



Marine Sciences Laboratory

EFFECTIVE DATE:

Battelle Pacific Northwest Laboratories
Marine Sciences Laboratory

**STANDARD OPERATING PROCEDURE
MSL-S-001-03**

Safe Diving Practices

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Safe Diving Practices

1.0 SCOPE AND APPLICATION

1.1 SCOPE

This Safe Diving Practices Standard Operating Procedure (SOP) outlines requirements for the scientific diving program at the Battelle/Marine Sciences Laboratory (MSL) in Sequim, Washington. The purpose of this SOP is to establish safety requirements for divers, diving procedures, and diving equipment that will govern all underwater projects requiring the use of self contained underwater breathing apparatus (SCUBA) and snorkel gear that are conducted under the MSL auspices. EACH DIVER IS ULTIMATELY RESPONSIBLE FOR HIS/HER OWN SAFETY AND MAY REFUSE TO DIVE IN CONDITIONS HE JUDGES TO BE UNSAFE.

1.2 APPLICATION

- 1.2.1 This SOP applies in situations where SCUBA diving is used to conduct underwater activity and where snorkeling gear is used for water surface-oriented activity.
- 1.2.2 This SOP applies to any employee (referred to as "individual" or "person" or "diver", below) of MSL.
- 1.2.3 All individuals who conduct diving operations under MSL auspices must agree to abide by this SOP. Agreement is signified by signing and submitting to the MSL Diving Officer (D.O.), or his/her designee, a MSL Safety Training Record contained in Appendix A.
- 1.2.4 This SOP includes all Appendixes.
- 1.2.5 Work for or with others or at foreign locations may have additional diving safety procedures that apply (e.g., Canadian waters). All operations must be conducted in compliance with this SOP and any additional or these diving safety procedures. If there are conflicting requirements, the D.O. will determine which approach, whichever results in safer diving operations.
- 1.2.6 Deviations from this SOP will only be permitted in emergency situations, where a diver is at risk of injury or casualty, or in the case of an off-normal event. Section 4.6.13 outlines the review process for emergency deviations. Variances to the procedures in this SOP are allowed only with advanced notification and authorization of the Diving Safety Board and Diving Risk Management Board in accordance with Section 4.6.12, Variance Procedures.
- 1.2.7 Use category. This procedure is generally information use.

2.0 DEFINITIONS

As used in this SOP, the listed terms and abbreviations are defined as follows:

Actual Dive Time (ADT):	The total time spent underwater on a single dive, including the precautionary safety stop.
Alternate Air Source:	An extra second stage regulator or low-pressure adaptor (e.g., Scubapro Air II or Sherwood Shadow) connected to a low pressure hose from the SCUBA regulator's first stage. This extra mouthpiece can provide air to share during a low air emergency and is sometimes called an octopus regulator or safe second regulator". In addition, a pony bottle with independent first- and second-stage regulators may be used as an alternate air source. .
Barotrauma:	A pressure induced injury.
Blue Water Diving:	Diving conducted without visual reference to the bottom. This technique is normally used for in situ observation of planktonic organisms.
Bottom Time:	The total elapsed time in minutes from the descent to the start of direct ascent (per U.S. Navy dive tables).
Buddy:	A diving partner assigned to accompany a diver when using the two diver buddy system.
Buddy Breathing:	A process where air is shared between divers as they ascend during a low air emergency.
Buddy System:	A system using a pair of divers who maintain responsibility for rendering assistance to each other.
Buoyancy Compensator (BC):	Any piece of diving equipment which holds air at the ambient pressure of the diver. The BC increases in air volume with ascent and decreases in volume with descent. The BC must be equipped with an inlet and exhaust valve(s).
Buoyant Ascent:	An ascent where equipment is removed (e.g., weight belt) or altered (e.g., buoyancy compensator) to effect a positive and rapid rise to the surface.
Certified Diver:	A diver who has completed training resulting in a certificate of proficiency from a recognized training organization.
Compressor:	A machine which compresses air to an elevated pressure for filling SCUBA cylinders. The pressure obtained from the compressor is less than 4000 pounds per square inch.

