allows, the equipment should be put in a container to prevent the spread of contamination. If the equipment is going to be immediately used by the next diver, it does not need more than gross decontamination until dive operations are completed for the day. The potentially contaminated equipment must remain in the EZ and should only be handled by the tender and the divers. The tender must wear appropriate PPE for the contaminant and situation (e.g., chemically/water resistive suit, rubber boots/booties, face shield/eye protection, gloves).

5.3.1.2 Samples and Sampling Equipment

While collection of environmental samples may be the reason for the dive operation, the safety and well-being of the diver is the tender's primary responsibility. Samples collected by the diver should be grossly decontaminated and encapsulated (e.g., placed inside resealable plastic bags) or placed into a sample cooler prior to being transferred from the EZ. Samples and sample containers are to be considered contaminated and should only be handled by personnel wearing appropriate PPE.

The diver should hand sampling equipment to the tender who should either set the equipment down in a designated area in the EZ or pass the equipment on to other personnel for decontamination or disposal. Sampling equipment has been in direct contact with the contaminated media being sampled and should only be handled by personnel wearing appropriate PPE. After the diver has completed the decontamination process, the sampling equipment can be decontaminated as specified in the field sampling plan.

5.3.1.3 Gross Decontamination

While still in the EZ, the diver should be grossly decontaminated to remove visible contamination including sediment, algae, plant life, etc. The tender may be responsible for gross decontamination. However, if the primary tender is required to move away from the diver, a second tender may be required to stay with the diver to ensure that the diver does not slip, trip or fall. If available, a hose with a spray nozzle may be used to rinse the diver with potable water, or material may be removed from the diver by hand.

If a hose is used to spray the diver, it should not be a high-pressure hose (e.g., a pressure washer). The tender should also take care not to direct the spray toward the seals around the diver's mask/helmet or gloves, to minimize the chance of forcing contaminants into the diver's suit. When spraying near the diver's mask/helmet, the tender should adjust to a gentle spray from the diver's face toward the back of his or her head (so the water goes over the seal instead of under it). When spraying the diver's hands, the spray should be directed from the diver's hand toward the elbow (so the water is not forced into the diver's gloves). The tender should take extra care to rinse out sediment or contaminants from wrinkles in the diver's suit and the areas around the glove cuffs and mask/helmet seals. Spraying should be systematic, starting at the head and working downward to the feet always considering wind direction and speed.

5.3.2 Contaminant Reduction Zone

Upon leaving the Exclusion Zone, the diver will enter the Contaminant Reduction Zone. In this zone, the diver will be thoroughly decontaminated. If the dive operation is land-based all wash water should be captured in a basin for proper disposal as specified in the site-specific HASP.

5.3.2.1 Diver Decontamination

One suitably dressed person is required to perform decontamination. However, using two or more people ensures that decontamination is quick and that at no time will the diver be left unattended. If necessary, the tender from the gross decontamination step should remain on the edge of the Exclusion Zone to minimize contamination of the Contaminant Reduction Zone.

The diver should be scrubbed with an appropriate decontamination solution, taking extra care around the diver's mask/helmet and gloves. Tenders should start at the diver's head and work down to the diver's feet, scrubbing in a downward motion. Soft-bristled brushes and/or sponges should be used to scrub the diver, since stiff-bristled brushes and harsh scrubbing may damage the dry suit. A strong solution of antibacterial soap does not require any contact time beyond that required to scrub the diver (refer to label directions). The soap should be rinsed off with water while it is still wet to more effectively carry away any biological agents.

Typically potable water or a surfactant based decontamination fluid is suitable in removing most biological agents from the dive equipment. If there is a need not only to remove the biological agents from the equipment, but additionally destroy (disinfect) these organisms a decontamination solution such as antimicrobial surfactant, bleach, or DF-200 (see Attachment 1) may also be necessary. These solutions require contact time with the biological agents in order to work properly. Disinfectant solutions should always be used per label directions and consistent with registered use (e.g., EPA List N for SARS-CoV-2). Contact time is defined as the length of time that the wet decontamination solution is on the diver's suit and/or equipment. The minimum effective contact time should be determined in advance to ensure appropriate treatment in the shortest amount of time to reduce stress on the diver. Some solutions (e.g., bleach) lose effectiveness when they dry up, and may have to be reapplied. This becomes difficult on hot or windy days when the diver's suit tends to dry quickly.

If a decontamination solution other than soap is used, it should be washed away with a soapy water scrub to ensure that the decontamination solution is completely removed from the diver. The soap will also act as a secondary decontamination solution.

After the diver has been scrubbed with decontamination solution, a final rinse with potable water is required. This step may be performed in a decontamination shower, with a hose, a pump sprayer, or using buckets. At no time should the diver move backward in the decontamination line.

During small boat operations, the contaminant reduction area will usually be on the dive platform or swim ladder. In these instances, all wash water will go directly overboard into the EZ. If extensive decontamination must be performed or decontamination solutions can't be released into the environment (e.g., tri-sodium phosphate [TSP], quats) the decontamination would need to occur on shore or on a larger vessel with a designated decontamination area.

For small boat operations, the entire decontamination process may take place with the diver standing on the dive platform or on the swim ladder (if conditions permit). In addition to proper PPE, Tenders should wear a personnel floatation device (PFD). At no time should Tenders put themselves at risk by leaning overboard attempting to decontaminate a diver. If the Tender cannot safely accomplish the decontamination with the diver on a ladder, it is the Divemaster's responsibility to find an alternative location (e.g. aboard the vessel, on a second vessel, or on the shore). For the purpose of this SOP, the area of the boat in which the diver is being decontaminated will become the Contaminant Reduction Zone after the diver has been grossly decontaminated.

5.3.2.2 Mask/Helmet/BCD/Emergency Gas Supply Removal

This step is required after every contaminated water dive. Up to the point where the decontamination solution is rinsed off, the diver has remained completely encapsulated. After the diver has been scrubbed, the BCD or EGS harness can be removed without removing the mask/helmet. The BCD/EGS can be set safely on a table or bench so that the mask/helmet does not have to be removed and the weight harness can be removed (the harness can either be decontaminated or kept in service for the next diver). If necessary, a second tender should hold the BCD/EGS while the first tender scrubs the area of the dry suit that had been covered by the other equipment. At this point, all contaminants should have been removed from the diver or neutralized.

Care should be taken when removing the diver's mask/helmet and dry suit. At this stage, a tender other than the one who scrubbed the diver should take over if needed. If a second tender is not available, the primary tender should change into fresh PPE (at a minimum the tender should don fresh gloves) before continuing to avoid recontamination of the diver.

When removing either the helmet or the mask, the area of the seal is critical. With the full-face mask, the area where the mask sits on the latex face seal of the dry suit hood will retain water. This water may still contain contaminants from the dive. Therefore, as soon as the mask has been removed, a paper towel should be used to wipe up the extra moisture to keep it from dripping into the diver's face. This should be followed immediately by a disinfectant wipe (e.g., alcohol wipes).

When wearing a helmet, the seal is around the diver's neck and the water left in the seam is less likely to drip onto the diver. However, this area should be wiped and disinfected immediately.

During this stage, the tender should assist the diver with removing all gear except the dry suit and dry gloves. The life support equipment (BCD/EGS) should be set aside for more thorough decontamination or kept in service for the next diver.

5.3.2.3 Dry Glove and Dry suit Removal

Dry suit outer gloves should be removed first by the tender by pulling the gauntlet over the diver's hand, so the glove is inside-out. The inner gloves should be left on the diver and removed as the final stage of the decontamination process.

The tender should wipe the area of the zipper with paper towels and unzip the dry suit and assist the diver with removing it. It is important that the tender only touch the outside of the suit, to prevent possible contamination of the inside of the suit.

The diver, with assistance from the tender, should take off the hood and pull their head through the neck seal. Once the suit has been pulled off of the divers head and arms, the diver should stand to pull the suit down past his or her waist and then sit on a clean seat (not the same one that had contact with the dry suit) facing the Contaminant Reduction Zone so the tender can assist pulling the dry suit off of the diver's legs and feet. Though the suit should be clean, it should be pulled off inside-out to reduce the chances the diver will contact the outside of the suit. The last apparel that should be removed from the diver are the inner gloves. The diver should then rotate on the seat to put his or her feet down on the side of the seat facing the Support Zone.

If the diver or tender notices a wet spot (as opposed to obvious sweat marks) on the diver's undergarments after removal of the suit, it is possible that the suit leaked. If the suit leaks in contaminated water, the inside of the suit must be decontaminated as well. The undergarments must be washed or discarded, and the diver should shower as soon as possible. The suit must also be repaired before it can be put back in service.

While the dry suit should be clean at this point, the areas that had been covered by the full-face mask straps and by the BCD/harness during decontamination should be gently scrubbed with the same decontamination solution used earlier. The dry suit can be moved to the Support Zone or reused after decontamination has been completed.

5.3.3 Support Zone

5.3.3.1 Hand and Face Wash/Shower

Once the dry suit has been removed, the diver has completed contaminant reduction, and can enter the Support Zone, where resources should be available for the diver to wash his or her hands and face. If available, a full shower with soap is preferred.

5.3.3.2 Observation Period/ Recovery

The diver should remain in the Support Zone for thirty minutes for observation. During this time, the diver should be given water or other non-caffeinated drinks and allowed to rest in a comfortable area. During the warmer months, a tent or other shaded area should be used if available. During colder weather, a sheltered area, preferably indoors should be used if available.

5.4 Emergency Decontamination

In the case of an emergency during a dive or during any stage of the decontamination process, an emergency decontamination procedure should be used. The Divemaster will determine the extent of decontamination required based on the level and type of contamination encountered versus the risk involved in delaying medical treatment. Efforts should be made to minimize exposure of the diver and emergency personnel to residual contamination. Information on the type and level of contamination associated with the site must be forwarded to the attending medical personnel so they may take appropriate precautions to protect themselves and others from exposure.

5.5 Tender Decontamination

Before leaving the Contaminant Reduction Zone, the tender must remove all potentially contaminated PPE. At the edge of the Contaminant Reduction Zone and the Support Zone, the exposure suit (e.g., Tyvek suit, etc.) should be pulled off inside out, taking care not to contaminate the tender's undergarments or skin. After the suit has been pulled down past the tender's waist, the tender should sit on a clean seat facing the Contaminant Reduction Zone and pull the suit off his or her legs. As each boot cover is pulled off inside out, the tender should turn and place the uncovered foot down on the side of the seat facing the Support Zone. Gloves should then be pulled off inside out and left in the Contaminant Reduction Zone. The tender should then wash his or her hands and face with soapy water. All PPE should be discarded with the other site-derived waste.

5.6 Equipment Decontamination

5.6.1 Full-face Mask Cleaning Procedure

At the end of each day, the full-face mask should be completely decontaminated following the procedure recommended by the manufacturer. For AGA masks the following procedure should be utilized:

- The AGA mask should be immersed in warm potable water and cleaned to remove any gross contamination and debris from the mask.

- The front cover assembly (or communications unit) should be removed by unscrewing the two thumb screws. The regulator (breathing valve) should be removed from the mask body by rotating one half turn clockwise and pulling outward. Dismantle the breathing valve by unscrewing the locking ring to remove the positive pressure unit. Only turn the locking ring, since turning the positive pressure unit may damage the o-ring used to seal the unit to the body of the breathing valve. The positive pressure unit assembly should be disassembled by removing the diaphragm assembly and separating the components (diaphragm assembly, spring and guide disk, and sealing disk). Do not disassemble the diaphragm assembly. Check for debris and damage to the diaphragm.

- Immerse all parts (with the exception of the communications unit) in a mild cleaning/disinfecting solution. Allow the contact time per label directions for disinfection, remove and rinse all parts thoroughly with potable water. Place all parts on a clean towel and allow to air dry.

- After all parts have dried, check all parts for visible damage, degradation, or contamination. Lubricate the o-rings and the sealing disk shaft with oxygen-compatible silicone grease. Reassemble the breathing valve and attach it to the AGA mask. The AGA mask function should be tested prior to storage. After testing function, screw the dust cap onto the hose connection, and place the mask into a large plastic bag for storage.

5.6.2 Helmet Cleaning Procedure

At the end of each day, the diving helmet should be completely decontaminated following the procedure recommended by the manufacturer and as generally outlined below.

- The helmet should be immersed in warm potable water and cleaned to remove any remaining gross contamination and debris on the external surfaces helmet.

- The regulator/diaphragm should be taken apart, cleaned and decontaminated as specified in the manufacturer's procedures.

- If the helmet is shared between divers, the liners and nose cups should be replaced or decontaminated as necessary.

- The helmet function should be tested prior to storage or reuse.

5.6.3 Dry Suit

The dry suit should be inspected and additional decontamination and/or repairs should be performed as needed. The suit should be inspected carefully for tears, abrasions, holes or areas where chemical damage may have occurred. Brittleness, stickiness, color changes, or swollen materials could indicate significant chemical damage. Any suit exhibiting these conditions should be removed from service and returned to the manufacturer for evaluation and/or repair.

5.6.4 Other Equipment

As practical, all other equipment (BCDs, weight harnesses, EGS harnesses, fins, knives, tools, etc.) should be decontaminated based on the contaminant. Slick materials are more amenable to decon and it should be noted that it is likely not possible to clean more porous materials.

- Gross contamination should be removed by rinsing or brushing with potable water. Greasy contamination should be scrubbed with a degreasing solution.

- Hard-surfaced equipment (e.g., knives, tools) generally does not require soaking, but porous-surfaced equipment (e.g., nylon webbing harnesses, BCDs) should be soaked in an appropriate decontamination solution per label instructions. It should then be scrubbed, rinsed with potable water, and examined. The procedure should be repeated until the equipment is clean. The equipment should also be examined for damage. Any equipment showing signs of damage should be removed and evaluated before being reused. Of particular importance is equipment used for life support or diver safety. This includes BCD bladders, harness webbing, etc.

- Some equipment may require disassembly in order to be effectively decontaminated (e.g., BCD). Refer to manufacturer's instruction for the disassembly, cleaning and reassembly.

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STANDARD OPERATING PROCEDURES FOR DIVER DECONTAMINATION

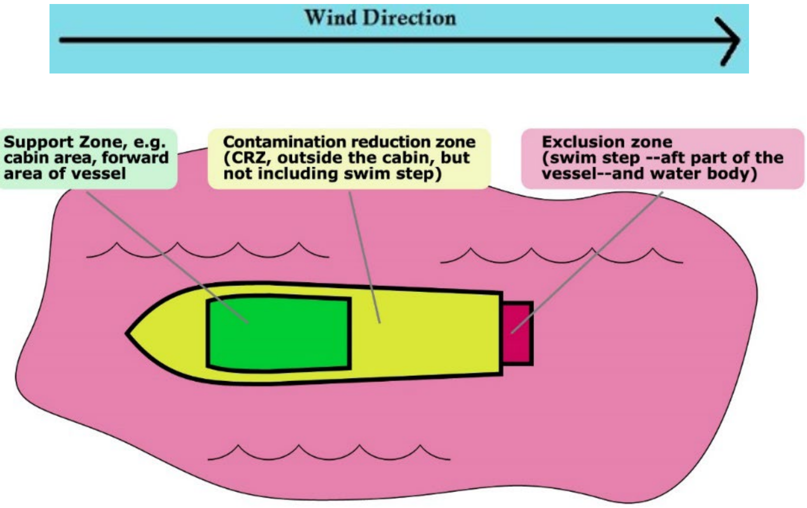
FIGURE 1. Decontamination Stages

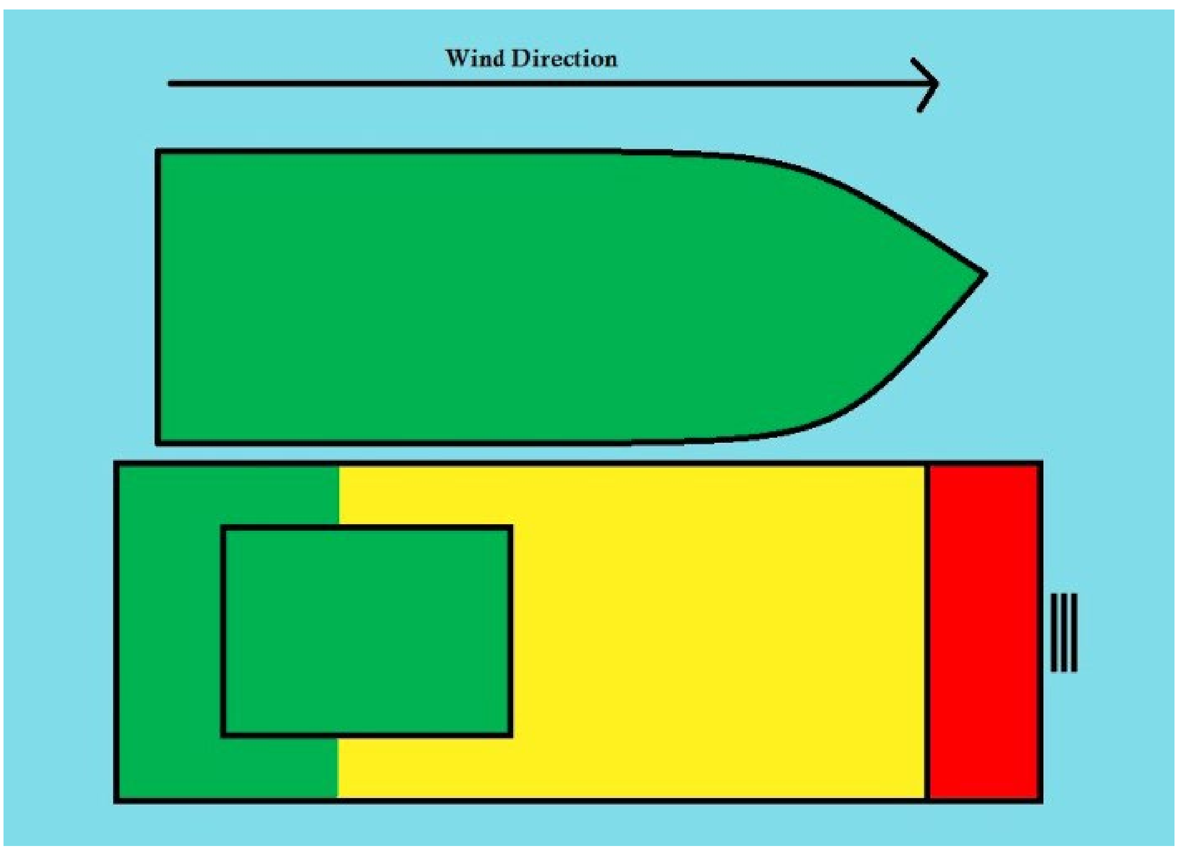
Area	Procedures	Comments
Exclusion Zone	• Exit water • Equipment Drop • Gross Decontamination	Re-used Equipment Staging
Contamination Reduction Zone	• Thorough Decontamination with Appropriate Decontamination Solution(s) • Potable Water Rinse Using Hose or Decontamination Shower • Mask/Helmet Removal • Dry suit Removal	Equipment Decontamination Site Derived Waste Storage
Support Zone	• Hand/Face Wash • Observation and Recovery • Shower	Surface Support Personnel