Compressed Gas Association (CGA):	An industry association which provides guidance in the use and care of compressed gas equipment.
Controlled Ascent:	A method of ascent where all the equipment remains in place as the diver rises by swimming. The diver controls his/her equipment to provide the ability to halt the ascent.
Cylinder:	A seamless pressure vessel meeting the U.S. Department of Transportation's standards of a 3AA, 3AL, or equal rating.
D.A.N.:	Divers Alert Network. D.A.N. operates as a 24 hour, 7 days a week emergency consultation service for diving accidents, and as a clearinghouse for information on diving accidents and diving accident treatment.
Decompression Sickness (DCS):	A diving disorder caused by inert gas (e.g., nitrogen gas) obstructions to blood circulation. The symptoms vary but the response is a result of blood flow blockage. Treatment of DCS requires a hyperbaric chamber. DCS is also called bends by diving text books.
Decompression Tables:	A listing of times and depth indicating the body's nitrogen loading.
Dive:	An in-water descent followed by an ascent while using SCUBA.
Dive Location:	A shore base, vessel, structure, or physical location from which a dive is to be conducted.
Dive Teams:	Divers and immediate support staff who control diving operations, including the designated person in charge.
Diver:	An individual in the water who is equipped with an apparatus that supplies air at ambient pressure.
Diver Recall Device:	A sound making device of sufficient amplitude to be heard by the divers.
Diving Officer (D.O.):	The individual who supervises all safety aspects of the MSL diving program.
Diving Operation:	A diving activity or a set of diving activities performed as part of a job or project.
Diving Supervisor (D.S.):	The individual who has been assigned by the D.O. to supervise all safety aspects of a particular diving operation.
Emergency Ascent:	An ascent made by a diver when low on air, nearly out of air, or under excessive stress.

Event Discovery and Response:	Battelle Pacific Northwest Laboratories subject area entitled Event Discovery and Response
Free Ascent:	An ascent in which the diver sheds his/her equipment and uses breath control to provide buoyancy as he rises to the surface. The term free ascent is often confused with a swimming ascent. A free ascent is considerably more dangerous than other SCUBA ascents.
Hyperbaric Chamber:	A pressure vessel for human occupancy used to decompress divers or to treat decompression sickness or other hyperbaric disorders. Hyperbaric chambers are most often hospital-based and staffed with trained medical support personnel.
Hyperbaric Exposure:	Operating under pressure conditions in excess of normal atmospheric pressure (1 atmosphere). Every subsurface dive entails hyperbaric exposure.
Hydrostatic Test:	A pressure test to 5/3 the working pressure of SCUBA cylinders (type 3AA or 3AL) per Department of Transportation regulations. This test is required at least every five years by the scientific and recreational diving community. The test is often referred to as a hydro in diving texts.
Lead Diver (L.D.):	The individual who has been designated by the D.O. or D.S. to be in charge of a particular diving activity at a particular dive location.
Live-boating:	The practice of tracking the divers flag or bubbles by supporting divers from a vessel that is underway.
Mixed gas diving	Mixed gas diving is the use of gas mixtures other than compressed air. In this manual, mixed gas diving refers only to enriched air nitrox (nitrox). Normal air is about 21% oxygen and 79% nitrogen. Nitrox air mixtures have higher levels of oxygen (32% or 36% oxygen) and lower levels of nitrogen. To produce nitrox mixtures, oxygen is blended in with compressed air as the tank is filled.
No-Decompression Limits:	Time and depth limits that permit the diver to ascend directly to the surface at the end of the dive. These limits shall not exceed the current U.S. Navy no-decompression Limits but can be more conservative depending on the project.
Normal Ascent:	An ascent made with an adequate air supply at a rate not exceeding 1 foot per second (some more conservative dive tables have a slower ascent rate.)
Off-normal event:	An unplanned or unexpected event, or the discovery of a deficiency in a procedure, plan, or system. The event must have real or potentially undesirable effects on personnel, equipment, facilities, or programs. Effects can include damage, loss, failure, or delays that can have undesirable results.
Pressure-Related Injury:	Any injury resulting from hyperbaric exposure, examples include air embolism,