NOTES:

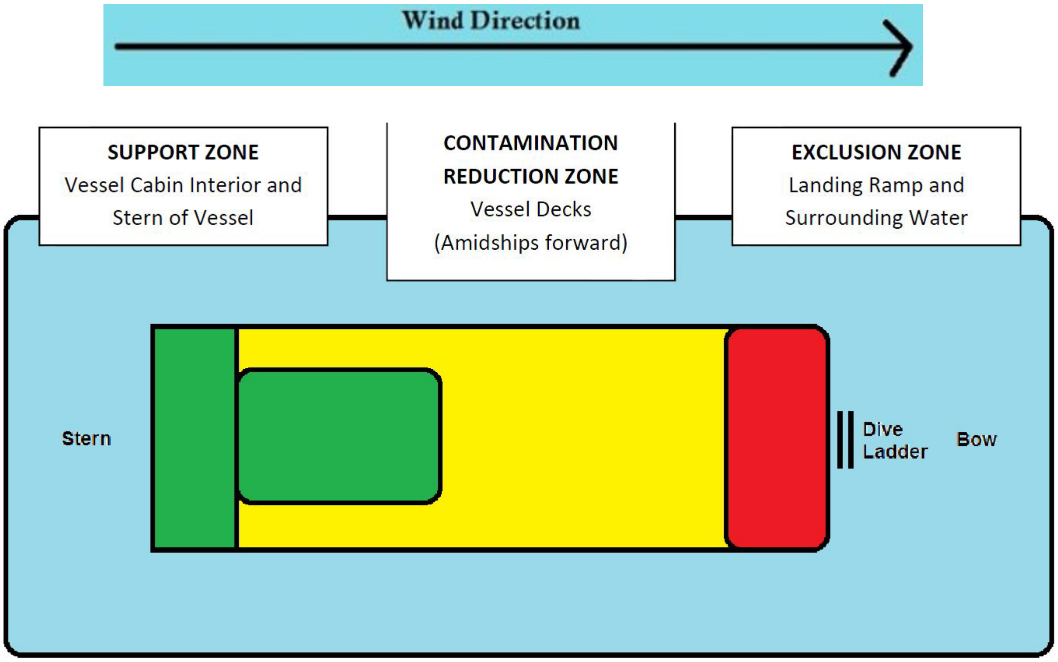
1. Decontamination stages must be determined on a site-specific basis and must be specified in the site-specific Dive Plan and HASP.
2. The Control Points indicate that access to each of the decontamination zones is to be controlled to a single-entry point.
3. Only divers and tender/decontamination personnel in appropriate PPE are allowed in the Exclusion Zone and Contaminant Reduction Zone.
4. At no time should the diver move backward in the decontamination process.

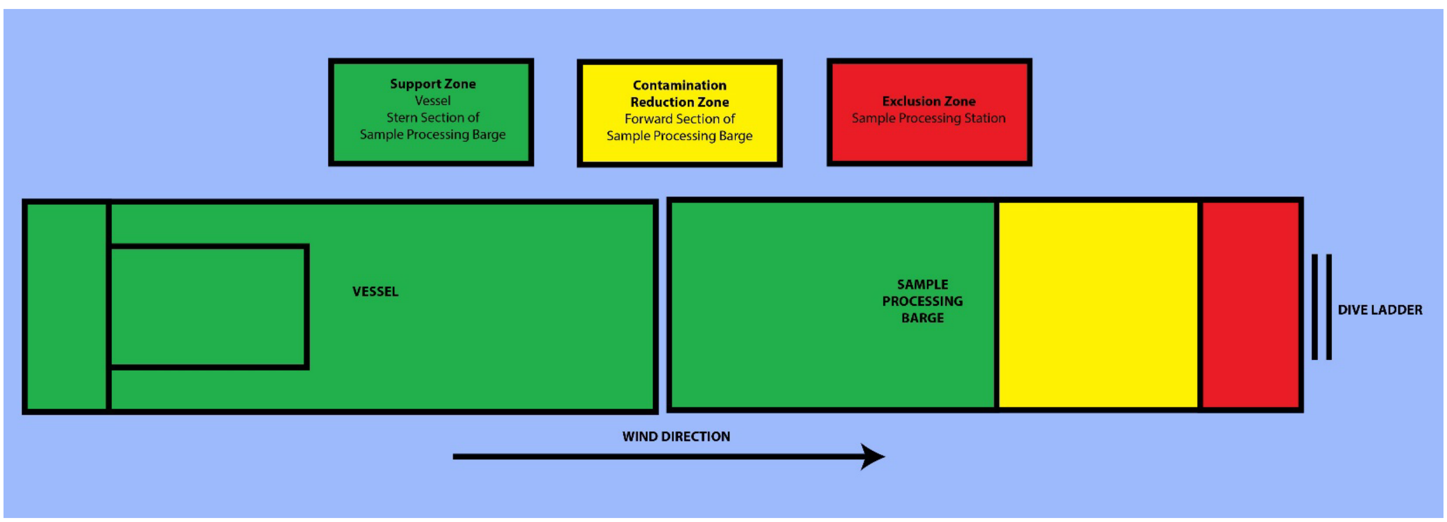
FIGURE 2: Example Vessel Configurations: delineating Exclusion Zone (red), Contamination Reduction Zone (yellow) and Support Zone (green). Note wind direction relative to the EZ.





STANDARD OPERATING PROCEDURES FOR DIVER DECONTAMINATION





ATTACHMENT 1: DIVER DECONTAMINATION SOLUTIONS

STANDARD OPERATING PROCEDURES FOR DIVER DECONTAMINATION

This attachment of decontamination solutions is not all-inclusive, and other suitable decontamination solutions may be used by the Divemasters with concurrence of the UDO and the Health and Safety Officer. This list is subject to change without notice as new products come to market or further testing is conducted.

The major considerations when choosing a decontamination solution are; 1) effectiveness against the expected site contaminants; 2) compatibility with dry suit materials and other equipment; 3) safety of exposure to both the diver and the tenders; 4) availability and cost; 5) use of biodegradable decontamination solutions or containment and disposal of used non-biodegradable solutions. Decontamination solutions and procedures should be described in the HASP prior to going on-site.

There are numerous decontamination solutions to choose from. Unfortunately, many of the most effective decontamination solutions are very aggressive, corrosive and toxic (LBL 2006). Many disinfectants and sterilants are well suited to cleaning hospital surfaces and equipment but are not safe to use on divers or some dive equipment. The objective of decontaminating the diver is to remove the contamination from the diver's suit so that the suit can be safely removed. There is no necessity to use solutions that are potentially dangerous to the diver or the equipment when other less dangerous solutions will yield satisfactory results. Removing the contaminants from the diver is more important than neutralizing chemical contaminants or killing biological contaminants. Killing biological contaminants on the diver's suit/equipment will usually not be the goal of the initial stage of the decontamination process (while the diver is still dressed), due to the wet contact time required to achieve this. A secondary definitive decontamination of dry suits and equipment may be required after the dry suit/equipment has been removed. Since some of the contaminants at a site may be unknown, it is necessary to use a decontamination solution that is effective for a variety of contaminants (EPA 1985).

Decontamination solutions prepared from concentrated products (e.g., soap or bleach) should be diluted with potable water and not site water, since site water may negatively impact the final strength of the prepared decontamination solution.

It is recommended that prior to the start of site activities the contaminants of concern should be identified, and care should be given to select the most appropriate decontamination solution(s). If contaminants are anticipated but not well documented a very conservative approach should be used in selecting the most effective broad based decontamination solution(s). Antimicrobial soap is generally a very effective decontamination solution since it will kill some biological contaminants and is also a surfactant which will remove most contaminants from the diver's suit. When the diver's suit is contaminated with oil and/or grease a decontamination solution with degreasing properties such as Simple Green may be effective as a single decontamination solution or in conjunction with other decontamination solutions. Always ensure the disinfectant is registered for the intended use and follow label directions. Although an iodine-based decontamination solution or alcohol may not be useful as a primary decontamination solution, it may be most effective for use decontaminating various pieces of dive equipment such full face masks (i.e., AGA masks). Harsher or more aggressive decontamination solutions such as TSP and quaternary-ammonium compounds (quats) may not be an ideal primary decontamination solution but may be useful in performing a secondary definitive decontamination on certain equipment after it has been removed from the diver. Certain commercially available decontamination solutions such as DF200 have been tested and shown to be effective on specific biological and chemical contaminants. Although this solution is more expensive than many of the other decontamination solutions listed below, when those contaminants are present DF200 would likely be the most reliable decontamination solution available.

Water

As noted above, the most important decontamination solution for removal of biological vectors is potable water (EPA, 2010). A plentiful supply of potable water, preferably from a low-pressure hose hooked up to a municipal water supply or a large water tank is the first and last step of all decontamination procedures. If a large tank is not available, smaller containers (e.g., 5-gallon buckets, collapsible plastic containers, Hudson sprayers) of potable water should be available. Water from a hose should not be under pressure any higher than typical municipal water pressure (40 to 70 pounds per square inch). High pressure hoses (e.g., pressure washers) may damage the diver's suit or force contaminants into seams or contaminate nearby surface support personnel. In some instances, a thorough rinse with potable water is all the decontamination the diver needs (e.g., after diving in salt water).

Commercial Soaps/Cleaning Solutions

A strong solution of soap/cleaning solutions (dish soap typically has more surfactant than hand soap) is the next most commonly used decontamination solution. Commercial soaps/cleaning solutions are readily available and produced by numerous companies using different various synthetic and/or natural active ingredients. When selecting a soap/cleaning solution the following properties should be considered:

1) Surfactant Effectiveness – The greater the surfactant effectiveness the easier the solution will remove contaminants and oil/grease during the decontamination process. A soap's surfactant action will remove most organic contamination and scrubbing with soapy water will remove sediment-associated inorganics (e.g., metals). Soap will also wash away biological contaminants (when biological contaminants are washed off, they are not killed, but their physical remove can result in an effective decontamination). When decontaminating oils and grease, the surfactants' effectiveness is usually a key consideration when selecting an appropriate decontamination solution.

2) Antimicrobial Properties – Some soap/cleaning solutions include antimicrobial additives. The active ingredient used in most antimicrobial soaps is triclosan. Triclosan works, even at very low concentrations, by blocking enoyl-acyl carrier-protein reductase (ENR), preventing bacteria and fungi from producing fatty acids needed for cell membranes and other vital functions (Senese 2005). Humans don't have the ENR enzyme, and so triclosan is harmless enough for use in a wide variety of consumer goods including cosmetics and toothpaste (Senese 2005). Because of its effectiveness and safety, antimicrobial dish soap is often the solution of choice for decontaminating patients arriving at hospital emergency rooms (USVA 2006; Jagminas 2006). In hand-washing experiments, antimicrobial soap was shown to be

more effective at removing biological agents than soap with no antimicrobial additive (CDC 2002). Consult the FDA and CDC for disinfectants appropriate for use on the Diver.

3) Biodegradability – Many biodegradable products are readily available. When decontamination solutions may be released into the environment during the decontamination process a biodegradable product should be used. When the decontamination solutions are controlled and contained, this criterion is of less importance. The products biodegradability is usually specified on the products label or the associated Material Safety Data Sheet (MSDS).

4) Safety – When selecting an appropriate soap/cleaning solution the safety to all personnel and equipment should be considered. To access the safety of a solution MSDS should be consulted. When possible, non-hazardous solutions with a HMIS health rating of 1 or less should be utilized. The MSDS will identify any specific health hazards (eye, skin, ingestion, and inhalation) and the appropriate protective equipment should be used if needed. The MSDS will also list any applicable first aid measures, accidental release measures, handling and storage requirements, exposure controls, and the solutions stability and reactivity (which is important when using multiple decontamination solutions and/or compatibility with dive equipment materials).

Biodegradable antimicrobial soap registered for its intended use is a useful decontamination solution because it has wide applicability, ready availability, it is safe for use on both the diver and the diver's suit, and it requires no special PPE or disposal. The leftover soap solution can be used to clean the decontamination zone, the boat or other equipment.

Numerous other safe, effective and biodegradable decontamination soap/cleaning solutions (with or without antimicrobial agents) are available and should be considered based on decontamination requirements. These products include Simple Green® All-Purpose Cleaner (general all-purpose cleaner/degreaser), Citrus Klean (natural citrus based cleaner/degreaser), BioSol (Organic solvent degreaser), ZEP Big Orange (natural citrus based cleaner/degreaser), ZEP Acclaim (liquid hand soap), Orange Blossom (natural citrus based cleaner/degreaser) and Citrus Magic (natural citrus based cleaner/degreaser). These products contain various natural and synthetic active ingredients including citrus terpenes [d-Limonene], sodium silicate/metasilicate, linear alcohol ethoxylate, sodium iminodisuccinate, monoethanolamine, dipropylene glycol methyl ether, dipropylene glycol monomethyl, and sodium dodecylbenzene suflonate.

Bleach

Sodium hypochlorite, in the form of chlorine bleach, is a biocide that is readily available in most supermarkets. Household bleach is approximately 6% sodium hypochlorite (Clorox 2005). A 5% solution of bleach (approximately six ounces mixed into a gallon of water) will kill most bacteria, fungi and viruses on a hard, non-porous surface after a five-minute contact time (Clorox 2006). In order to overcome the consumption of free chlorine by organic matter in the site water, a 10% solution of bleach (12 ounces in a gallon of water) could be used for diver decontamination. Contact time, in this case, is defined as the length of time the wet solution is in contact with the surface to be cleaned. Contact time should follow label instructions for EPA registered usage. It is difficult to keep the diver wet for the entire contact time, so bleach is not the best choice to decontaminate the diver's suit. However, it is quite simple and effective to soak the diver's fins, harness, BCD, etc. Care must be taken when using bleach as a decontamination solution, since it will burn eyes and mucous membranes in a 10% solution. Bleach can burn unprotected skin and can damage clothes and dive equipment. Proper PPE (e.g., disposable rain suits, face shield, surgical gloves) is mandatory when using bleach as a decontamination solution.

Calcium hypochlorite is also used as a biocide, and it is readily available in powder form (e.g., swimming pool chlorine granules). A 10% calcium hypochlorite solution has greater available chlorine than a sodium hypochlorite solution. However, the powder is not readily soluble in water, and should be mixed thoroughly in warm, preferably soft to moderately hard water prior to use. This makes it difficult to achieve a desired concentration. Calcium hypochlorite granules can burn unprotected skin and can damage clothes and dive equipment. The powder also poses an inhalation risk (Arch Chemicals 2002). Proper PPE (e.g., disposable rain suits, face shield, respirator mask, surgical gloves) is mandatory when using calcium hypochlorite as a decontamination solution.

Due to the potential harm caused on hoses, brass, and other life support components, bleach should not be used on regulators, full face masks, and suits but may be appropriate for hard surfaces in well ventilated areas.

Betadine

Betadine is a brand name for a 10% povidone-iodine solution commonly used in hospitals under FDA registration to disinfect wounds and prepare skin for surgery. Undiluted Betadine will kill most pathogens after ten minutes of contact time (always refer to label instructions). Contact time, in this case, is defined as the length of time the wet solution is in contact with the surface to be cleaned. The diver must effectively be kept wet with undiluted Betadine for the entire contact time to prevent the solution on the suit from drying. Iodophors such as Betadine use povidone to slow the release of iodine, while using surfactants to increase penetration (Abedon 2003). Since the solution is reddish-brown, it may be easy to see if any areas have been missed. Care must be taken when using Betadine as a decontamination solution since prolonged contact of large skin areas can lead to excessive absorption of iodine (Purdue 2005). Betadine will also burn eyes and mucous membranes, and will stain clothing, dive equipment, and boats. Proper PPE (e.g., disposable rain suits, face shield/eye protection, gloves) is mandatory when using Betadine, and it is recommended that all surrounding surfaces be covered with disposable plastic sheeting to prevent permanent staining.

Pre-mixed iodine based solutions with a cleaning agent such as Multi-Wash™ Mini have been tested and are commercially available. These types of solutions may not be ideal for primary diver decontamination but are effective in cleaning and disinfecting certain types of dive gear such as full-face masks (Scott Health and Safety 2009). Always use disinfectants registered for their intended usage and follow label instructions.

Quaternary-Ammonium Compounds

Many commercial and household cleaners are based on QATS. These products (e.g., Zepamine A) are designed primarily for deodorizing and sanitizing general household areas, kitchens, cafeterias, food processing equipment/utensils. Additional uses include algae control in pools and cooling systems (Zep 2006). Quats are highly toxic to fish and aquatic plants, and care should be taken not to allow decontamination liquids to enter any body of surface water. If quats are mixed with chlorine bleach, the exothermic reaction is potentially explosive and the resultant chlorine gas may be hazardous. Quats are also corrosive to skin and eyes, and proper PPE and disposal of wash fluid is required.

TSP

TSP is an acronym for tri-sodium phosphate, a strong cleaner/degreaser. However, in the 1970s use of phosphate-containing products was limited. Some products on the market today that are sold as TSP may contain other ingredients and can be less than half TSP (Savogran 2001a). Other products sold as TSP or TSP-substitutes may contain no phosphate and may be acutely corrosive to skin and eyes (Red Devil 2006, Savogran 2001b). TSP products are commonly used to prepare surfaces for painting, remove mildew from home siding, and remove stains from patios or driveways. While TSP is a common household cleaner, it is not appropriate for some materials. TSP will stain metals and can etch glass and fiberglass. When using TSP solutions, care should be taken to cover the surrounding area with plastic sheeting and the decontamination liquids should not be allowed to enter any body of surface water. Proper PPE and disposal of wash fluid is mandatory when using TSP products.

Alcohol

Isopropyl alcohol (IPA) is also a good biocide (NIH 2006), and while it may not be appropriate for decontaminating the diver's entire suit and/or equipment due to cost, it is ideal for wiping down the areas under the seals of the diver's AGA mask (the latex seal around the diver's face where the mask meets the dry suit), or around the area where the diver's helmet mates to the dry suit. IPA is readily available in supermarkets as a 70% IPA/30% water solution, or as individually packaged wipes. Contact time can be fairly short for the registered usage (always follow the label directions). Care should be taken not to get IPA on the diver's face or in the diver's eyes. The readily available 70% IPA solution should not be diluted further before use. Tenders should wear at least eye protection and gloves when working with IPA.

DF200

There have been several recently developed commercial decontamination solutions that have been demonstrated to be effective in neutralizing chemical and biological warfare (CBW) agents. DF-200 is one of these products that have been shown to be very effective against CBW agents while being environmentally safe, work on a wide range of material surfaces and need contact times ranging from about 1 to 30 minutes depending on the organism (DUI 2009).