	mediastinal emphysema, subcutaneous emphysema, pneumothorax, or decompression sickness.
Psi (g):	Pressure in pounds per square inch (gauge).
PSI:	Professional SCUBA Inspectors.
SBMS	Standards Based Management System. The SBMS provides PNNL staff with Laboratory-wide standards, procedures, and guidelines that are current, accurate, and relevant to the work they perform.
Scientific Diving:	All diving performed by individuals necessary to and part of a scientific, research, or educational activity and in conjunction with a project or study for the advancement of science under the jurisdiction of any public or private research or educational institution or similarly recognized organization, department, or group. Scientific diving does not include performing any tasks usually associated with commercial diving such as: placing or removing heavy objects underwater, construction, demolition, cutting, or welding that are not associated with a scientific project.
SCUBA Diving:	A diving procedure (surface independent) where the diver uses open-circuit, self-contained underwater breathing apparatus.
Snorkeling:	A water surface-oriented procedure where a person breathes air at the water surface without mechanical assistance or specialized equipment other than a snorkel.
Swimming Ascent:	An ascent that can be made under normal or emergency conditions by simply swimming to the surface.
Timekeeping device:	A watch, electronic device, or dive computer that displays elapsed time underwater.
Visual Cylinder Inspection (VCI):	A visual inspection to determine whether a cylinder meets the standards of Professional SCUBA Inspectors, including an 18-step procedure and written summary of findings. NOT USED IN DOCUMENT

3.0 RESPONSIBLE STAFF

3.1 ADMINISTRATION

3.1.1 As directed in ~~PNNL-MA-43~~ [the SBMS Subject Area for Underwater Diving](#), the MSL Laboratory Manager* shall:

Have overall responsibility and oversight of MSL diving program

Appoint a MSL Diving Officer (D.O.) for the MSL diving program

Provide all required diving equipment, safety equipment, and equipment maintenance

Request an annual diving physical for MSL staff members who are certified divers

Provide MSL divers with a copy of the physician's written report

In addition, as established in this SOP, the MSL Laboratory Manager shall:

Assure SOP compliance by inspection and review

Provide mandatory training for all MSL divers

Supervise the revision of the Safe Diving Practices SOP every three years

Review advice provided by a safety representative from PNNL and MSL Quality Assurance Representative

* The MSL Laboratory Manager may designate another person to act in his/her capacity during his/her temporary absence. All reference herein to MSL Laboratory Manager shall include his/her authorized representative.

3.2 DIVING RISK MANAGEMENT BOARD MEMBERSHIP, DUTIES, RESPONSIBILITIES, AND AUTHORITY

This board provides guidance to the MSL Laboratory Manager and D.O.

3.2.1 Membership

The Diving Risk Management Board will be comprised of four members. The Board chairman will be the MSL Laboratory Manager or his/her appointee. One member shall be representative from the upper management team or their designee. One member shall be a safety representative. The fourth member shall be the D.O. from MSL. Board members will serve two year terms with automatic reappointment. Resignation from the board is tendered by letter or verbal communication to the ~~MSL Laboratory Manager~~ [representative from the upper management team](#). The board may bring in outside experts to provide advice on technical aspects of diving safety or diving operations.

3.2.2 Duties

Because of the potential health hazards that accompany diving, and in support of Federal regulations and U.S. Department of Energy (DOE) orders, the Diving Risk Management Board shall perform the following duties:

Review past and proposed diving projects for lessons learned

Monitor ongoing and proposed diving projects

[Annually review the qualifications of the D.O. for recertification.](#)

Review and approve the SOP annually

Ensure SOP compliance by review of Diving Safety Board minutes and MSL Laboratory Safety and MSL Quality Assurance reports or summaries.

3.2.3 Responsibilities

At a minimum, the Diving Risk Management Board will hold annual meetings, scheduled at twelve month intervals.

Minutes of the meeting will be taken by the D.O.

3.2.4 Authority

Any member who has the concurrence of one additional member may call a meeting of the Diving Risk Management Board with a request to ~~the MSL Laboratory the representative from the upper management team~~ and his/her written endorsement. The Diving Risk Management Board shall have the authority to monitor and/or stop diving projects.

3.3 **DIVING SAFETY BOARD MEMBERSHIP, DUTIES, RESPONSIBILITIES, AND AUTHORITY**

3.3.1 Membership

The MSL Diving Safety Board will be comprised of ~~up to five members~~ [the following members](#). A majority of the Board members will be active MSL divers per WAC 296-37-510 (2) (ii). The Board chairman will be the D.O. One member shall be the MSL Laboratory Manager or his/her appointee. One member shall be a safety representative from PNNL. Additional members shall be active MSL divers. Board members will serve two-year terms with automatic annual reappointment. Resignation from the board is tendered by letter or verbal communication to the MSL Laboratory Manager. The board may bring in outside experts to provide advice on technical aspects of diving safety or diving operations.

3.3.2 Duties

Because of the potential hazards to health that accompany diving, and in support of Federal regulations, the Diving Safety Board shall perform the following duties:

Annually review (if necessary revise) the written knowledge evaluation for MSL diver certification

~~Annually Review~~ review and report on accidents/incidents

~~Annually review qualifications of D.O. for recertification~~ MOVE TO DIVE RISK MANAGEMENT BOARD

Review past and proposed diving projects

Monitor ongoing diving projects

Approve the SOP annually, and revise the SOP every three years

Assure SOP compliance through audits and monitoring

Serve as an Appeals Board; the appeals process is outlined in section 4.6.14

Advise the MSL Laboratory Manager with respect to programs, equipment, and facilities, which are necessary to maintain and advance diving safety.

3.3.3 Responsibilities

At minimum, the Diving Safety Board will hold semi-annual meetings, scheduled at six month intervals.

Minutes of the meeting will be taken by the D.O.

3.3.4 Authority

Any member who has the concurrence of one additional member may call a meeting of the Diving Safety Board with a request to the MSL Laboratory Manager and his/her written endorsement. The Board shall have the authority to monitor and/or stop diving projects.

3.4 DIVING OFFICER QUALIFICATIONS, DUTIES, RESPONSIBILITIES, AND AUTHORITY

3.4.1 Qualifications

The D.O. shall hold a valid SCUBA certification issued by a recognized agency (see Section 8.2.1). The position of D.O. is administrative in nature. The D.O. shall be an individual whose management, technical, and diving experience will enable him/her to effectively supervise all safety aspects of MSL's diving program. The individual will be reviewed initially and meet with the Diving [Safety-Risk Management](#) Board for performance review and to schedule recertification, professional development, and other training.

3.4.2 Duties

The D.O. shall formally establish a line of responsibility for the safety of each diving operation conducted under the auspices of MSL whether job, task, or training related. The line of responsibility shall be established in writing. The safety aspects of each diving operation will be supervised on site by a Diving Supervisor (D.S.)* designated by the D.O. If diving operations are to be conducted at more than one site, the D.S. shall designate a Lead Diver(s) (L.D.)* to be responsible for diving safety at each dive site (see Figure 1: Safety Chain of Command; Figure 2: Policy Chain of Command). Individuals selected to act as L.D. shall be approved by the D.O.

The D.O. shall promote diving safety at the MSL by conducting training sessions and practice drills.