EasyDECON™ DF200 by Intelagard, a DF200 based decontamination solution distributed by Diving Unlimited International (DUI), was developed as a decontamination solution for use with CBW agents, but it has also been shown to be effective with a select number of toxic industrial chemicals (i.e., organophosphates, chlorine, ammonia, hydrogen cyanide and malathion) and other biological pathogens (*E. coli*, *Salmonella*, *Pfiesteria*, *Giardia*, fungus and molds) (DUI 2009).

Although DF200 will neutralize biological contaminants and select chemicals (i.e., organophosphates) it will also act as a surfactant, removing but not neutralizing other chemicals, such as oil/metals etc. Although DF200 may be most effective in some decontamination procedures, unlike many of the other solutions listed, it is not readily available in the field and would be one of the most expensive decontamination solutions evaluated.

Other Decontamination Agents

For crude oil/grease on a dry suit or other dive equipment, a variety of cleaning solutions or wipes impregnated with cleaning agents/degreasers are available. For disinfecting the area under a diver's AGA mask seal or where the helmet mates with the dry suit a variety of individually sealed wipes are readily available (e.g., Saniwipes, benzalkonium chloride wipes, etc.). For chemical and biological agents from terrorism-related incidents, the National Institute of Justice lists other decontamination solutions that may be investigated for suitability (NIJ 2001). Before using any cleaning solvent, its safety for skin contact and compatibility with dry suit and equipment materials must be assessed.

STANDARD OPERATING PROCEDURES FOR DIVER DECONTAMINATION

TABLE 1. Decontamination Solution Effectiveness/Safety on Slick Decontamination Compatible Surfaces:

Decontamination Solution	Use Against Biological Contaminants*	Use Against Chemical Contaminants	Safety for Diver Skin Contact	Dive Gear Compatibility
Potable Water	C[1]	D[2] C[3]	1	1
Antimicrobial Soap	A	A	1	1
10% Bleach[4]	A	B	2	3
Simple Green	B	B	1	1
Quaternary Ammonium	A	B	3	2
TSP	B	A	3	3
70% Isopropyl Alcohol	A	C	3	2

*For removal and/or disinfection of biological contaminants. Some decontamination solutions may disinfect certain biological contaminants while only removing others. If the intent is disinfection of the biological contaminant, the user must ensure the decontamination solution is registered for such as use by reviewing the product label. If the product is registered for use, e.g. the List N for disinfection effective against SARS-CoV2, the user must follow directions and pay close attention to required contact time.

Effectiveness: A = Most Effective, B = Very Effective, C = Effective, D =Not effective
Safety/Compatibility: 1 = Not Harmful, 2 = Potentially Harmful, 3 = Harmful if precautions are not followed

1: 95% removal of biological vectors was achieved on a Viking drysuit using solely potable water; Pedersen, 2010.
2: Hydrophobic chemicals
3: Hydrophilic chemicals
4: Bleach is not recommended on life support equipment due to its destructive nature on metal, brass, and plastic.

STANDARD OPERATING PROCEDURES FOR DIVER DECONTAMINATION

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APPENDIX L

Biohazards Of Diving Operations and Aquatic Environments

Acknowledgements

"Biohazards of Diving Operations and Aquatic Environments" (September 1994) was originally prepared in conjunction with the National Underwater Diving Safety Management Program by Jerry J. Tulis, Ph.D.; Ricky L. Langley, M.D., M.P.H.; and Amy M. Gitelman, M.P.H., Occupational and Environmental Medicine, Duke University Medical Center, Durham, NC, for the U.S. Environmental Protection Agency (EPA) Office of Administration and Resources Management, Safety and Sustainability Division, Washington, D.C. The substantive information in this original paper remains unchanged. However, it underwent extensive editing and some information was added December 2017, before publication of the EPA *Diving Safety Manual*, revision 1.4.

The EPA Diving Safety Board would like to thank the Divers Alert Network (DAN) and in particular Matías Nochetto, M.D., Director, Medical Programs, and Ricky L. Langley, M.D., M.P.H, FACP, FACOEM, of the North Carolina Department of Health and Human Services for their valuable input to this document as well as board members Steven Donohue, Alan Humphrey, and Sean Sheldrake for their contributions.

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

CDC	Centers for Disease Control and Prevention
CMV	Cytomegalovirus
DAN	Divers Alert Network
DEET	N,N-Diethyl-meta-toluamide
EBV	Epstein-Barr virus
EPA	U.S. Environmental Protection Agency
HAB	Harmful Algal Bloom
HBV	Hepatitis B
HCV	Hepatitis C
HIV	Human Immunodeficiency Virus
IGRA	Interferon Gamma-Release Assays
OSHA	Occupational Safety and Health Administration
PAM	Primary Amoebic Meningoencephalitis
PCF	Pharyngo-conjunctival Fever

BIOHAZARDS OF DIVING OPERATIONS AND AQUATIC ENVIRONMENTS

1. PURPOSE

The purpose of this document is to help safeguard divers, boat operators and other personnel involved in aquatic operations from biohazards they may encounter in the environment. Information on potential workplace biohazards is provided to help protect employees while performing duties like collecting water, sediment, and sludge samples; acquiring marine and freshwater specimens; and conducting various diving procedures. This document focuses on those biohazards that may be unique to, or pose a higher risk for, participants in the EPA's Diving Program.

Since EPA diving projects may involve diving and boating in water with biological or chemical contaminants, the EPA Diver Training curriculum includes use of variable-volume dry suits, full-face masks, compatible dive equipment and procedures for contaminated water diving, first aid for marine wounds, and proper diver decontamination methods. However, all trained EPA divers and support personnel must continually update their awareness of possible biohazards in the marine environment.

"Biohazards of Diving Operations and Aquatic Environments" sets forth measures for minimizing workers' occupational exposure to biohazards in underwater and diving operations. The hazards involved in dive operations are the same ones EPA workers may encounter in land-based operations but may also include hazards unique to the aquatic environment. The scope of this document does not include biohazards that divers or field personnel may face on the surface from mosquito and other terrestrial disease-causing organisms. As with any field operation, aquatic and dive operations involve aspects of physical activity that can result in injury leading to infection. Handling diving and aquatic equipment and supplies commonly involves the potential for lacerations or abrasions that can become infected by microorganisms.

First responder activities for injured divers, or the sharing of diving equipment, can also introduce risk of exposure to bloodborne pathogens. However small the risk, employers should provide training on universal precautions, work practice controls, personal protective equipment and other provisions of the Occupational Safety and Health Administration (OSHA) "Bloodborne Pathogens" standard, available at Title 29 of the Code of Federal Regulations, part 1910.1030.

Further potential for infection exists from the aquatic environment, both fresh and saltwater, such as exposure to biohazards from waterborne microorganisms, microbial toxins, plants and animals that may be encountered in diving operations. This document also provides some information on first aid for injuries and treatment related to biohazards.

2. BACKGROUND

Water covers more than 70 percent of the Earth's surface, and many vocational activities involve exposure to water and the biota present in water. All oceans, seas, lakes, rivers and ponds contain a wide variety of microorganisms, in addition to higher forms of aquatic life.

All diving operations are conducted in biologically contaminated water, the degree of hazard being a function of the type and number of potentially infective or venomous organisms and aquatic life present. Seawater and inland waters are essentially mixtures of many different microorganisms, some that inhabit the aquatic environment and others that originate from human and animal excreta and shedding.

The majority of microorganisms found as aquatic inhabitants are harmless to humans – normal commensals of animals, birds and mammals. But there are dangerous and life-threatening life forms in all the waters of the world. Certain species of viruses, bacteria, fungi, algae and parasites are recognized as human pathogens and opportunistic microorganisms; the major sources of these disease-producing organisms are human and animal excreta, especially from infected hosts. Besides these normal inhabitants of marine and fresh waters, contamination of water from various sources poses an increased hazard to exposed persons. The discharge of raw sewage into oceans, lakes and rivers is the primary source of exposure to potentially infectious and toxigenic microorganisms for both humans and animals, including consumable species such as shellfish. These sources of contamination include human and animal waste, industrial wastes, agricultural wastes, and other forms of pollution such as fertilizer runoff from farms. Many species of animal viruses, bacteria, fungi, algae and parasites are found in sewage effluents that may be discharged into rivers, oceans and lakes.

The appearance of water per se may be misleading for workers (seemingly pristine, crystal-clear water can be grossly contaminated with microorganisms, containing upwards of a million per milliliter). However, brackish, foul-smelling water is significantly more likely to have extensive microbial contamination – unless the pollution is due to toxic chemicals, which may also be detrimental to microbial life and pose a risk to the diver. Taking protective measures is prudent when entering water known to have been influenced, or potentially influenced, by effluents from sewage disposal.

The injuries often experienced during aquatic operations, including abrasions, lacerations and punctures, are readily contaminated with microorganisms, potentially leading to infection. In addition, exposure of mucous membranes of the eyes (i.e., conjunctival exposure), nose (i.e., rhinal exposure), and mouth; exposure of the ear canal; exposure to genitalia, and the swallowing and aspiration of contaminated water can lead to serious infections and intoxications.

A hierarchy of protective measures can be used to eliminate or significantly reduce exposures to aquatic biohazards. Included are accepted and proven engineering operations, good work practices, and the use of personal protective equipment. An adjunct to these measures of protection against infectious microorganisms and animal toxins is the use of vaccines and other prophylactic chemotherapeutic or biological agents (preventative medicines).

Typically, every EPA Diver is issued a complete set of personal diving equipment, which often includes a full-face mask, dry suit with dry hood, and dry gloves, to minimize potential exposure to biological and chemical contaminants. However, equipment – such as diving helmets – is sometimes shared during diving operations. Shared equipment can become contaminated with blood and other body fluids. Consequently, the possibility of transmission of human diseases from one diver to another exists, especially for diseases such as hepatitis B, hepatitis C, tuberculosis, herpes virus and human immunodeficiency virus (HIV), among others. This document describes appropriate precautions and other measures to eliminate or reduce the potential for disease transmission when using shared diving equipment.

Information and training should be provided to employees on the presence of aquatic biohazards. This training must include information on the cause of potential infectious diseases and envenomation (poisonings), the clinical onset and symptoms of specific diseases, measures for prevention and control of exposure, and accepted treatment modalities (methods of therapy). Specific information on the proper cleaning and disinfection of diving equipment is mandatory.

The healthcare provider will give medical assistance to injured and ill workers, keep injury and infection records for employees, immunize employees as indicated and keep vaccination records, provide periodic serologic testing to establish immune status and infectivity, conduct skin testing to monitor exposures to certain infectious agents (e.g., tuberculosis), and conduct periodic physical examinations on employees.

The employer maintains the full responsibility for ensuring that all employees whose duties require exposure to aquatic environments have the best protection possible against exposure to both pathogens and other hazards associated with polluted waters.

3. BIOHAZARDS OF AQUATIC ENVIRONMENTS

Many potential health hazards affect people performing diving and aquatic operations. These hazards can be segregated into five categories: infectious microorganisms, dermatoses, intoxications, envenomations and dangerous non-venomous aquatic animals.

It is important that the person involved with diving or sample/specimen collection and processing be cognizant of the potential hazards involved in these operations in the waters they are working in, and that they always perform their tasks as safely as possible to reduce or eliminate injury or illness.

3.1 Infectious Microorganisms

All bodies of water worldwide, including saltwater and freshwater, contain many species of microorganisms. Some of these microorganisms represent indigenous organisms and others represent contaminating organisms, from sewage, industrial and agricultural wastes, and human and animal shedding. Among both the indigenous and contaminating microorganisms, in all bodies of water, may be species of viruses, bacteria, fungi, algae and parasites that are human pathogens – that is, associated with human disease. Table 1 lists some of the pathogens that can be transmitted by water.

Human exposures to waterborne pathogenic and opportunistic microorganisms most often result in illnesses such as gastroenteritis (i.e., inflammation of the stomach and intestines), respiratory disease, wound infections, otitis externa (infection of the external ear canal), conjunctivitis (i.e., infection of the conjunctiva of the eyes) and sinusitis. However, more serious consequences and life-threatening complications can occur. In addition, during diving operations workers may be exposed to the blood or body fluids of coworkers as a result of sharing equipment, thereby facilitating the transmission of disease agents. Exposure of workers in the aquatic environment most often occurs through contact (i.e., skin, eyes and ears), penetrating injuries and respiration, especially during aspiration of contaminated water. Some of the more important viruses, bacteria, fungi, algae and parasites associated with waterborne disease or diving operations are briefly discussed in this document.

An evaluation by a health care provider is recommended when symptoms of disease or injury are evident or if the diver is concerned they may have been exposed to a potentially harmful agent.

Table 1. Selected Pathogens That Can Be Transmitted by Water

Agent	Disease	Incubation Period
Bacteria		
Aeromonas spp.	Wound infection	1-2 days
Burkholderia pseudomallei	Pneumonia, skin lesions	1-21 days
Campylobacter spp.	Gastroenteritis	3-5 days
Cronobacter sakazakii	Infections, sepsis, pneumonia	Unknown
Escherichia coli	Gastroenteritis	10-72 hours
Helicobacter pylori	Chronic gastritis	5-10 days
Klebsiella spp.	Skin infections, respiratory infection	Unknown, likely a few days
Legionella spp.	Pontiac fever Pneumonia	5-66 hours 2-14 days
Leptospira spp.	Weil's disease (headache, chills, fever, nausea, neck or joint pain)	2-20 days
Plesiomonas shigelloides	Gastroenteritis	24-48 hours
Providencia	Gastroenteritis, urinary tract infection	1-4 days

Agent	Disease	Incubation Period
Psuedomonas spp.	Skin infection, eye infection, respiratory infection	1-3 days
Shiga-toxin-producing *E. coli* 0157:H7	Gastroenteritis, hemolytic uremic syndrome, kidney failure	12 hours-8 days
Salmonella enteric serovar typhi	Typhoid fever	7-28 days
Salmonella spp.	Salmonellosis	8-48 hours
Shigella spp.	Bacillary dysentery	1-7 days
Staphylococcus aureus	Skin infections	Variable, commonly 4-10 days
Vibrio cholerae O1	Profuse, watery diarrhea, vomiting, rapid dehydration	9-72 hours
Vibrio cholerae non-O1	Watery diarrhea	1-5 days
Vibrio spp.	Wound infections, gastroenteritis, sepsis	2 hours-7 days
Yersinia enterocolitica	Gastroenteritis	2-7 days
Parasites		
Acanthamoebae	Eye infections, meningitis	Days-weeks
Balantidium coli	Gastroenteritis	4-5 days
Blastocystis	Gastroenteritis	Unclear
Cryptosporidium parvum	Diarrhea	1-2 weeks
Cyclospora cayatanensis	Watery diarrhea alternating with constipation	2-11 days
Dracunculis medinensis	Guinea worm	10-12 months
Entamoeba histolytica	Amoebic dysentery	2-4 weeks
Fasciola spp.	Liver flukes	3-11 weeks
Giardia lamblia	Diarrhea, malabsorption	5-25 days
Isospora belli	Diarrhea	3-14 days
Microsporidium	Chronic diarrhea, weight loss	Unknown
Naegleria fowleri	Primary amoebic meningoencephalitis	Minutes to hours
Schistosomes	Skin rash (non-invasive forms) Systemic illness (invasive forms): fever, headache, myalgia, diarrhea, rash, respiratory symptoms	Within 12 hours 2-6 weeks
Toxoplasma gondii	Toxoplasmosis	5-20 days

Agent	Disease	Incubation Period
Viruses		
Adenovirus	Respiratory illness, conjunctivitis, vomiting, diarrhea	1-5 days
Aichi virus	Gastroenteritis	27-60 hours
Astrovirus	Vomiting, diarrhea	3-4 days
Calicivirus	Vomiting, diarrhea	15-50 hours
coronavirus	Vomiting, diarrhea, respiratory illness	2-4 days
Coxsackievirus group A	Meningitis, fever, herpangina, respiratory illness, paralysis	2-10 days
Coxsackievirus group B	Myocarditis, congenital heart anomalies, rash fever, meningitis, respiratory illness, pleurodynia	2-6 days
Echovirus	Meningitis, encephalitis, respiratory illness, rash diarrhea, fever, myocarditis, endocarditis	2-10 days
Enterovirus	Meningitis, encephalitis, respiratory illness, acute hemorrhagic conjunctivitis, fever, gastroenteritis	3-10 days
Hepatitis A virus	Infectious hepatitis	15-50 days
Hepatitis E virus	Hepatitis	15-65 days
Norovirus	Epidemic vomiting and diarrhea	1-3 days
Poliovirus	Paralysis, meningitis, fever	6-20 days
Rotavirus	Diarrhea, vomiting	1-4 days
Sapoviruses	Gastroenteritis	1-4 days
Algae		
Desmodesmus armatus	Wound infection	Unknown
Prototheca spp.	Wound infection	10 days-4 months

Adapted from Heymann 2014 and Yates 2016

3.1.1 Viruses

Many viruses can be found in marine and inland waters, especially those polluted with sewage. Most viruses are found in human and animal wastes that can contaminate aquatic environments.

Currently there are more than 200 human enteric viruses that may be found in wastewater. Enteric viruses, also known as enteroviruses, are those viruses that originate from the intestinal tract. They are found at concentrations of 1 million virus particles per gram of feces. According to Melnick et al. (1978), sewage levels of about 7,000 virus particles per liter are common in the

United States, with levels in parts of the world reaching more than 500,000 virus particles per liter of sewage. Viruses contaminating the oceans, seas, lakes and other bodies of water through the dumping or release of sewage possess a variable survival in these aquatic environments – that is, viruses are obligate intracellular parasites and cannot replicate without specific animal host cells. Survival of free viruses in seawater is a function of both the specific virus and the environmental conditions. Studies have indicated that survival is enhanced significantly by lower water temperature and the presence of sediments. Enteroviruses such as the polioviruses and coxsackieviruses have been shown to survive from 1 to 3 months in seawater, depending on the season (summer or winter, respectively). The bacteria found in seawater also affect the survival of viruses by releasing antiviral metabolites that rapidly inactivate viruses. In sewage treatment plants, chlorination is moderately effective in viral inactivation.

The knowledge that viruses can survive for many weeks upon release to marine or fresh waters is important for the understanding and application of exposure and infection control practices. Moreover, besides the viruses associated with shedding and the release of sewage that contribute to the pollution of aquatic systems, there are viruses that inhabit aquatic life as either indigenous commensals (intestinal symbionts) or pathogens that can infect humans or contaminate seafood.