* The individuals appointed D.S. and L.D. (as these positions are described and referred to in this SOP) are responsible for the safety aspects of the diving operations in which they are engaged. These individuals may or may not also be responsible for other aspects of the diving operation such as technical or scientific planning, direction, reporting, or management.

3.4.3 Responsibilities

The D.O.** shall be responsible for the administration of the safety aspects of MSL's diving activities. His/her responsibilities shall include:

Maintaining and implementing this Safe Diving Practices SOP, which shall include a copy of WAC 296-37 Safety Standards for Commercial Diving Operations (see Appendix B).

Arranging for independent review of the Safe Diving Practices SOP and training.

Coordinating safety aspects of all diving-related activities with the safety representative from PNNL.

Administering the MSL diver certification process.

Providing or arranging diver training per the SOP (See Section 8.0), including training on the SOP.

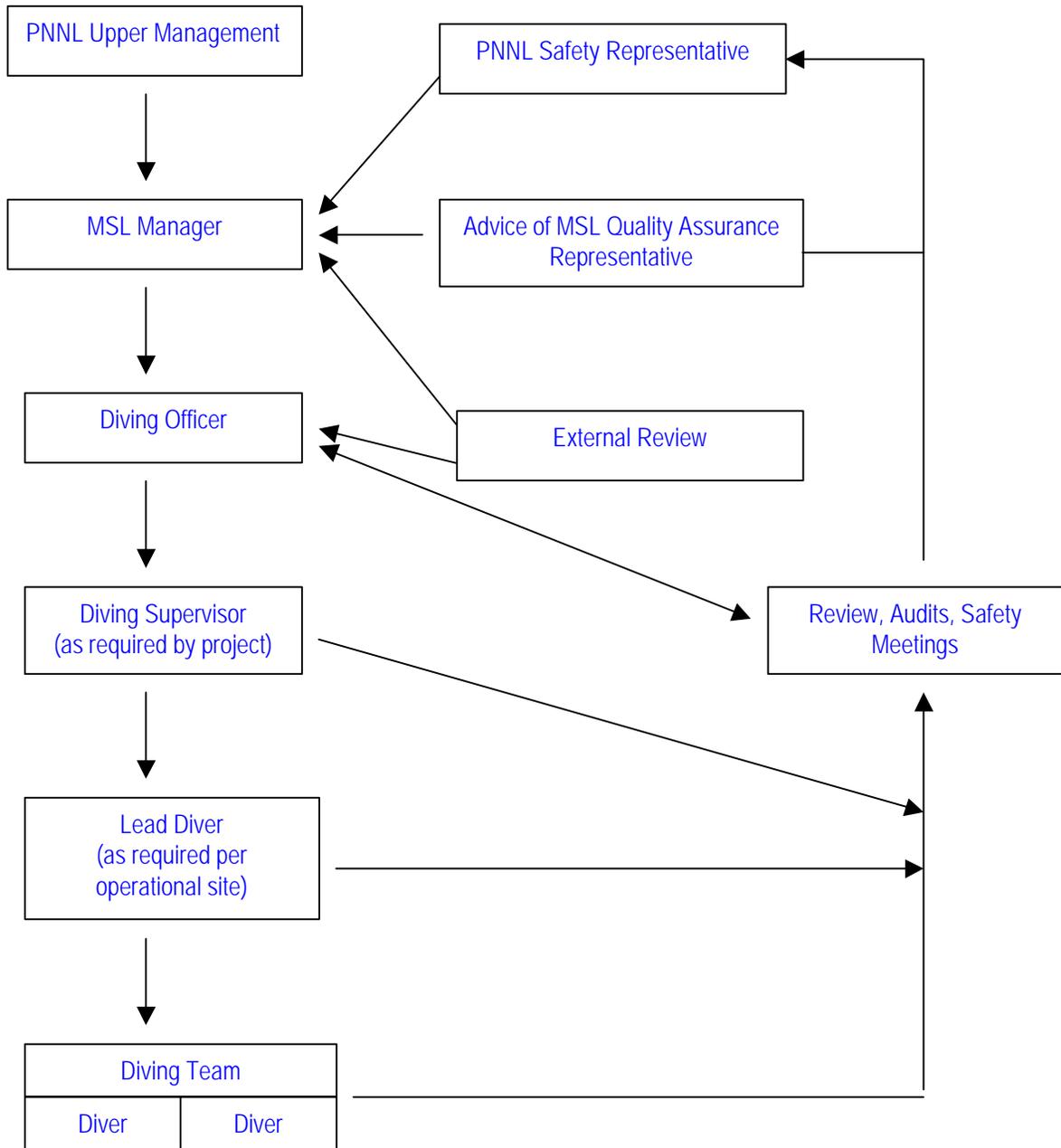


Figure 1. Safety Chain of Command for MSL Diving Operations

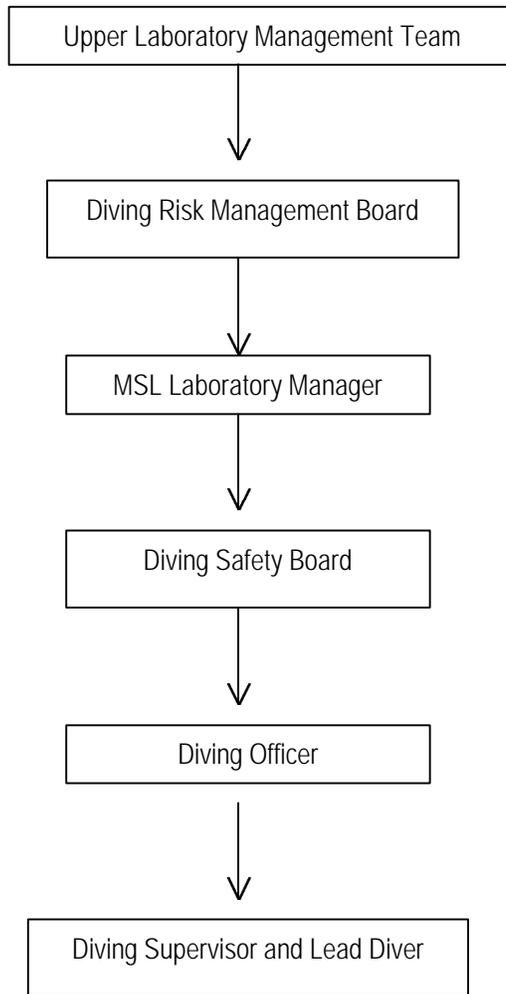


Figure 2. Policy Chain of Command for MSL Diving Operations

Maintaining records for all MSL diving-related matters (see Section 5.2).

Serving on the Diving Risk Management Board and chairing the Diving Safety Board.