The major virus families recognized as sewage-associated waterborne organisms that pose a risk to humans are the following:

- *Adenoviridae:* adenoviruses
- *Astroviridae:* astrovirus
- *Caliciviridae:* norovirus, Sapporovirus
- *Hepeviridae:* hepatitis E
- *Picornaviradae:* Aichivirus, coxsackievirus, poliovirus, echovirus, hepatitis A
- *Reoviridae:* rotavirus A, B and C

Viruses that are transmissible through blood and other body fluids could pose a risk to divers sharing equipment that becomes contaminated with these fluids. Among these are:

- Hepatitis B (HBV)
- Hepatitis C (HCV)
- Human immunodeficiency virus (HIV)
- Cytomegalovirus (CMV)
- Epstein-Barr virus (EBV)
- Hemorrhagic fever viruses
- Varicella zoster virus (chickenpox or shingles)
- Influenza and common cold viruses
- Exanthematous viral infections

The following subsections briefly discuss the more important sewage-associated viruses (i.e., adenoviruses, enteroviruses, hepatitis A and hepatitis E) and bloodborne pathogens (i.e., hepatitis B, hepatitis C, and HIV) found in aquatic environments and operations.

3.1.1.1 Adenoviruses

Adenoviruses are primarily associated with infections of the conjunctiva, respiratory system and intestinal tract. There are more than 40 serotypes of human adenoviruses. Adenoviral infections are primarily transmitted through the fecal-oral route and by contact, with fecal shedding continuing for months or years after initial infection. Ocular infections have been associated with exposure to fecal-contaminated water, resulting in sporadic or epidemic outbreaks of pharyngo-conjunctival fever (PCF). Disease onset is abrupt, with sore throat, fever and conjunctivitis; accompanying headache, malaise, nausea and diarrhea are common. In adults, the disease is milder than among children, and primarily involves the eyes. Complete recovery occurs in several weeks.

3.1.1.2 Enteroviruses

Enteroviruses include viruses responsible for gastroenteritis and for human poliomyelitis, which is transmitted through the fecal-oral route. Enteric viruses can cause a variety of illnesses including gastroenteritis and more rarely encephalitis, meningitis, conjunctivitis, myocarditis and respiratory illnesses.

One of the more serious illnesses is polio. During the gastrointestinal phase of infection, copious quantities of poliovirus are shed in the feces; this phase may last for months. With proper sewage management, the poliovirus is inactivated; where sewage management is minimal or absent, the poliovirus remains viable in the environmental setting for months. Transmission takes place through consumption of contaminated water or food, or exposure to virus-contaminated vectors (e.g., flies). Most infections remain asymptomatic, with approximately one paralytic case for every 100-150 infections. Highly effective live and inactivated vaccine preparations against poliomyelitis are available. In less developed regions of the world, poliomyelitis remains a serious public health problem.

For the majority of enteroviruses, there are no vaccines available and treatment is primarily symptomatic.

3.1.1.3 Hepatitis A

Hepatitis A is usually spread through the fecal-oral route, i.e., through sewage-contaminated water and food (including seafood), and by contact. The virus can survive in both salt and fresh water. Clinical symptoms include fatigue, fever, nausea, malaise and jaundice. The disease is self-limiting, with a fatality rate of less than 0.1 percent. No chronicity (i.e., association with cirrhosis or carcinoma of the liver) or carrier state develops, as can occur with HBV and HCV infections. A vaccine for hepatitis A is available. Prophylaxis with immune globulin should be considered for travel to endemic areas if travel occurs within less than 1 week of vaccination.

3.1.1.4 Hepatitis B

Hepatitis B is usually spread through contact with contaminated blood or body fluids or as a sexually transmitted disease. Clinical disease presents with fever, malaise and jaundice. Serious sequelae include liver disease, cirrhosis and cancer; a carrier state may develop. Risks for divers and other aquatic workers include exposure to contaminated diving equipment and working in polluted waters contaminated by human body fluids. Highly effective vaccines are available that are mandated by the OSHA Bloodborne Pathogen standard for workers at risk of exposure to blood or body fluids. Antiviral medications are available for treatment of infection.

3.1.1.5 Hepatitis C

Hepatitis C is usually spread through contact with contaminated blood or by sexual transmission. Clinical disease is often mild and asymptomatic and characterized by waxing and waning elevation in liver enzyme levels. Anorexia, fatigue, nausea, abdominal pain and jaundice may occur. About 80 percent of cases may develop a chronic hepatitis. Serious sequelae may include fatty liver, liver cancer and cirrhosis; infected persons have an increased risk of lymphoma, glomerulonephritis and autoimmune thyroid problems. Risks for divers and other aquatic workers include exposure to contaminated diving equipment. Although there is currently no vaccine to prevent hepatitis C, medications are available and highly effective to treat the infection.

3.1.1.6 Hepatitis E

Hepatitis E is usually transmitted through the fecal-oral route through sewage-contaminated water and food, including shellfish. There is some evidence that hepatitis E may also be a zoonotic infection. Anorexia, fatigue, nausea, abdominal pain and jaundice may occur. The disease is usually mild, and no chronic state is recognized except in immunocompromised persons. However, it may be serious in pregnant females with up to 20 percent mortality. Treatment is primarily symptomatic, although the antiviral agent ribavarin has shown some effectiveness in clearing the infection. There is no commercially available vaccine yet but trials are underway. Immunoglobulin has not proven effective.

3.1.1.7 Human Immunodeficiency Virus

HIV is responsible for the clinical condition recognized as acquired immunodeficiency syndrome (AIDS). HIV is transmissible in the occupational setting by accidental needle stick, mucous membrane exposure or viral contact with broken skin (e.g., eczema). Infections usually remain latent for many years, ultimately leading to a variety of life-threatening AIDS-defined clinical conditions, including opportunistic infections (e.g., candidiasis, pneumocystis) and cancer. Among employees whose tasks involve diving operations with shared equipment, the opportunity for exposure to the blood and/or body fluids of coworkers exists, unless the equipment is scrupulously cleaned and disinfected after each use. No vaccine is available currently. Prophylactic chemotherapeutic medications are available if exposure has occurred. (Follow the latest Centers for Disease Control and Prevention [CDC] guidelines for bloodborne pathogen exposures, available at https://www.cdc.gov/niosh/topics/bbp/guidelines.html.)

3.1.2 Bacteria

Although certain bacterial species exist as indigenous microflora in the aquatic environment, the primary sources of waterborne bacteria associated with human infection come from sewage effluents. Raw and treated sewage contains many species of bacteria, some of which are human pathogens. The majority of bacteria found in aquatic environments are enteric organisms (primarily gram-negative species such as *E. coli*, *Salmonella* sp. and *Shigella* sp.). Other contaminating bacterial species are the gram-positive organisms (e.g., staphylococci and streptococci) and the acid-fast organisms (i.e., the mycobacteria).

Skin and soft tissue infections resulting from injuries in the aquatic (fresh and salt water) environment are not uncommon. Many species of "common bacteria" such as *E. coli, Klebsiella pneumoniae, Proteus* sp*., Psuedomonas aeruginosa, Staphylococcus* sp. and *Streptococcus sp*. can cause skin and soft tissue infection after an injury resulting in pyodermas, impetigo and erysipelas. However, some more unusual bacteria can cause severe or prolonged skin and soft tissue infections. These are presented in Table 2 below.

Table 2. Marine Bacteria Causing Human Skin and Soft Tissue Infections

Aeromonas hydrophila
Chromobacterium violaceum
Comamonas sp.
Edwardsiella tarda
Erysipelothrix rhusiopathie
Mycobacterium abscessus
Aeromonas hydrophila
Chromobacterium violaceum
Comamonas sp.
Edwardsiella tarda
Erysipelothrix rhusiopathie
Mycobacterium abscessus
Mycobacterium fortuitum
Mycobacterium marinum
Shewanella sp.
Streptococcus iniae
Vibrio alginolyticus
Vibrio cincinnatiensis
Vibrio damsela
Vibrio metchnikovii
Vibrio vulnificus

Adapted from Diaz 2014 and Diaz and Lopez 2015

In addition to the bacteria found in the aquatic environment, there are other potentially infectious organisms that could be associated with the sharing of diving equipment due to contact with the sputum of an ill person. Among these bacteria are the causative agents of tuberculosis (*Mycobacterium tuberculosis,* which is readily liberated in the expelled air of clinically ill individuals) and *Pseudomonas aeruginosa* (an opportunistic bacterium associated with otitis externa and other potentially serious infections).

The following subsections briefly discuss the more important bacterial pathogens associated with aquatic environments and operations, including *Aeromonas, Campylobacter, Erysipelothrix, Mycobacterium, Pseudomonas, Vibrio, Salmonella, Leptospira, Legionella* and fecal coliform bacteria.

3.1.2.1 *Aeromonas*

Aeromonas species are gram-negative rod-shaped bacteria found as natural inhabitants of freshwater, where they are responsible for infection among cold-blooded animals (e.g., frogs, snakes, alligators). They can survive in both fresh and salt water, and have been isolated from many harbor waters. The motile species – i.e., *A. hydrophila, A. caviae* and *A. sobria* – are associated with human diseases such as soft tissue infections and gastroenteritis by either penetrating trauma or ingestion, aspiration may result in respiratory infection and septicemia (blood poisoning). Puncture wounds contaminated with *Aeromonas* can develop cellulitis within 8 hours, with erythema (reddening), edema (swelling) and a purulent discharge (pus). Localized pain is considerable; fever, chills and lymphangitis (inflammation of the lymph nodes) may occur. *Aeromonas* infections are treatable with a variety of antimicrobials; therapy for serious infections should include a combination of an aminoglycoside and either a fluoroquinolone or third- or fourth-generation cephalosporins until culture and antibiotic sensitivities are reported.

3.1.2.2 Campylobacter

Campylobacter species are found worldwide as commensals (intestinal symbionts) in a large number of wild and domestic animals. Species responsible for human infection include *C. jejuni*, which has the broadest animal reservoir; *C. coli;* and *C. fetus*. Outbreaks of disease have been associated with the consumption of contaminated food or water, and the fecal-oral route has been implicated in person-to-person spread. The disease is diagnosed more often in children than adults, and may account for about 9 percent of all diarrheal cases. Several clinical forms of *C. jejuni* disease exist, from the most common enteritis (of one to seven days' duration with fever, headache, abdominal pain and diarrhea) to an acute colitis with fever, abdominal cramps, and bloody diarrhea. *C. fetus* presents less often with enteric disease, more often as an acute bacteremia. Most *C. jejuni* infections are self-limiting; effective antibiotic therapy is available.

3.1.2.3 Erysipelothrix Rhusiopathiae

Erysipelothrix rhusiopathiae is the causative bacterium of erysipeloid in humans, where it occurs primarily as an occupational disease. Common names for erysipeloid are fish-handler's disease, crayfish poisoning, speck finger and blubber finger. *E. rhusiopathiae* is a gram-positive organism found as a normal inhabitant of many wild and domestic animals, birds and fish. The organisms are found in the surface slime of both saltwater and freshwater fishes. Human infections usually occur on the hands at the site of skin injury as nonsuppurative purplish erythematous lesions (purple-red rashes), associated with pain and itching. Most infections are self-limiting, although complications including endocarditis (inflammation of the heart's interior lining) can occur. Antibiotics provide effective treatment.

3.1.2.4 Fecal Coliforms

Fecal coliforms are gram-negative, non-spore-forming bacteria (in the family *Enterobacteriaceae*) that ferment lactose; they are widely used as indicators of fecal pollution because of their high numbers in fecal waste and because they are often easier to quantify than pathogens directly. Total coliform bacteria can be used as indicators of fecal contamination in fresh water and drinking water, but are not recommended as indicators for recreational water due to their ubiquity in the environment. Thermotolerant coliforms have been used as indicators of fecal contamination of fresh water. However, the presence of total coliforms and thermotolerant coliforms has also been associated with non-fecal sources of contamination. Thus, *E. coli* has been used as an indicator for its apparent specificity to fecal material. The EPA has promulgated levels of *E. coli* and enterococci (gram-positive bacteria) as indicators of fecal pollution in recreational waters. Ingestion of fecal coliforms including *E. coli* may result in a gastroenteritis and uncommonly renal damage. Skin injuries may become infected by these organisms but are usually minor in a healthy person.

3.1.2.5 Legionellae

Legionellae are the causative bacteria of legionellosis and Pontiac fever. The *Legionellae* are composed of at least 48 species, although about 70 percent of human infections are due to *L. pneumophila*. Legionnaires' disease has been reported worldwide, both as endemic outbreaks and sporadic cases. The natural habitat for the *Legionella* bacterium is water, including ponds, lakes, water cooling towers, showers, nebulizers, whirlpools, etc., with transmission occurring primarily from inhalation of contaminated aerosols. The bacterium can survive and multiply in tap water for longer than one year; hyper-chlorination is required for microbial inactivation. This opportunistic pathogen generally afflicts people with specific risk factors (e.g., elevated age, smoking, alcohol consumption). Two distinct clinical conditions have been described: (1) Legionnaires' disease, a lower respiratory illness that can lead to systemic disease, with extensive pulmonary involvement, respiratory failure, and death; and (2) Pontiac fever, a self-limiting influenza-like illness without pneumonia. No vaccine is available; antibiotic therapy is recommended for Legionnaire's disease.

3.1.2.6 Leptospira Interrogans

Leptospira interrogans, the causative bacterium of leptospirosis, is contracted through contact with infected animals or contaminated water: the bacteria enter the body through a skin break or through mucous membranes. Many wild and domestic animals act as reservoirs, and may represent the major source of human infection. Swimming, wading, bathing, diving or other contact with water in ponds, streams and reservoirs contaminated with urine from infected animals is often the source of human infections, sometimes resulting in outbreaks of illness. Onset of clinical disease is abrupt and influenza-like; serious sequelae include liver, kidney and central nervous system involvement. The disease occurs worldwide, especially during the summer in temperate climates and as an endemic disease in the tropics. Effective antibiotic therapy is available; prophylactic use of antibiotics among high-risk occupational groups is recommended.

3.1.2.7 Mycobacterium Marinum

Mycobacterium marinum is a rod-shaped mycobacterium that is responsible for a disease called fish tank granuloma or aquarium granuloma. These are granulomatous skin lesions, which occur primarily at skin sites associated with prior abrasions and a relatively lower skin temperature, e.g., elbows, knees, toes, and fingers. The organism is widely distributed in nature, occurring in soil, water, and fish. The clinical infection begins several weeks after exposure, as small papules that enlarge and may ulcerate. They may or may not be painful, and there may or may not be a discharge. Complete healing may be spontaneous, but it usually requires several months to two years. These microorganisms will not grow in standard cultures; require a lower temperature; and take longer to grow, which usually results in a delayed diagnosis. Antimicrobial therapy is available. Heat packs may potentiate antibiotic therapy.

3.1.2.8 Mycobacterium Tuberculosis

Mycobacterium tuberculosis is the causative bacterium of tuberculosis. It poses a negligible risk of infection directly from an aquatic environment. This bacterium is spread from person to person by contaminated aerosols released through the coughing of clinically ill people. Expelled sputum and phlegm can contaminate the interior surfaces of the mouthpiece and second stage. The microorganisms in these potentially infectious aerosols may remain viable for long periods, and with the infectious dose of tuberculosis being extremely small – i.e., 1-10 organisms – predisposed coworkers could theoretically be infected.

The most common form of tuberculosis is characterized by pulmonary involvement, with persistent productive cough, night sweats, weight loss and enlargement of lymph nodes. Although tuberculosis is rare in healthy young people, it can be fatal in the immunocompromised and in young children. Antimicrobial regimens are available and recommended. Periodic tuberculin skin testing or blood testing with interferon gamma-release assays (IGRAs) should be used to determine if workers have been exposed and need to be treated.

3.1.2.9 Pseudomonas Aeruginosa

Pseudomonas aeruginosa, a gram-negative bacillus, is the primary cause of otitis externa (i.e., swimmer's ear) after exposure to water. The disease is common among divers as a result of altered flora of the ear canal due to prolonged water exposure, and will prevent workers from diving. Dermatologic and eye infections occur; pneumonia and urinary tract infections have been reported. Treatment for otitis externa generally involves the use of antibiotic-steroid ear drops. Serious complications can occur in immunocompromised individuals or diabetics.

3.1.2.10 Salmonella

Salmonella species found as waterborne pathogens may cause three distinct clinical diseases:

1. A self-limiting gastroenteritis
2. A septicemia
3. An enteric fever (i.e., typhoid fever)

Salmonellae can survive in seawater for several weeks. Several thousand serotypes of *Salmonella* exist; the most relevant serotypes associated with human infections are:

- *S. enterica* serotype Typhi, responsible for typhoid fever
- *S. enterica* serotype Typhimurium, which causes gastroenteritis
- *S. enterica* serotype Enteritidis, which causes gastroenteritis
- *S. enterica* serotype Choleraesuis, which causes septicemia

3.1.2.11 Salmonella Serotype Typhi

Salmonella enterica serotype Typhi is solely carried by humans; it is spread through the fecal-oral route, and by the consumption of contaminated water and food. In the United States and other developed countries, the control of carriers, chlorination of water, sewage management and prophylactic vaccination have kept typhoid fever under control, with about 70 percent of U.S. cases acquired during travel to endemic areas outside the United States. Among the developing countries, waterborne transmission represents the major route of infection. Typhoid fever may be prolonged, lasting about three weeks, with fever, malaise, lethargy, constipation, diarrhea and bacteremia. The mortality rate is 2-10 percent, with a relapse rate of 20 percent. Antibiotic therapy is available. A recently developed live oral vaccine is considered efficacious and should be used for prophylaxis against typhoid fever for those working in endemic areas. (See the CDC website: https://wwwnc.cdc.gov/travel.)

3.1.2.12 *Vibrio*

Vibrio species are ubiquitous inhabitants of both saltwater and freshwater, with at least 34 identified species, 11 of which are human pathogens. The majority of human infections are generally caused by the following three species:

- *V. cholerae*
- *V. parahemolyticus*
- *V. vulnificus*

The *Vibrio* species primarily responsible for gastroenteritis resulting from fecal-oral transmission or ingestion of polluted water include:

- *V. cholerae*
- *V. parahemolyticus*
- *V. mimicus*

- *V. hollisae*
- *V. fluvialis*
- *V. fournissais*

The *Vibrio* species responsible for soft-tissue infections, otitis and sepsis resulting from penetrating trauma or contact include:

- *V. vulnificus*
- *V. alginolyticus*
- *V. damsela*
- *V. metchnikovii*
- *V. cincinnatiensis*

Although vibrios do exist naturally in the aquatic environment, the contribution of fecal contamination from infected people and carriers is difficult to ignore in endemic and epidemic regions of the world, especially where sanitation is inadequate or absent.

3.1.2.13 Vibrio Cholerae

Vibrio cholerae, a nonhalophilic organism, has been associated with several pandemics of cholera since 1817. Enteric infections occur primarily through the consumption of, or exposure to, contaminated water or food, especially uncooked seafood. Clinical disease symptoms typically include severe diarrhea with dehydration; possible serious sequelae include coma, convulsions and death. The disease is endemic and epidemic in Southeast Asia, Africa, India, the Middle East, Southern Europe, Central and South America, and the Oceanic Islands. A short-lived and moderately effective vaccine is available and may be recommended by certain countries. (Check with the CDC for the latest information on foreign travel.) Treatment includes fluid replacement, antibiotics and symptomatic therapy.

3.1.2.14 Vibrio Parahemolyticus

Vibrio parahemolyticus is a halophilic organism, is found worldwide as a major cause of gastroenteritis from the consumption of seafood (e.g., Japanese summer diarrhea). The organism has been isolated from seawater, sediment, suspended particulates and marine life. The majority of infections worldwide occur during the warm summer months. Human infections result primarily from the eating of raw seafood (e.g., oysters and sushi) or undercooked seafood (e.g., crabs, shrimp, lobsters). Wounds exposed to the marine environment can become infected with *V. parahemolyticus,* resulting in a cellulitis, and ocular and ear infections have been reported. Serious sequelae such as septicemia, pneumonia and osteomyelitis are rare. Recovery is usually spontaneous after several days; antibiotic therapy is used to treat wound infections or septicemia.

3.1.2.15 Vibrio Vulnificus

Vibrio vulnificus, a halophilic organism, is an insidious and highly invasive marine pathogen, that causes three distinct clinical disease syndromes:

1. Wound infections, typically from contact with brackish water while harvesting oysters or handling of shellfish. These infections, either from the contamination of pre-existing wounds or injury in the marine environment, may become edematous (swollen) and erythematous (red) within hours, accompanied by lymphadenopathy. Intense pain occurs at the infected site, with fever, chills and nausea; complications, especially in persons with underlying disease like diabetes or immunosuppression, can result in a fatality rate of 7-22 percent. Mechanical protection using puncture-resistant gloves is highly recommended in these environments. Antibiotic treatment should be administered promptly should signs of infection occur.
2. A primary septicemia, with malaise, fever, chills, vomiting, diarrhea, prostration and a mortality rate of 50 percent, especially among people with pre-existing liver disease who consume raw seafood. Antibiotic treatment should be administered promptly.
3. An acute, self-limiting diarrhea from the consumption of raw seafood.

3.1.3 Fungi

The most common fungal infections associated with the aquatic environment are the dermatophytoses, caused by a large group of fungi collectively known as dermatophytes or "ringworm" fungi. Another less frequently encountered fungal infection associated with polluted waters is pseudallescheriasis.

3.1.3.1 Epidermophyton, Microsporum and Trichophyton

Epidermophyton, *Microsporum* and *Trichophyton* are the fungal genera responsible for the dermatophytoses; 24 species are currently recognized. Tinea pedis is ringworm of the feet or athlete's foot, particularly affecting the interdigital webs and soles. Infection can occur by contact with wet floors or decks, e.g., in communal showers and bathing facilities. a nuisance infection, though if untreated it can progress to lymphadenitis. Antifungal medications (topical and oral) are readily available, many as nonprescription drugs.

3.1.3.2 Pseudallescheria Boydii

Pseudallescheria boydii is the causative fungal agent of pseudallescheriasis. The fungus has been isolated from various environmental sources, including soil, polluted water, sewage, waterlogged pastures, swamps, algae and animal manure. Many local and systemic diseases have been attributed to *P. boydii,* including sinusitis, meningitis, cerebral abscess, pulmonary involvement, endocarditis, arthritis and cutaneous granulomata. Invasive disease from near drowning due to aspiration of polluted water has been documented; most infected patients suffered brain abscesses and death. Traumatic implantation of *P. boydii* in healthy people has resulted in chronic, localized infections of soft tissue, bone and the cornea. Chemotherapy with the azole antifungals appears effective.

3.1.4 Algae

3.1.4.1 Protothecosis

Protothecosis is an uncommon algal infection caused by two species of the genus *Prototheca,* namely *P. zopfii* and *P. wicker hamii*. Although rare, cases have been reported from all regions of the world, including the southeast United States. Species of *Prototheca* have been isolated from both marine and fresh water; aquatic sediments; soil; and foods contaminated with polluted water, soil, or animal feces. Infections involve the soft tissues of the extremities resulting from penetrating trauma and exposure of existing lesions with contaminated water or soil. The course of infection is extremely indolent (slow to occur), lasting months or years, with little evidence of self-healing. Surgery and antifungal medications have been used to treat cutaneous lesions.

3.1.4.2 Harmful Algal Blooms

Harmful algal blooms (HABs) are also known as red tides, blue-green algae or cyanobacteria. Cyanobacteria are photosynthetic bacteria that occur naturally in fresh and salt water bodies. Certain environmental conditions, such as elevated levels of nutrients from human activities (e.g., nitrogen and phosphorus), warmer temperatures, still water, and plentiful sunlight can promote the growth of cyanobacteria to higher densities, forming cyanobacterial blooms. When the bloom is formed by toxin-producing bacteria, it is generally referred to as an HAB. Some HABs produce dangerous toxins in fresh or marine water, but even nontoxic blooms hurt the environment and local economies. For example, when masses of algae die and decompose, the decaying process can deplete oxygen in the water, causing the water to become so low in oxygen that animals either leave the area or die. The genera of cyanobacteria most related to adverse health effects include *Anabaena, Microcystis, Oscillatoria, Aphanizomenon* and *Nodularia*. Cyanobacteria may produce a variety of toxins, with more than 60 identified so far. The toxin-producing cyanobacterial genera most commonly observed in North American lakes are presented in Table 3 below.

Table 3. Selected Toxin-Producing Cyanobacterial Genera in North American Lakes

Genus	Potential Toxins Produced
Anabaena (Dolichospermum)	Anatoxin-a, homoanatoxin-a, anatoxin-a (S), cylindrospermopsin, microcystin, saxitoxin
Aphanizomenon	Anatoxin-a, homoanatoxin-a, cylindrospermopsin, microcystin, saxitoxin
Cylindrospermopsis	Anatoxin-a, homoanatoxin-a, cylindrospermopsin, microcystin, saxitoxin
Lyngbya	Anatoxin-a, homoanatoxin-a, lyngbyatoxin, saxitoxin
Microcystis	Microcystin
Nostoc	Microcystin
Nodularia	Nodularin
Oscillatoria	Anatoxin-a, homoanatoxin-a, cylindrospermopsin, microcystin, saxitoxin
Planktothrix	Anatoxin-a, homoanatoxin-a, microcystin, saxitoxin

Adapted from Otten and Paerl 2016

The toxins can be grouped into four functional classes:

1. Neurotoxins – anatoxins, saxitoxins
2. Hepatotoxins – microcystins
3. General cytotoxins – cylindrospermopsin
4. Lipopolysaccharide endotoxins

Exposures to toxins may occur via ingestion, inhalation and skin contact. Ingestion of water involved in algal blooms has caused deaths in animals. Symptoms from human exposure to algal blooms include gastroenteritis, fatigue, headaches, skin and eye irritation, hay fever symptoms, and asthma. Immediate showering after contact with the water and symptomatic therapy is recommended if exposure to an HAB occurs. The World Health Organization and the EPA have established guidelines for evaluating HABs.

3.1.5 Parasites

Various human and animal parasites are found as contaminants of both marine and fresh waters worldwide. The majority of parasitic infections from exposure to the aquatic environment are the result of contact with or ingestion of fecal contaminated water or food. The subsections below briefly discuss some of the more important parasitic infections of humans that are associated with fecal polluted water: amoebiasis, giardiasis, schistosomiasis and cryptosporidiosis. Information on amoebic meningitis, a serious waterborne disease caused by exposure to free-living pathogenic amoebae, is also presented.

3.1.5.1 Cryptosporidium

Cryptosporidium hominis and *C. parvum* are the protozoan parasites responsible for cryptosporidiosis, which is transmitted by contact and through the ingestion of contaminated water. Outbreaks and epidemics have been reported, with fecal-oral transmission implicated. Animals can act as reservoirs. Clinical symptoms include watery diarrhea, fever, abdominal pain and anorexia. The parasite is found worldwide, with normal water chlorination proving ineffective in its destruction. Treatment is supportive and includes rehydration therapy and maintenance of proper electrolyte balance. Antiparasitic therapy is available.

3.1.5.2 Entamoeba Histolytica

Entamoeba histolytica is the protozoan parasite responsible for amoebic dysentery or "Montezuma's revenge." About 400 million persons worldwide are infected; 100 million have acute or chronic disease – meaning that most infected people have asymptomatic disease. *E. histolytica* normally lives and multiples in the large intestines of infected humans but may assume a more pathogenic form and invade the tissues. Clinical disease is associated with acute diarrhea, abdominal pain, fever, chills and headache. Cysts are the only infective form; they are excreted with the feces and remain somewhat tolerant of environmental conditions (e.g., they survive in feces and cool water for 1-2 weeks). Transmission is primarily through fecal contaminated water and food; insects often act as carriers of the infective cysts. The prevalence of amoebiasis varies, with 5 percent infectivity in the United States and 40 percent in tropical areas of the world. Antiparasitic treatment is available.

3.1.5.3 Giardia Lamblia

Giardia lamblia is the parasitic protozoan responsible for giardiasis, an intestinal infestation that occurs worldwide, especially in warmer climates. The disease is readily transmitted to others, especially where sanitary conditions are not observed. The route of transmission is fecal-oral, and one index case can infect hundreds of people through the contamination of food or water. Several animals, including dogs and beavers, act as reservoirs of disease, and may be responsible for the contamination of streams and other inland waters. Clinical disease is associated with foul-smelling stools and anorexia, and although not fatal, the disease can prove extremely discomforting. Antimicrobial treatment is available and recommended for symptomatic cases.

3.1.5.4 Naegleria Fowleri

Naegleria fowleri is a pathogenic free-living amoeba that causes a disease called primary amoebic meningoencephalitis (PAM), or amoebic meningitis, among previously healthy people. The amoebae enter the nasal passages while people are submerged (i.e., swimming or diving) in warm freshwater harboring *N. fowleri;* only a few amoebae are required for infection to occur. The amoebae migrate up the nasal mucosa, penetrate the cribriform plate, and enter the cranium, where a rapidly fatal encephalitic disease ensues. Symptoms include fever, severe headache, vomiting, confusion, delirium and coma. The mortality rate from PAM is extremely high. Although this amoeba is ubiquitous, infections remain rare. Diving in suspect warm and polluted freshwater should be avoided; hyper-chlorination destroys the amoebae. Immediate medical evaluation and treatment is required if PAM is suspected. An investigational new drug therapy is available from the CDC.

3.1.5.5 Schistosoma

Schistosoma species, including *S. haematobium, S. mansoni* and *S. japonicum,* have been recognized as human parasites since antiquity. The clinical disease schistosomiasis occurs worldwide in tropical regions of Africa, the Caribbean, South America, the Middle East, Southeast Asia and India. More than 200 million people worldwide are infected. The larval fluke (worm) responsible for schistosomiasis is transmitted from contaminated freshwater to humans by penetrating the “unbroken” skin; a freshwater snail acts as the intermediate host. After penetration, the larvae mature and the host experiences a rash, fever, malaise, cough, abdominal pain and nausea; bloody diarrhea and enlargement of the liver can occur. The deposition of human waste in bodies of water containing the intermediate snail host is the single most important epidemiologic finding. Antiparasitic treatment is available.

3.2 Dermatoses

Various microscopic and macroscopic aquatic animals are responsible for dermatologic problems among persons exposed to aquatic life while swimming, wading or diving in fresh or seawater.

Several of the more important organisms associated with dermatologic reactions in humans are discussed below.

3.2.1 Cymothoidism

Cymothoidism, or sea louse dermatitis, is caused by the bite of free-swimming crustaceans or cymothoids, i.e., sea lice that live as parasites on invertebrates and fish. They are found in the shoal waters of both tropical and temperate shorelines, where they are buried in the sandy bottom. The cymothoids will attack any organism near their domain, including humans. Sea lice can quickly attach to any prey and inflict sharp bites that result in hemorrhagic wounds. Cymothoids are commonly found along the southern California coast. Wounds should be cleansed with soap and water and an antibiotic ointment should be applied.

3.2.2 Schistosome Dermatitis

Schistosome dermatitis, also called cercarial dermatitis or "swimmer's itch," is caused by penetration of the skin with nonhuman schistosomes, i.e., microscopic immature larval forms of schistosomal flatworms of birds and other nonhuman animals. Cutaneous infestation occurs worldwide, both from salt and freshwater and in all geographic regions. Cercarial dermatitis primarily affects exposed areas of the body; symptoms include a prickling sensation, itching and the appearance of a red maculopapular rash. Complications include secondary bacterial infections. Brisk toweling immediately after leaving the water may be helpful in preventing infestation. Applying water-resistant sunscreens containing niclosamide to the skin may prevent cercarial penetration; dimethyl phthalate and N,N-Diethyl-meta-toluamide (DEET) have been reported as an effective cercarial repellent. Topical corticosteroids, calamine ointment and oral antihistamines may help the itching.

3.2.3 Seabather's Eruption

Seabather's eruption, also known as "sea lice," "sea poisoning," "sea critters" and "ocean itch," is caused by a group of marine animals known as cnidarians that possess tentacles with stinging nematocysts. Most outbreaks have been recorded in South Florida and the Caribbean and have been attributed to the larval form of the thimble jellyfish, *Linuche unguiculata*. These larvae are barely visible, appearing like finely ground pepper, and are trapped by bathing suits and diving apparel. Skin lesions range from a barely discernible macular rash to a generalized maculopapular and vesicular eruption; urticarial lesions have been reported. The dermatitis is associated with intense itching; other symptoms include nausea, diarrhea, chills, and weakness, difficulty in sleeping, muscle spasms, and general malaise. Treatment includes the use of antihistamines and hydrocortisone creams, with epinephrine for extensive eruptions.

3.2.4 Seaweed Dermatitis

Seaweed dermatitis is caused by exposure to the seaweed *Lyngbya majusculata,* a common blue-green alga found throughout the Pacific, Indian and Caribbean oceans. Swimmers and divers exposed to toxic varieties of *L. majusculata* develop an erythematous dermatitis (reddened skin rash) associated with stinging, burning and itching. These dermal sensations may develop within minutes to hours after exposure. The rash may progress to an escharotic (burn scabbing) blistering dermatitis, especially in perianal, perineal or scrotal areas. Oral, ocular and mucous membrane lesions have been reported, as well as a facial rash and conjunctivitis, possibly associated with exposure to aerosolized seaweed fragments. Seaweed dermatitis is treated symptomatically with cool compresses and topical corticosteroids. Washing with soap and water upon leaving the water may prevent the development of dermatologic problems.

3.2.5 Cutaneous Larva Migrans

Cutaneous larva migrans, also known as creeping eruption, sandworm and plumber's itch, is caused by exposure of the skin to the filariform larvae of nonhuman hookworms (e.g., of dogs, cats and raccoons). The sources of human infection include soil and sand contaminated with animal feces – e.g., exposure of bare feet or other body parts to contaminated beach sand above the high-water mark or beneath beach houses. Infections occur worldwide, especially in tropical and subtropical areas, e.g., along the coast of Florida and the Gulf of Mexico in the United States. Upon penetration of human skin, the larvae cannot complete their normal life cycle, although they can remain under the skin for months. Symptoms begin immediately after penetration, with a red papule at the site of entry that becomes enlarged and vesicular. The embedded larvae can move up to several centimeters per day, leaving torturous tracks with extreme itching. Treatment is both systemic and topical with antiparasitic medication. The wearing of sandals and other protective clothing is recommended in potentially contaminated areas.

3.2.6 Other Allergic Reactions

Divers, dive masters and aquatic workers should be aware that, in addition to environmental exposure, allergic reactions can develop among workers exposed to diving equipment materials, especially from the mouthpiece, suit and face mask. Diving equipment is made of many different chemicals, some of which can cause allergic responses among sensitized divers. These reactions are manifested by the appearance of skin irritation, including rashes, vesicle formation and weeping lesions. A diagnosis of allergic contact dermatitis can usually be made with a case history, physical examination and patch testing. An investigation to determine the specific cause of contact dermatitis is important, since other materials may be substituted to allow continued diving. Treatment includes the use of cold Burow's solution dressings, antihistamines and corticosteroids.

Shellfish allergies are often associated with ingestion of shellfish but can also result from contact with shellfish in the environment. Aquatic workers, divers and dive masters should be aware of severe allergies that coworkers under their supervision may have, such as fish or shellfish allergies. Workers with these types of allergies should be required to have EpiPens or other countermeasures onsite in case of allergic reaction. They should also be required to wear gloves and take whatever protective measures are needed to avoid contact with potential allergens.

3.3 Intoxications

Dinoflagellates in the aquatic environment produce many toxins that may cause severe illness in humans; most are the result of ingestion of the toxin. In addition, dinoflagellate toxins bioaccumulate in filter-feeding marine animals such as oysters and clams. Consumption of contaminated oysters and other marine animals, especially raw, can cause intoxication, with symptoms ranging from numbness of the extremities, headache, nausea, vomiting and diarrhea in milder cases to muscle paralysis, respiratory distress, memory impairment and, occasionally, death in severe cases.

Exposure of divers and other personnel engaged in marine operations most often occurs through the inhalation of aerosolized dinoflagellate toxins. The unarmored dinoflagellate *Karenia brevis* (previously *Ptychodiscus brevis*) is associated with "red tide" outbreaks, with fish kills and human exposures taking place during algal blooms. Ocean waves tend to lyse the dinoflagellates, thereby releasing the toxin which can become airborne along coastal areas. The released toxins possess both a hemolytic and a neurotoxic effect. Symptoms of respiratory exposure include conjunctivitis, rhinitis (runny nose), bronchitis, and respiratory irritation. The use of respiratory protection and goggles should limit exposure. Treatment is symptomatic.

3.4 Envenomations

Many varieties of aquatic animals can envenomate divers and other workers while engaged in marine and fresh water operations. Both vertebrate and invertebrate animals can be involved in envenomation, using different mechanisms and producing different toxins. Preventative measures, including wearing wet and dry suits, hoods, gloves, and covering exposed skin, should be emphasized for divers and aquatic workers to help avoid exposure.

3.4.1 Venomous Invertebrates

Venomous invertebrates, such as jellyfish, stinging corals, sea anemones, sea pansies, hydroids and the Portuguese Man of War belong to a group of marine animals known as cnidarians, with more than 9,000 species worldwide. They possess stinging nematocysts used to envenomate victims. Nematocysts are triggered by contact, which leads to skin penetration with the concurrent release of toxins that can cause intense pain, inflammation at the sites of exposure and urticarial skin rash (hives).

While envenomations have rarely led to systemic symptoms and death, reactions to the sting from the clinging jellyfish (*Goniomemus sp*.) in New England waters have caused respiratory distress in divers and required hospitalization.

The DAN website contains up-to-date, comprehensive information on general treatment principles for jellyfish and hydroid stings at http://www.diversalertnetwork.org/medical/articles/Marine_Life_Trauma.