Disseminating information to divers on MSL diving procedures, equipment, safety, and training.

Providing copies of this SOP to all MSL divers.

Specifying equipment and approving purchases, repairs, or services.

** The D.O. may designate another person to act in his/her capacity during his/her temporary absence or in the case of foreign and/or remote operations. All reference herein to D.O. shall include his/her authorized representative.

3.4.4 Authority

THE D.O. SHALL HAVE THE AUTHORITY TO CHANGE OR TERMINATE ANY DIVING OPERATION OR ACTIVITY TO ENSURE THE DIVERS SAFETY. THE AUTHORITY TO TERMINATE A DIVING OPERATION SUPERSEDES THAT OF PROJECT AND LINE MANAGEMENT.

3.5 **DIVING SUPERVISOR QUALIFICATIONS, RESPONSIBILITIES, AND AUTHORITY**

The D.S., as a MSL diver, shall hold a valid SCUBA certification issued by a recognized agency (see Section 8.2.1). The D.S. shall be responsible for the safety requirements of all diving personnel and activities of a diving operation. The D.S. also shall be responsible for the safety-related record-keeping requirements that take place as part of a diving operation. For those diving activities that the D.S. cannot directly supervise (e.g., when several dive sites are involved), he shall designate (in writing) a L.D. to be responsible for the safety of each diving activity that he cannot directly supervise.