3.4.1.1 Box Jellyfish

Chironex fleckeri (known as the "sea wasp") and *Chiropsalmus quadrigatus* are the most dangerous of the invertebrate cnidarians identified as box jellyfish, and the most explosive envenomation process known to mankind. Deaths have been reported in as little as three minutes. For survivors, nematocyst stings from these jellyfish produce immediate discolored wheals that progress to extensive swelling, erythema (reddening), vesiculation (blistering) and necrosis. The victim experiences immediate intense pain that can be incapacitating. Within minutes after tentacle attachment and envenomation, the affected person may become cyanotic, convulsive and pulseless. Pulmonary edema is evidenced upon autopsy. The four-handed box jellyfish *(Chiropsalmus quadrumanus)* has a habitat spanning from South Carolina to the Caribbean, the Gulf of Mexico and as far south as Brazil. It can inflict extremely painful stings and is the slightly smaller American cousin to the Australian sea wasp.

First aid is of utmost importance, as the victim may die within minutes of being stung. Once visible tentacles have been removed, the area should be treated with vinegar. This stabilizes any unfired nematocysts to prevent further envenomation. The area can be washed with sea water (never fresh water, since it could cause osmotic lysis) to flush out any remaining tentacles. Vinegar does not neutralize the toxins; it just makes the unfired nematocysts more stable to handle. Apply heat by immersing the affected area in hot water (upper limit of 113°F/45°C) for 30 to 90 minutes.

The DAN website contains up-to-date, comprehensive information on first aid for exposure to nematocysts at http://www.diversalertnetwork.org/health/hazardous-marine-life/portuguese-man-of-war. Poison centers are also sources for updated treatment; they can be reached at 1-800-222-1222.

The Commonwealth Serum Laboratories of Melbourne, Australia, has developed an antivenom for *C. fleckeri* stings, but it is not readily available for cases of "sea wasp" poisoning in the United States. Other treatment is supportive and may require advanced life support in an intensive care unit.

Irukandji syndrome results from small box jellyfish found near Australia, *Carukia barnesi* and *Malo kingi*, and is responsible for an extremely painful symptomatic complex. These small cubozoans' bells measure only a few millimeters, but their tentacles are up 3 feet (1 meter) long. Deaths from these smaller species are rare, but stings are extremely painful and can cause systemic symptoms including cardiovascular instability that require immediate medical attention.

3.4.1.2 Echinoderms

Echinoderms, including starfish (or sea stars) and sea urchins, possess hard exoskeletons with spines that can easily penetrate the human skin, even muscular layers or joints. Sea urchins are probably the most imminent threat to divers. Most of them do not have any specific venom, but puncture wounds can cause a variable degree of pain, redness and swelling. In some cases, muscle weakness and paresthesias (i.e., sensations of burning, prickling or formication) may be present, particularly on long-spined species of the genus *Diadema*. Cardiac arrhythmias and other severe reactions are rare. The decision of whether to remove spines surgically is usually based on joint or muscular layer involvement and whether there is pain with movement or signs of infection. Spines will usually encapsulate in a short time, but they may not always dissolve. A reactive granuloma is a common reaction to remaining small foreign bodies. Do not attempt to remove spines embedded deeper in the skin; let medical professionals handle those. Deeply embedded spines may break down into smaller pieces, complicating the removal process. Ancillary treatment is supportive.

The DAN website contains up-to-date and comprehensive information on first aid for exposure to sea urchin spines at http://www.diversalertnetwork.org/health/hazardous-marine-life/sea-urchins.

3.4.1.3 Mollusks

Mollusks, including cone snails and cephalopods, may envenomate upon handling. Cone snails envenomate by a radular tooth or dart that produces localized paresthesias, numbness and paralysis, which may progress to respiratory arrest. Cephalopods such as octopi secrete toxic saliva (tetrodotoxin), which is inoculated into the victim through a bite from its beak. These bites usually produce modest bleeding and can be painful, causing swelling, redness, inflammation, blurred vision, numbness, difficulty in swallowing and occasional paralysis.

The blue-ringed octopi are a small, venomous species that live in tropical tide pools from south Japan to the coastal reefs of Australia and the western Indo-Pacific. These small octopi are the only cephalopods known to be dangerous to humans. Treatment for mollusk envenomation is primarily supportive.

3.4.1.4 Polychaetes

Several species of polychaete marine roundworms have biting jaws with venom glands. Bites can cause swelling, pain and erythema (reddening), with spontaneous healing in several days. Some species – called bristle worms – have bundles of bristles, called setae, on their sides that resemble fiber optics. Contact with these bristles can result in localized numbness, redness and moderate swelling that can be followed by vesiculation (blisters). Treatment is symptomatic.

3.4.2 Venomous Vertebrates

Venomous vertebrates have venom glands that can inflict serious injury to victims upon accidental exposure. More than 100 species of marine fish have defensive venom-injecting apparatuses. Although worldwide in distribution, most venomous species are found in tropical and semi-tropical waters around coral reefs. Included are stingrays, scorpion fish, lion fish, weever fish, stonefish, zebrafish, tiger fish, turkey fish, fire cod, toadfish, stargazers, stonelifters, catfish surgeonfish and (particularly relevant to divers in the Pacific Northwest) rockfish. Venom glands are usually associated with spines or barbs in front of the dorsal, anal or pectoral fins and spines in the tail and gill covers. In the stingray, the venom gland is at the tip of the long-barbed spine.

Envenomations are associated with immediate and intense pain at the puncture site. Bleeding from the penetrating wound is usually proportionate to what one would expect for the location. Associated symptoms may include nausea and vomiting. Weakness, respiratory distress, convulsions and numbness are rare. Deaths are very rare, and perhaps only from species of stone fish *(Synanceja verrucosa, S. horrida)* and stingrays. Treatment of stung limbs involves immersion of the limb in hot water (110-120°F/43-49°C) for 30-60 minutes. All embedded spines, barbs or other foreign materials must be removed from the injured site. Antibiotics and tetanus toxoid should be administered to patients stung by stingrays or fish, where larger penetrating wounds are encountered. Antivenom is available for stonefish envenomations. Supportive therapy is generally adequate.

Sea snakes have paddle-shaped tails and tiny fangs, are highly venomous, and are native to the Indo-Pacific Ocean. Some species can be found in the western tropical Americas, but there are no sea snakes in the Atlantic. The bite is usually painless and results in small puncture wounds. Most bites do not result in envenomation; nevertheless, all bites should be treated as potentially lethal until proven not. Generalized rhabdomyolysis (i.e., disintegration or dissolution of muscle) is the dominant feature of sea snake envenomation. Early symptoms include headache, thirst, sweating and vomiting, with generalized aching and tenderness of the muscles within 30 minutes. The venom contains neurotoxins that can cause paralysis, respiratory arrest and death if the victim is not adequately supported. Trismus, or lockjaw, is a frequent manifestation. Renal failure and cardiac arrest are the result of damage to skeletal muscles (rhadomyolysis and hyperkalemia). Antivenom is available and should be given immediately upon development of symptoms.

Some venomous terrestrial snakes, such as the water moccasin (*Agkistrodon piscivorous*), also like to live near water bodies.

The DAN website contains up-to-date and comprehensive information on general treatment principles for vertebrate marine envenomations at http://www.alertdiver.com/?articleNo=491.

It is imperative that medical personnel evaluate injuries from envenomations as promptly as possible.

3.5 Dangerous Non-Venomous Aquatic Animals

Dangerous non-venomous aquatic animals can seriously injure divers and others inhabiting the aquatic environment because of their aggressive behavior and size.

Many species of sharks have attacked divers and swimmers in temperate and tropical waters around the world, inflicting severe and fatal injuries. Other potentially dangerous marine and freshwater animals include barracudas, moray eels, alligators and crocodiles, electric eels, piranhas, and several non-venomous snakes such as the brown water snake.

Some mammals may also be dangerous for humans, including the orca and sea lion. All wounds from these animals should be thoroughly debrided; rabies prophylactic vaccination should be considered.

Table 4 lists zoonotic infections from marine mammal encounters, while Table 5 presents zoonotic infections transmitted from fish, amphibians and reptiles.

Table 4. Zoonotic Diseases Transmitted from Marine Mammals to Humans

Genus and Species	Disease	Clinical Signs/Symptoms Reported in Humans from Marine Mammal Encounters
Bacteria		
Bisgaardia hudsonensis	Seal finger	Dermatitis
Brucella pinnipedialis and *B. ceti*	Brucellosis	Headache, lethargy, severe sinusitis
Erysipelothrix rhusiopathiae	Erysipeloid (humans), erysipelas (marine mammals)	Localized dermatitis/sepsis in severe cases
Leptospira interrogans (serovars pomona, gryppotyphosa)	Leptospirosis	Renal failure
Mycobacterium marinum and *M. pinnipedii*	Mycobacteriosis	Lethargy, weight loss, anorexia, granulomatous dermatitis (marinum) and tuberculosis (pinnipedii)
Mycoplasma phocacerebrale, M. phocarhinis, M. phocidae	Mycoplasmosis (seal finger)	Localized dermatitis
Virus		
Calicivirus (San Miguel sea lion virus)	Seal finger	Skin blisters (vesicles) and influenza-like illness
Influenza A virus	Influenza	Conjunctivitis
Parapoxvirus	Seal finger	Single papule, milker's nodule
Fungus		
Ajellomyces dermatitidis	Blastomycosis	Cellulitis and lymphadenitis
Lacazia loboi	Lobomycosis	Granulomatous dermatitis

Adapted from Waltzek et al. 2012

Table 5. Zoonotic Infections Transmitted from Fish, Amphibians, Reptiles

Aeromonas spp.
Campylobacter spp.
Clostridium spp.
Edwardsiella tarda
Enterobacter spp.
Erysipelothrix spp.
Escherichia coli
Flavobacterium meningosepticum
Gnathostoma spp.
Klebsiella spp.
Mycobacterium spp.
Nocardia spp.
Plesiomonas shigelloides
Pseudomonas fluorescens
Salmonella spp.
Serratia spp.
Staphylococcus spp.
Streptococcus iniae
Streptococcus spp.
Spirometra spp.
Yersinia spp.

The DAN website contains a medical guide to handling interactions with marine creatures: http://www.alertdiver.com/Bites_and_Attacks_.

Chapter 16 in the *NOAA Diving Manual* (NOAA 2017) describes hazardous aquatic animals, identification of signs and symptoms, as well as treatment options.

4. CONTROLLING AND PREVENTING EXPOSURE

4.1 General Considerations

It is clearly understood that we exist in a world full of health risks, risks that affect us every day of our lives. When operating in the aquatic environment, an awareness of the potential and real risks present is necessary to avoid a serious consequence; that is the purpose of this document. As Barsky (2007) stated in *Diving in High Risk Environments,* "when diving in contaminated water ... precautions include obtaining the right equipment, maintaining it according to manufacturer's specifications, completing the initial training, continuing with monthly training dives to ensure competency in the use of the equipment, and maintaining a realistic attitude about what you can and can't do."

Thus, risk reduction is the key. By understanding the biohazards present in the aquatic environment, we can minimize or prevent exposure to these biohazards. Through the deployment of a hierarchy of exposure control measures generally understood and accepted in the management of biohazards – namely engineering practices, good work habits, medical surveillance and prophylactic vaccination, and the use of appropriate protective equipment and apparel – risk can be reduced.

The most important preventive strategy to avoid occupational disease while conducting aquatic operations is "exposure control." When conducting diving operations in known polluted waters, the need for optimal protection from exposure to these waters is indicated. All body parts must be protected by diving apparel, and extreme care must be exercised to avoid mucous membrane and oral exposure to even minute quantities of water.

This section emphasizes good work habits, in conjunction with medical monitoring and the use of personal protective equipment, to control and prevent exposure.

4.1.1 Diving After Rainfall/Runoff

A good mitigation measure is to avoid diving immediately after a rainfall or runoff event, especially in urban areas. These events can cause non-point source discharges: specifically, stormwater can wash pet waste and other pollutants from impervious surfaces into bodies of water. In older cities, stormwater sewers may be interconnected with sanitary sewers; heavy rainfall may lead to these combined sewers overflowing and carrying untreated sewage into water bodies.

How long to wait to dive after a runoff event depends on many factors, including the flushing rate of the water body and the type of dive gear being used (i.e., whether it includes a fully encapsulating dry suit and full-face mask).

EPA maintains a website that allows the public to determine if beach areas are closed now or have been closed in the past. The site can be found at https://www.epa.gov/beaches/find-information-about-your-beach.

4.1.2 Dermal Protection

It is imperative that diving personnel with pre-existing wounds, incompletely healed surgical incisions or underlying disease completely refrain from entering the aquatic environment unless they take other mitigating measures, including wearing a dry suit with dry hood and dry gloves and a full-face mask. Many pathogenic and opportunistic microorganisms require an easy portal of entry, such as a previous cut, abrasion or wound, in order to infect.

In general, when divers have open lesions or other wounds, they should not dive. However, simple skin lesions can be treated with a petroleum-based antibiotic ointment and covered. The wound should be thoroughly cleaned after the dive, with removal of all dressings and medications.

Abrasions and open wounds can occur when certain body parts – e.g., the toes, knees, wrists and axillae – chafe against the seams and collars of diving suits. Wearing a full-body skin under the diving suit can prevent chafing.

4.1.3 Respiratory Protection

Divers should avoid using standard SCUBA with mouthpiece second-stage regulators in urban or potentially contaminated waters: they can inadvertently ingest water by placing such mouthpieces in their mouths. In addition, a mouthpiece regulator's exhalation valve cannot be water-tight, by design – ambient water may leak into the mouthpiece, where it is aerosolized on inhalation and inhaled and/or ingested by the diver. Divers using mouthpiece regulators should be aware that minute quantities of the water they are diving in are entering their bodies through this route of exposure. At a minimum, divers should consider using positive pressure full-face masks.

In more contaminated environments, a dual or quad exhaust regulator (typical of a diving helmet directly mated to the suit) or even exhaust to the surface may be necessary to fully control this pathway.

Upper respiratory infections tend to swell the passages of the eustachian tube and the sinuses; diving under these conditions can cause barotraumas of the sinuses or the middle ear. Pre-existing lower respiratory infections can lead to pulmonary barotraumas and serious injury due to mucous plugging of the small airways, thereby preventing the escape of air during ascent. Anyone experiencing systemic illness should refrain from diving until fully recovered.

In addition, people who have underlying diseases or are immunocompromised are significantly more susceptible to serious and life-threatening infection upon exposure to the aquatic environment. Waterborne microorganisms can cause serious respiratory disease when the normally sterile lung is contaminated through near-drowning or accidental aspiration of polluted water.

4.1.4 Good Work Habits

Workers engaged in operations in the aquatic environment need to adhere to standard procedures of infection control. Exposure to potentially polluted waters must be prevented or limited to avoid infection. After being used in potentially polluted water, diving equipment must be decontaminated to prevent exposure of the diver or attending personnel to waterborne biohazards and pathogenic microorganisms. Decontamination involves the initial cleaning and decontamination of the exterior of the diving equipment. The exterior is decontaminated to remove or destroy any potentially dangerous microorganisms acquired from the aquatic environment. Moreover, personal hygiene is mandatory; employees must shower immediately upon removal of diving equipment.

4.1.4.1 Diving Suit Decontamination

For decontamination procedures, see EPA Diving Safety Manual, Appendix K, “Standard Operating Procedures for Diver Decontamination.”

4.1.4.2 Personal Hygiene

Immediately following the removal of diving equipment, the diver should shower with soap. All undergarments, including bathing suits, underwear, etc., should be washed as soon as possible. Suits and gear should be hung in a manner that allows water to drain and stored in an open-air area until completely dry.

Divers can apply an ear drop solution of 50 percent white distilled vinegar and 50 percent isopropyl alcohol to their ears (or use a commercially available product) following a dive as precautionary measure to prevent infection.

Residues left on diving equipment from cleaning, decontamination and/or disinfection may cause allergic responses or skin irritation. Thoroughly rinsing equipment should prevent these problems.

4.1.4.3 Sample Collection

Workers collecting aquatic specimens and environmental samples, including potentially polluted water and aquatic sediments, must be cognizant of the presence of pathogenic microorganisms and dangerous life. They must take care when handling water samples contaminated with sewage: such samples contain many enteric microorganisms, some of which can cause disease upon exposure of abraded skin or mucous membranes. Touching the oral cavity, nasal passages or eyes with contaminated hands – gloved or ungloved – can result in localized or systemic infections of these areas, i.e., gastrointestinal infections, sinusitis or conjunctivitis. Injuries from marine and freshwater animals, including penetrations from barbs, spines, and fins, can become infected when exposed to contaminated water or aquatic sediments. Many venomous marine animals can inflict painful stings or bites resulting in envenomation; heavy-duty gloves must be worn when handling these marine animals.

Important exposure control measures to consider when collecting aquatic materials include the complete avoidance of water potentially contaminated with pathogenic microorganisms. Workers who must be exposed to these waters must use protective apparel that covers all exposed body parts. All used protective apparel must be discarded in appropriate biohazard containers if disposable, or properly decontaminated if it is to be reused. Since most collection will be done with the hands, protective gloves and vigorous hand-washing are important principles of infection control; topside personnel must also take these precautions where collected specimens and sediments may be handled, processed and discarded.

In general, many persistent biological and chemical contaminants tend to concentrate in sediment rather than in the water column (EPA et al. 2010; Hendrick et al. 2000; Hoffman et al. 2003; U.S. Navy 2004). Therefore, simply avoiding contact with the sediment by remaining above it and taking care not to suspend sediment inadvertently by finning action may reduce the diver's potential exposure.

5. MEDICAL MONITORING PROGRAM

5.1 Medical Surveillance

The EPA medical surveillance program is covered in Section 4.5 of the EPA Diving Safety Manual. Divers and field personnel are examined by a physician either annually or biennially depending on their duties. Additionally, a hyperbaric physician reviews the Medical Evaluation Form and the recommendation of the primary physician before clearing a diver to conduct underwater operations. The examination includes a complete history of illnesses and general health and a comprehensive medical examination. Tests also include pulmonary function tests, EKG, EEG and audiogram.

5.2 Prophylactic Vaccination

As an important adjunct to the use of personal protective equipment, good work habits and diver training, the use of specific vaccines will help prevent certain infections associated with the aquatic environment. Although many disease-causing agents are found in polluted waters, primarily from sewage effluents, the number of vaccines available to protect the worker is limited. Nevertheless, serious diseases can be prevented with these vaccines, and divers should avail themselves of their protective value.

Among the vaccines that are recommended for all personnel engaged in diving and other aquatic operations are those developed against the viral infections that cause hepatitis A, hepatitis B and poliomyelitis, and against bacterial infections that cause typhoid fever, cholera and tetanus. In addition, when workers are engaged in marine operations in semi-tropical and tropical waters – especially where insect vectors of various viral, rickettsial, bacterial and parasitic diseases are present – the need for additional vaccines, prophylactic medications and insect repellents needs to be considered. If the diver may be operating in bat-infested caves, then consider prophylactic rabies vaccination. If the diver is operating in a situation that may involve exposure to bioterrorism agents, then other vaccinations are available for certain agents such as anthrax and smallpox. More information on bioterrorism agents and diseases can be found at the CDC website (https://emergency.cdc.gov/agent/agentlist.asp).

5.3 Post-Exposure Evaluation

An employee who suffers an accident or potential exposure to biohazards, including polluted waters containing pathogenic microorganisms, needs to be promptly evaluated by medical personnel.

When an exposure to infectious agents is suspected, the exposed areas need to be thoroughly cleansed and the worker monitored for the onset of clinical symptoms.

The exposure of diving personnel to the residual blood or body fluids of other divers (e.g., during use of shared diving equipment) needs to be addressed through training described below and must include information on the risk of hepatitis B, hepatitis C and HIV.

For all occupational exposures, employees involved in diving and other operations need to be monitored periodically until the injury has healed or recovery from infection or illness is complete. Diving personnel may need to be restricted from diving operations until the medical provider deems it safe for the employee to resume diving.

6. EMPLOYEE AWARENESS

6.1 General Considerations and Training

Employees whose job requirements involve potential exposure to waterborne pathogenic microorganisms, aquatic life responsible for dermatoses and envenomation, and dangerous marine and freshwater animals should be aware of these risks. This includes employees whose occupational duties involve diving operations in both seawater and freshwater; the monitoring of estuarine and coastal waters; the collection of water samples, sediments, sludge, and sewage; the collection of marine and freshwater animal and plant species; and the laboratory use and disposal of collected environmental samples and specimens.

EPA's Diver and Divemaster Training, as well as required EPA field safety training and required annual refresher training, provide instruction on these topics. In addition, the DAN provides training that includes bloodborne pathogens and hazardous marine life injuries and first aid. The curriculum for these courses is available at https://www.diversalertnetwork.org/training/.

Other health and safety training required for field workers or provided as a part of the EPA Diver Training includes:

- Good work practices
- Use of protective clothing
- Medical surveillance programs
- Compliance with the OSHA Bloodborne Pathogen standard
- Diving in contaminated and polluted water
- Choosing safe diving equipment
- Decontaminating diving equipment

Dive Units may also consider additional regional training on:

- Geographic distribution of infectious agents and reporting dangerous marine life exposure incidents
- Personal hygiene after diving
- Contraindications to diving

6.2 Biological Safety

One purpose of this document is to make our divers, boat operators and other personnel involved in aquatic operations more aware of biohazards they may encounter in the environment. Biological safety information in this document includes:

- Etiology of waterborne infectious diseases
- Sources of water pollution
- Infectivity of microorganisms from aquatic environments
- Transmissibility of aquatic microorganisms
- Clinical symptoms of relevant diseases
- Symptomatic and specific treatment
- Vaccine prophylaxis

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8. GLOSSARY/DEFINITIONS

Antibiotics: Also called antibacterials, a type of antimicrobial drug used in treating and preventing bacterial infections. Includes aminoglycosides, fluoroquinolones, cephalosporins, penicillins, tetracyclines, to name a few.

Cercarial dermatitis: Swimmer's itch.

Commensal: An intestinal symbiont.

Conjunctivitis: Infection of the eyes.

Dermatophytes: Ringworm fungi.

Edema, edematous: Swelling, swollen.

Endocarditis: Inflammation of the heart's interior lining.

Enteric bacteria: Bacteria arising from the intestinal tract, primarily gram-negative organisms (e.g., *E. coli*) but also gram-positive (e.g., enterococci).

Enteric viruses: Viruses originating from the intestinal tract.

Envenomation: Poisoning.

Erysipelas: An acute infection, typically with a skin rash. Usually caused by *Streptococcus* bacteria on scratches or otherwise infected areas.

Erythema: Reddening.

Erythematous lesions: Purple-red rashes associated with pain and itching.

Gastroenteritis: Inflammation of the stomach and intestines. Symptoms include nausea, vomiting, diarrhea, abdominal cramps, occasionally fever.

Halophilic organisms: Organisms that need saline environment for growth.

Lymphangitis: Inflammation of the lymph nodes.

Macular or maculopapular rash: A type of rash characterized by a flat, red area on the skin that is covered with small confluent bumps.

Mycobacteria: Acid-fast bacteria.

Nonhalophilic: - Organisms able to grow in fresh, but not saltwater.

Otitis: Infection of the ear canal.

Otitis externa: Swimmer's ear.

Prostration: Collapse, weakness, debility, lassitude, exhaustion, fatigue, tiredness, enervation.

Purulent discharge: Pus.

Pyoderma: Any skin disease that is pyogenic (has pus).

Sepsis, septicemia: Blood poisoning, a life-threatening complication of an infection. This can damage multiple organ systems, leading them to fail, sometimes even resulting in death.

Staphylococci and streptococci: Gram-positive bacteria.

Vesicular, vesicles, vesiculation: Rash featuring small blisters on the skin.

APPENDIX M

Safety Audit Checklist

Safety Audit Checklist

I. DIVING SAFETY PLAN AND DIVE PLAN

The Diving Safety Plan and Dive Plan can be two separate documents or they may be combined. The dive plan is specific to the proposed dive operation, and the diving safety plan can be either a generic plan developed by the dive unit or simply a copy of the Diving Safety Policy, the U.S. Navy Decompression Tables, and area specific emergency information. The elements of each plan are combined in the following checklist.

A. EMERGENCY INFORMATION

1. Was the nearest medical facility (i.e., hospital or clinic) identified?
o YES o NO o N/A; Comments:

2. Was a method of communication with the nearest medical facility established?
o YES o NO o N/A; Comments:

3. Was the nearest operational hyperbaric chamber identified?
o YES o NO o N/A; Comments:

4. Was a method of communication with the hyperbaric chamber established?
o YES o NO o N/A; Comments:

5. Was a method of emergency evacuation identified?
o YES o NO o N/A; Comments:

6. Was a method of communication with the means of emergency transportation established?
o YES o NO o N/A; Comments:

7. Are the Divers Alert Network (DAN) telephone numbers, (919) 684-2948 and (919) 684-9111, for medical advice and locations of hyperbaric chambers listed?
o YES o NO o N/A; Comments:

8. Is a copy of the most recent EPA's *Diving Safety Manual* readily available at the dive site to address unanticipated events or procedural issues?
o YES o NO o N/A; Comments:

Safety Audit Checklist

B. PROJECT SPECIFIC INFORMATION

1. Did the dive plan describe the proposed dive project?
o YES o NO o N/A; Comments:

2. Were the objectives of the proposed dive project clearly identified?
o YES o NO o N/A; Comments:

3. Were the potential hazards identified?
o YES o NO o N/A; Comments:

4. Were the potential sources of pollution identified?
o YES o NO o N/A; Comments:

5. Were other environmental conditions identified and discussed in the dive plan?
a. tidal heights o YES o NO o N/A; Comments:

b. water currents o YES o NO o N/A; Comments:

c. max. dive depth o YES o NO o N/A; Comments:

d. in-water visibility o YES o NO o N/A; Comments:

e. weather o YES o NO o N/A; Comments:

f. boat/vessel traffic o YES o NO o N/A; Comments:

6. Were the Divers, boat operators, and support personnel identified in the plan?
o YES o NO o N/A; Comments:

7. Has the dive plan been approved by the Unit Diving Officer?
o YES o NO o N/A; Comments:

8. Was the dive clearly defined as a scientific or light working dive, with associated requirements in the dive plan per EPA Diving Safety Manual, Appendix E, "Checklist for Light Working Diving Operations"?
o YES o NO o N/A; Comments:

Safety Audit Checklist

II. PRE-DIVE BRIEFING AND ACTIVITIES

The project leader and Divemaster for the dive should gather all project personnel together just before diving operations are to start and review the following topics.

1. Was there a review of emergency evacuation procedures?
   o YES o NO o N/A; Comments:

2. Was there a review of diving accident management and emergency equipment (e.g., first aid and oxygen kits)?
   o YES o NO o N/A; Comments:

3. Were any safety protocols for the dive reviewed (e.g., a safety stop buoy line descent/ascent, low air supply procedures/alternate air source use)?
   o YES o NO o N/A; Comments:

4. Were the diver-to-diver and tender-to-diver communication procedures reviewed?
   o YES o NO o N/A; Comments:

5. Was there a review of the project description and objectives?
   o YES o NO o N/A; Comments:

6. Was there a review of the potential hazards:
   a. Pollution sources?
   o YES o NO o N/A; Comments:

   b. Environmental conditions: waves/strong currents/visibility?
   o YES o NO o N/A; Comments:

7. Were decontamination materials available and decontamination procedures reviewed for polluted water diving operations?
   o YES o NO o N/A; Comments:

8. Was there a review of any specialized equipment for the dive (e.g., pinger, pinger locator, current meters, remotely operated vehicles (ROVs), dive sleds, oxygen meters for Oxygen Enriched Air [Nitrox])?
   o YES o NO o N/A; Comments:

9. Were the dive team roles identified (i.e., Divemaster, alternate Divemaster, tender, and if needed, standby Diver)?
   o YES o NO o N/A; Comments:

Safety Audit Checklist

10. Did the Divers check all of their dive equipment prior to each dive?
o YES o NO o N/A; Comments:

11. Were the tank pressures checked and recorded before each Diver entered the water and subsequent dive start times by the divemaster or tender?
o YES o NO o N/A; Comments:

12. Was the personal emergency information available for each Diver (e.g., medical history, family notification) and stored in a manner to ensure the privacy of the information?
o YES o NO o N/A; Comments:

13. Was vessel traffic control notified, if necessary?
o YES o NO o N/A; Comments:

III. OPERATIONS DURING THE DIVE

During the dive it is important to observe the position of the support vessel(s), operation of the equipment, and the topside diving personnel.

1. Was the tender monitoring the Divers and not performing another function that could interfere with tending responsibilities?
   o YES o NO o N/A; Comments:

2. Were the appropriate dive flags displayed on the vessel tending the Divers?
   a. red/white "diver down" flag on inland/coastal waters?
   o YES o NO o N/A; Comments:

   b. red/white flag and blue/white code alpha flag in waters with international vessel traffic?
   o YES o NO o N/A; Comments:

3. Was the size of the dive flags appropriate for the diving operation?
   o YES o NO o N/A; Comments:

4. Was a standby Diver equipped and ready to provide immediate assistance?
   o YES o NO o N/A; Comments:

5. Was a tender-to-diver communication system deployed (i.e., diver recall unit)?
   o YES o NO o N/A; Comments:

6. Were the emergency first aid, Automatic External Defibrillator (AED) onsite, and oxygen kits on the dive platform?
   o YES o NO o N/A; Comments:

7. If applicable, were appropriate light working dive requirements followed per EPA Diving Safety Manual, Appendix E, “Checklist for Light Working Diving Operations”?
   o YES o NO o N/A; Comments:

IV. POST-DIVE PROCEDURES

Monitoring post-dive diving operations is important to ensure that Divers are taking the necessary precautions to avoid injury, protect themselves from environmental conditions, and maintain their equipment.

1. Did the Divemaster and/or tender monitor each Diver exiting the water for signs and symptoms of "bubble trouble"?
   o YES o NO o N/A; Comments:

2. Were the Divers protecting themselves from hypothermia or hyperthermia?
   o YES o NO o N/A; Comments:

3. Was freshwater (or other appropriate fluids) available to prevent dehydration?
   o YES o NO o N/A; Comments:

4. Were the water depths, bottom time, and tank pressures of each Diver recorded after each dive?
   o YES o NO o N/A; Comments:

5. Was a dive report prepared that included appropriate information specific to the diving operation (e.g., water depths and bottom times for the dives, tank pressures, achievement of objectives, hazards encountered, malfunctions and lost equipment)?
   o YES o NO o N/A; Comments:

6. Were appropriate decontamination procedures followed when diving in polluted waters?
   o YES o NO o N/A; Comments:

7. Did the Divers properly clean and store their equipment when they were not diving or after they had completed the diving operations?
   o YES o NO o N/A; Comments:

Safety Audit Checklist

V. DIVING PERSONNEL AND RECORDS REVIEW

An evaluation of the training, background, and capabilities of each Diver involved in the diving operation is of primary importance.

1. Were all Divers current with diving physical examinations (within one or two years depending on whether the dive unit conducts 30 days or more of hazmat water dives each year, or has been so advised by a physician)?
   o YES o NO o N/A; Comments:

2. Were all Divers current with Cardiopulmonary Resuscitation (CPR) and AED certification?
   o YES o NO o N/A; Comments:

3. Were all Divers current with first aid training?
   o YES o NO o N/A; Comments:

4. Were all Divers current in oxygen administration
   o YES o NO o N/A; Comments:

5. Were all Divers certified for their respective levels of responsibility (i.e., as Divers or Divemasters)?
   o YES o NO o N/A; Comments:

6. Were all Divers using the air compressor, trained in its operation, if one was at the dive site?
   o YES o NO o N/A; Comments:

7. Is there record of a rescue drill within the past 12 months (i.e., rescue of an incapacitated Diver from the water to the diving platform) been performed?
   o YES o NO o N/A; Comments:

8. Had all Divers maintained their proficiency (i.e., dived within the last three months)?
   o YES o NO o N/A; Comments:

9. Were all Divers experienced with the conditions that were expected during the project?
   o YES o NO o N/A; Comments:

10. If the answer to nos. 8 or 9, above, is negative, what provisions and preparations has the divemaster undertaken to prepare the Diver for the new situation?
    Comments:

Safety Audit Checklist

VI. DIVE EQUIPMENT

Diving equipment must be maintained according to the requirements in the Diving Safety Policy, the manufacturer's specifications, whichever are the most conservative.

A. SCUBA EQUIPMENT

1. Were all SCUBA cylinders tested within the 5-year hydrostatic test date?
o YES o NO o N/A; Comments:

2. Had all SCUBA cylinders been visually inspected within the past 12 months?
o YES o NO o N/A; Comments:

3. For EPA-owned or leased compressors, was an air quality test result obtained within the past 6 months? (Air quality must meet the standard, as cited in EPA Diving Safety Manual, Appendix A, "EPA Diving Safey Rules"?
o YES o NO o N/A; Comments:

4. If the compressor was not in use for more than six months, was it labeled with "TAGOUT" or had the air quality been tested before dive operations resumed?
o YES o NO o N/A; Comments:

5. Were all regulators critically examined, calibrated, or overhauled according to the manufacturer's recommended service interval?
o YES o NO o N/A; Comments:

6. Had all of the Diver's gauges (e.g., pressure, depth, compass, bottom timers, and watches) been critically examined and calibrated or replaced according to the manufacturer's recommended service interval?
o YES o NO o N/A; Comments:

7. Had all valves and hoses been critically examined and replaced or overhauled as needed?
o YES o NO o N/A; Comments:

8. Were all belts and buckles in good condition?
o YES o NO o N/A; Comments:

9. For dry suit diving, were all dry suits leak-free?
o YES o NO o N/A; Comments:

10. Were all buoyancy compensators in good condition and maintained in accordance with manufacturers specifications?
o YES o NO o N/A; Comments:

Safety Audit Checklist

11. Were all buoyancy compensators capable of being inflated by two methods (one other than oral)?
o YES o NO o N/A; Comments:

12. Had the Diver communication equipment been checked prior to use?
o YES o NO o N/A; Comments:

13. Was a dive ladder available for the Divers to enter the dive platform? (Some boats are low to the water or have swim step and do not require a dive ladder.)
o YES o NO o N/A; Comments:

14. Was hygienic maintenance performed on all full-face masks?
o YES o NO o N/A; Comments:

15. Were all full-face masks free of corrosion and in good operating condition?
o YES o NO o N/A; Comments:

16. Were the head harness and buckles in good condition?
o YES o NO o N/A; Comments:

17. Were the manufacturer's repair and maintenance manuals available for the specialized dive equipment (e.g., the communication equipment, and full-face masks), if personnel are certified to service equipment or was spare equipment available in case of equipment failure in the field?
o YES o NO o N/A; Comments:

18. Was the dive equipment, in general, free of corrosion and in good working condition?
o YES o NO o N/A; Comments:

19. Were adequate spare parts and repair materials available at the dive site?
o YES o NO o N/A; Comments:

20. Is out of service dive equipment (e.g. regulators) clearly tagged out?
o YES o NO o N/A; Comments:

B. FIRST AID EQUIPMENT

1. Was the emergency oxygen kit capable of servicing two Divers with demand second stage regulators at the same time?
o YES o NO o N/A; Comments:

2. Did the emergency oxygen kit have an oxygen cylinder that was size Jumbo D or M22 (640 liters) size E or M24 (680 liters) and/or two size D or M15 (425 liters ea.) or larger cylinders?
o YES o NO o N/A; Comments:

3. Had the regulator on the oxygen cylinder been maintained according to the manufacturer's specifications?
o YES o NO o N/A; Comments:

4. Did the oxygen kit contain a cylinder wrench (or wheel) for opening and closing the tank valve?
o YES o NO o N/A; Comments:

5. Were the hoses, valves, and regulators in the oxygen kit in good condition and clean, particularly of oil and grease?
o YES o NO o N/A; Comments:

6. Were the oxygen cylinders within 5-year hydrostatic test date?
o YES o NO o N/A; Comments:

7. Were the valve seats and washer seal in good condition?
o YES o NO o N/A; Comments:

8. Was the oxygen cylinder stored in a manner to prevent excessive temperatures (i.e., where the temperature may exceed 125 degrees Fahrenheit)?
o YES o NO o N/A; Comments:

9. Was there an adequately supplied first aid kit (appropriate for the project) available for the Divers, the contents stored properly, and appropriate for the users?
o YES o NO o N/A; Comments:

10. Were spare oxygen [washer seals] available?
o YES o NO o N/A; Comments:

11. Was there a backboard for emergency use on board the survey vessel or in the dive staging area?
o YES o NO o N/A; Comments:

Appendix N

Memorandum of Agreement on EPA's Diving Safety Program

EPA MEMORANDUM OF AGREEMENT
BETWEEN THE
SAFETY, HEALTH AND ENVIRONMENTAL MANAGEMENT DIVISION
AND
DIVING SAFETY BOARD

Background

In 1982, the Occupational Safety and Health Administration (OSHA) exempted scientific diving from commercial diving regulations (29 CFR 1910, Subpart T) when (1) the diving operation met OSHA's definition of scientific diving; (2) the diving operation is part of a diving program that uses a safety manual; and (3) the diving program is directed and controlled by a diving control board that conforms to certain criteria (29 CFR 1910.401[a][2][iv]). OSHA's final scientific diving guidelines for the exemption became effective in 1985.

Purpose

The purpose of this Memorandum of Agreement (MOA) is to establish a formal agreement between EPA's Safety, Health and Environmental Management Division (SHEMD) and Diving Safety Board (DSB) on the Agency's Diving Safety Program. This MOA affirms SHEMD's authority for oversight of EPA's Dive Safety Program, including administrative, compliance, and training requirements. It also affirms the DSB's authority for overall programmatic and operational management of EPA's Diving Safety Program. Furthermore, the DSB retains the autonomy specified in OSHA's scientific diving exemption (29 CFR 1910.401), which ensures that administrative or operational demands do not unduly influence or require field personnel to perform dive operations with unreasonable risk.

Primary Roles and Responsibilities of SHEMD

Roles

The Director of SHEMD appoints a SHEMD Representative to serve on EPA's DSB. The primary roles of the SHEMD Representative is to:

1. Attend DSB meetings as an ex officio member.
2. Serve as a liaison on the DSB.
3. Provide safety and health assistance, guidance and support to the DSB.
4. Lead and conduct independent audits of EPA's dive units in accordance with EPA's *Diving Safety Manual*.

The SHEMD Representative will also ensure that a valid MOA is in effect to provide autonomy to the DSB as required by OSHA under the scientific diving exemption (29 CFR Part 1910.401).

Responsibilities

The SHEMD Representative is responsible for:

1. Attending annual DSB meetings
2. Maintaining headquarters reports of the Diving Safety Program, including:
   (a) DSB annual reports
   (b) Audit reports
3. Recommending changes in policy to the DSB

Primary Roles and Responsibilities of the DSB

The DSB is composed of the Unit Diving Officers (UDOs) as voting members, representing one vote from each diving unit and the SHEMD Representative as an ex officio member. Non-voting consultants, where necessary, may be invited to provide essential expertise on matters relating to the Diving Safety Program.

Roles

The DSB has autonomous and absolute authority over EPA's Diving Safety Program's scientific operations. All recommendations for revisions of the policy, diving rules, or other requirements associated with this program must be agreed upon by consensus of the voting members of the DSB. As determined by the DSB Chairman, all voting members of the DSB will be polled if the business at hand can be delayed, and the absent vote(s) would determine the decision.

Responsibilities

The DSB is responsible for:

1. Recommending policy and changes in operating procedures within EPA to ensure a safe and efficient Diving Safety Program
2. Reviewing existing policies, procedures, and training needs to ensure a continually high level of technical skills and knowledge throughout the Diving Safety Program
3. Planning, programming, and directing policy pertaining to the initial certification of new divers and refresher training of experienced divers in cooperation with the Diving Safety Program's Technical and Training Directors
4. Approving changes in operating policy
5. Serving as an appeal board in cases where a diver's certification has been suspended
6. Planning, programming, and directing diver workshops, seminars, and other activities considered essential to maintaining a high level of competency and safety among divers
7. Reviewing EPA diving accidents or potentially dangerous incidents and reporting on preventive measures to ensure safe diving

8. Reviewing all budgeted advanced diving projects, or directing the DSB Chairman to establish and chair an approved review committee for such projects
9. Directly advising SHEMD on any policies, procedures, or actions that affect the safety or efficiency of EPA diving activities
10. As necessary, reviewing EPA contracts and cooperative agreements that involve diving.
11. Reviewing diving reciprocity agreements and, when necessary, dive plans for non-EPA divers when funded and supervised by EPA.
12. Securing sufficient funds to administer, support, and comply with the safety and health requirements associated with EPA divers.

Duration of Agreement

This agreement will commence on the date of the signature of all parties and will continue in effect until amended through agreement by the parties.

Wesley J Car

U.S. Environmental Protection Agency
Wesley J. Carpenter, Acting Director
Safety, Health and Environmental Management Division

4/21/10
(Date)

Kennard W Potts

U.S. Environmental Protection Agency
Kennard Potts, Chairman
Diving Safety Board

4/22/10
(Date)

APPENDIX O

EPA Letters of Certification (Examples)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
CENTER FOR ENVIRONMENTAL MEASUREMENT AND MODELING
GULF ECOSYSTEM MEASUREMENT AND MODELING DIVISION
EPA DIVER TRAINING CENTER
1 SABINE ISLAND DRIVE • GULF BREEZE, FL 32561-5299

LETTER OF CERTIFICATION TO DIVE

FOR THE U.S. ENVIRONMENTAL PROTECTION AGENCY

FIRST AND LAST NAME

Is Hereby Certified to Dive at The Level of:

TRAINEE DIVER

Period of Agreement: DATE through DATE

AUTHORIZATION: You are authorized to use open-circuit, self-contained underwater breathing apparatus (SCUBA) incident in the performance of your official duties and subject to the prescribed EPA policy and regulations governing the use of such equipment, per the EPA Diving Safety Manual.

RESTRICTIONS: When diving in unfamiliar conditions, you must be under the supervision of a diver trained and experienced in those conditions. At the Unit Diving Officer's (UDO's) discretion, you may perform light scientific dives. You are initially authorized to dive to a depth of 60 FSW. Deeper depths may be authorized in writing by your Unit Diving Officer. You may serve as a surface tender.

SPECIAL QUALIFICATIONS: This diver has successfully completed Open Water SCUBA Certification, First Aid, CPR, AED and the EPA medical requirements for SCUBA has been approved.

REMARKS: This diver has completed all requisite requirements except for the EPA Scientific and Light Working Diver Training Program.

Mel Parsons Date	Cheryl Hankins Date
Chairperson, EPA Diving Safety Board	Training Director, EPA Diving Safety Board

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
CENTER FOR ENVIRONMENTAL MEASUREMENT AND MODELING
GULF ECOSYSTEM MEASUREMENT AND MODELING DIVISION
EPA DIVER TRAINING CENTER
1 SABINE ISLAND DRIVE • GULF BREEZE, FL 32561-5299

DATE

LETTER OF CERTIFICATION TO DIVE

FOR THE U.S. ENVIRONMENTAL PROTECTION AGENCY

FIRST AND LAST NAME

Is Hereby Certified to Dive at The Level of:

SCIENTIFIC and LIGHT WORKING DIVER

AUTHORIZATION: You are authorized to use open-circuit, self-contained underwater breathing apparatus incident to the performance of your official duties, and subject to the prescribed EPA policy and regulations governing the use of such equipment, per the EPA Diving Safety Manual.

RESTRICTIONS: When diving in unfamiliar conditions, you must be under the supervision of a diver trained and experienced in those conditions.

SPECIAL QUALIFICATIONS: This diver has successfully completed Diving Accident Management, Oxygen Enriched Air, Full Face Mask and Dry-Suit Training.

REMARKS: The above individual was examined and found technically qualified and psychologically adapted for diving.

______________________________	______________________________
Mel Parsons Date	Cheryl Hankins Date
Chairperson, EPA Diving Safety Board	Training Director, EPA Diving Safety Board

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
CENTER FOR ENVIRONMENTAL MEASUREMENT AND MODELING
GULF ECOSYSTEM MEASUREMENT AND MODELING DIVISION
EPA DIVER TRAINING CENTER
1 SABINE ISLAND DRIVE • GULF BREEZE, FL 32561-5299

DATE

LETTER OF CERTIFICATION TO DIVE

FOR THE U.S. ENVIRONMENTAL PROTECTION AGENCY

FIRST AND LAST NAME

Is Hereby Certified to Dive at The Level of:

DIVEMASTER

AUTHORIZATION: You are authorized to plan, manage and lead EPA dive operations and to use open-circuit, self-contained underwater breathing apparatus incident to the performance of your official duties, and subject to the prescribed EPA policy and regulations governing the use of such equipment, per the EPA Diving Safety Manual.

RESTRICTIONS: When managing dive operations or diving in unfamiliar conditions, you must be under the supervision of a diver trained and experienced in those conditions.

SPECIAL QUALIFICATIONS: This diver has successfully completed Diving Accident Management, Scientific and Light Working Diver Training, Oxygen Administration, Dry Suit and Dive Master Training.

You are hereby certified to supervise EPA divers.

REMARKS: The above individual was examined and found technically qualified and psychologically adapted for diving.

____
Mel Parsons Date
Chairperson, EPA Diving Safety Board

____
Cheryl Hankins Date
Training Director, EPA Diving Safety Board

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
CENTER FOR ENVIRONMENTAL MEASUREMENT AND MODELING
GULF ECOSYSTEM MEASUREMENT AND MODELING DIVISION
EPA DIVER TRAINING CENTER
1 SABINE ISLAND DRIVE • GULF BREEZE, FL 32561-5299

DATE

LETTER OF CERTIFICATION TO DIVE

FOR THE ENVIRONMENTAL PROTECTION AGENCY

FIRST AND LAST NAME

Is Hereby Certified to Dive at The Level of:

PROVISIONAL DIVEMASTER

AUTHORIZATION AND RESTRICTIONS: You are authorized to plan, manage and lead EPA dive operations under the supervision of a fully certified EPA Divemaster. You must complete at least 100 EPA dives or combination of dives and up to 35 Divemaster Days as defined in the EPA Diving Safety Manual, to be certified to independently plan and manage EPA dive operations. Once your UDO submits a written request to the Diving Safety Board Chairperson and Training Director verifying the completion of Divemaster requirements, you may be issued a certificate qualifying you as a fully certified EPA Divemaster. You are authorized to use open-circuit, self-contained underwater breathing apparatus incident to the performance of your official duties, and subject to the prescribed EPA policy and regulations governing the use of such equipment, per the EPA Diving Safety Manual.

SPECIAL QUALIFICATIONS: This diver has successfully completed Diving Accident Management, Scientific and Light Working Diver Training, Oxygen Administration, and Dry Suit/FFM Training.

You are hereby certified to supervise EPA divers under the supervision of a fully certified EPA Divemaster and subject to the restrictions listed above.

REMARKS: The above individual was examined and found technically qualified and psychologically adapted for diving.

Mel Parsons Date	Cheryl Hankins Date
Chairperson, EPA Diving Safety Board	Training Director, EPA Diving Safety Board

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
CENTER FOR ENVIRONMENTAL MEASUREMENT AND MODELING
GULF ECOSYSTEM MEASUREMENT AND MODELING DIVISION
EPA DIVER TRAINING CENTER
1 SABINE ISLAND DRIVE • GULF BREEZE, FL 32561-5299

DATE

LETTER OF CERTIFICATION TO DIVE

FOR THE ENVIRONMENTAL PROTECTION AGENCY

FIRST AND LAST NAME

Is Hereby Certified to Dive at The Level of:

<u>EPA DRY SUIT AND FULL-FACE MASK DIVER</u>

AUTHORIZATION: You are authorized to use a Dry Suit and Full-Face Mask with open-circuit, self-contained underwater breathing apparatus incident to the performance of your official duties, and subject to the prescribed EPA policy and regulations governing the use of such equipment per the EPA Diving Safety Manual.

RESTRICTIONS: When diving in unfamiliar conditions, you must be under the supervision of a diver trained and experienced in those conditions.

SPECIAL QUALIFICATIONS: This diver has successfully completed Diving Accident Management, Scientific and Light Working Diver Training, Oxygen Enriched Air, Oxygen Administration, Dry Suit and Full Face Mask Training.

REMARKS: The above individual was examined and found technically qualified and psychologically adapted for diving.

____
Mel Parsons Date
Chairperson, EPA Diving Safety Board

____
Cheryl Hankins Date
Training Director, EPA Diving Safety Board

APPENDIX P

Letters of Reciprocity (Examples)

Example of an Interagency LOR:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

DIVING SAFETY BOARD

APRIL 08, 2019

____
NOAA Diving Program Manager
Office of Marine and Aviation Operations
33 East Quay Rd.
Key West, FL 33040

Dear ___________,

I am pleased to provide the enclosed Reciprocity Agreement between the United States Environmental Protection Agency (EPA) Diving Safety Board and National Oceanic and Atmospheric Administration (NOAA) for the 2019 calendar year. Under this agreement, NOAA divers will be allowed to participate in EPA sponsored projects and operations.

Maintenance of this agreement is contingent upon compliance with EPA diving regulations and standards. When participating on EPA dive operations, NOAA divers are required to provide the EPA project Unit Dive Officer (UDO) with; a current letter of reciprocity or authorization to dive, signed by their Diving Safety Officer, verifying them as being a diver in good standing in the NOAA dive program.

I look forward to continuing this relationship with your program. This Reciprocity Agreement may be renewed annually. If you have any questions, please feel free to contact me at 706-355-8714.

Sincerely,

Mel Parsons

Mel Parsons
Chairperson, EPA Diving Safety Board

Enclosure

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

DIVING SAFETY BOARD

Diver Authorization Reciprocity Agreement

Between

The United States Environmental Protection Agency
Diving Safety Board

And

The National Oceanic and Atmospheric Administration
Diving Program
Gregory B. McFall
NOAA Diving Program Manager

Period of Agreement: January 1, 2019 - December 31, 2019

The United States Environmental Protection Agency (EPA) Diving Program Diving Safety Board (DSB) recognizes the National Oceanic and Atmospheric Administration (NOAA) Diving Program's authorization to dive as equivalent to EPA authorization. Under this agreement, NOAA divers are allowed to participate in EPA sponsored diving projects and operations. Each diver will be required to present to the EPA project Unit Diving Officer (UDO) a current letter of reciprocity or authorization to dive, signed by the NOAA Diving Safety Officer and if a non-federal employee, must present proof of coverage for worker's compensation. This agreement can only be applied to personnel directly employed by or working under the control of the NOAA diving program, unless agreed upon by both diving programs.

Maintenance of this agreement is contingent upon strict compliance with all EPA diving regulations and standards, when diving on EPA projects, as set forth in the EPA Diving Safety Policy. This policy specifically includes the following: diver certification, current medical clearance for divers, current CPR and First Aid certifications for divers, periodic inspection and testing of certain pieces of diving equipment, the preparation and approval of a dive plan before each dive operation, the logging of the details of each dive, the maintenance of diver proficiency, the presence of a qualified divemaster at each dive site.

This agreement may be terminated or modified by the EPA Dive Safety Board at any time. This agreement may be renewed annually by mutual consent of both diving programs.

Mel Parsons
Chairperson, EPA Diving Safety Board

April 8, 2019
Date

Example of a multi-diver LOR for a single project:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 4

Science and Ecosystem Support Division
980 College Station Road
Athens, GA 30605-2720

__________, Unit Diving Supervisor May 09, 2019
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, FL 33149

Dear __________

Please review the following Letter of Reciprocity (LOR) for EPA Divers ___________, _________, and myself for upcoming dives to collect sediment samples at Port Everglades.

As the UDO for EPA's Athens, GA Lab and the EPA's Diving Safety Board Chairperson, I certify that all divers listed are current and in good standing in EPA's Scientific Diving Program. All divers are permanent US EPA employees and as such, will be working in an official capacity and covered by Workman's Compensation.

Please feel free to contact me with any questions or if you need further information.

Thank you.

Sincerely,

Mel Parsons

Mel Parsons, Unit Diving Officer
Chairperson, EPA Diving Safety Board
USEPA
980 College Station Rd.
Athens, GA 30605
Ph: 706.355.8714
Cell: 706.202.5092
Email: parsons.mel@epa.gov

Diver Information

Diver	Level	Physical*	CPR/AED	First Aid	O_2 Cert.	Equip. Serviced
	Scientific Diver	02/20/18	09/20/17	09/20/17	05/18/18	05/19
	Dive Master	04/27/18	03/28/18	03/28/18	05/18/18	01/19
	Dive Master	04/02/19	03/28/18	03/28/18	05/09/19	01/19
	Dive Master	09/14/18	03/28/18	03/28/18	05/07/19	01/19
	Dive Master	09/18/18	02/21/19	02/21/19	09/17/18	05/19

*EPA physicals and certifications are good for two years from the date of issuance or certification.

Diver Certifications

Diver	EPA Certified*	Nitrox	Depth Certified
	05/2016	05/2016	100
	05/1988	10/1991	130
	10/2014	10/2014	100
	05/2010	05/2010	130
	05/2009	05/2009	130

* Scientific Diver, Dry Suit/FFM, Diving Accident Management

EPA Dive Stats

Diver	Dives Past Year	Last Dive	Depths	Total Dives
	31	03/28/19	30-75’	120
	32	04/05/19	20-130’	~1800
	12	05/08/19	20-130’	300
	35	05/08/19	20-130’	272
	31	04.14/19	20-125’	~500

Emergency Contact Information

Diver	Emergency Contact	Relation	Phone	E-mail

APPENDIX Q

EPA Dive Program Report (Template)

ANNUAL REPORT OF DIVE TRAINING AND OPERATIONS

Diving Unit:	***[Input Dive Unit]*** ***[e.g., Region or Laboratory]*** ***[Input UDO Name]*** ***[List Alternate UDO Name(s)]***	Time Period:	***[Input Start Date]*** ***[Input End Date]***

A. DIVING ACTIVITIES

1. Describe each type of diving operation; include pollutant exposure (use separate sheet, if necessary).

2. Locations of diving operations (list each state and type of water body).

3. Dive Statistics:

Number of Dives:

Scientific: ***[Input Number]***
Light Work: ***[Input Number]***
Training: ***[Input Number]***
Proficiency: ***[Input Number]***

Total minutes:

Scientific: ***[Input Number]***
Light Work: ***[Input Number]***
Training: ***[Input Number]***
Proficiency: ***[Input Number]***

Number of Exposure Days*
Scientific: ***[Input Number]***
Light Work: ***[Input Number]***
Training: ***[Input Number]***
Proficiency: ***[Input Number]***

*Each day of diving is an exposure day per diver regardless of how many dives each diver performs (e.g., three divers diving making two dives on a single day would equal three exposure days and two divers making one dive on a single day would equal two exposure days).

B. DIVING ACCIDENTS, INJURIES, OR INCIDENTS

1. Describe all accidents, injuries, and incidents.

   (Use separate sheet if necessary, and include copies of all applicable forms, e.g., EPA form 1440-9, CA-1 or CA-2)

C. DIVE TRAINING

1. Describe the type of training conducted/received, and list the name, office, and level of certification for each trainee. (Use separate sheet if necessary)

2. List any training needed.

D. DIVE EQUIPMENT

1. Same as last year. ***[Yes or No]***

2. If no, list and note the equipment that is new or removed from service.

   [List all equipment added or removed from service, use separate sheet if necessary]

3. Describe any important equipment problems.

4. Equipment needed.

E. REVIEW OF UNIT DIVING PERSONNEL

[List diving personnel names and certification levels.]

F. TIME SPENT ON THE NATIONAL DIVE PROGRAM

1. Time expenditures.

ACTIVITIES		TIME
A.	Assistance with Diver Training Course	***[hours]***
B.	Review of Documents ***[Identify and list (e.g., dive plans)]***	***[hours]***
C.	Performing Action Items ***[Identify and list (e.g., Prep for & Audit of Dive ops)]***	***[hours]***
D.	Preparation for and Attendance at Meetings ***[Identify and list]***	***[hours]***
E.	Technical Assistance to Other Units ***[Identify and list]***	***[hours]***
F.	Other	***[hours]***

2. Fiscal (monetary) expenditures:

   A. COST OF TRAVEL SPENT ON NATIONAL PROGRAM
   [list costs by trip]