3.5.1 Qualifications

The D.S. shall be an individual whose management, technical, and diving experience will enable him/her to effectively supervise all safety aspects of the diving operation to which he is assigned. The assignment is made by the D.O. on a project-by-project basis, based on the technical requirements of the project and the individual's qualifications.

3.5.2 Responsibilities

The D.S. shall assume overall responsibility for diving safety and related record keeping activities on the job or task. His/her responsibilities shall include:

Ensuring that the planning and execution of all diving operations are conducted safely.

Assessing the diving work scope and tasks to be performed in the context of anticipated diving safety considerations.

Ensuring that the dive plan is approved by the D.O. and the MSL Laboratory Manager before diving activity is started.

Providing assistance to project management in the assignment of divers to ensure that their experience is commensurate with the diving assignment.

Designating a L.D. for each independent activity as necessary.

Ensuring that the required diving equipment and facilities are present at the dive site and are in good working condition (see Sections 4.1 and 4.4).

Ensuring that all divers and diving support personnel are familiar with the Daily Dive Plan, that each individual is cognizant of his/her assigned task, that the plan is observed, and that all personnel are alerted to and understand any change of the plan during the course of the operation (see Section 4.5.3).

Ensuring that the required diving procedures are adhered to before, during, and after each dive (see Sections 4.6.7 through 4.6.9).

Ensuring that preplanned emergency procedures are followed in the event of a diving-related incident, accident, injury, or casualty (see Section 4.6.10 and Appendix F), and that the MSL Laboratory Manager and D.O. are notified of the situation as soon as possible, (see Section 4.6.11), and preparing a follow-up report.

Submitting a Diving Operations Report to the D.O. after each diving operation. See Appendix C for a Diving Operations Report template.

3.5.3 Authority

THE D.S. OF THE DIVING OPERATION SHALL HAVE THE AUTHORITY TO CHANGE OR TERMINATE THE DIVING OPERATION OR ACTIVITY TO ENSURE THE DIVERS SAFETY. THE AUTHORITY FOR TERMINATING THE DIVING ACTIVITY SUPERSEDES THAT OF PROJECT AND LINE MANAGEMENT.

3.6 LEAD DIVER QUALIFICATIONS, RESPONSIBILITIES, AND AUTHORITY

3.6.1 Qualifications

The L.D., as a MSL diver, shall hold a valid SCUBA certification issued by a recognized agency (see Section 8.2.1). The L.D. shall be an individual whose technical and diving experience will enable him/her to effectively supervise all safety aspects of the diving site to which he is assigned. The L.D. is appointed by the D.S. as required, based on the individual's qualifications and project's geographical and technical requirements.

3.6.2 Responsibilities

The L.D. shall be responsible for the diving operations assigned to him/her by the D.S. His/her responsibilities shall otherwise be the same as those of the D.S. (Section 3.5) with the following exceptions:

Prepare and submit a written dive work plan for his/her diving operation to the D.S. for review and coordination prior to the beginning of each diving operation.

Coordinate with the D.S. any changes to be made in the Daily Dive Plan.

Immediately notify the D.S. and D.O. of any deviation from the proposed plan, and the D.S., D.O., and MSL Laboratory Manager of any diving-related incident, accident, injury, casualty.

3.6.3 Authority

THE L.D. OF THE DIVING OPERATION SHALL HAVE THE AUTHORITY TO CHANGE OR TERMINATE THE DIVING ACTIVITY AT THAT SITE TO ENSURE EVERY DIVER'S SAFETY. THE AUTHORITY FOR TERMINATING THE DIVING ACTIVITY SUPERSEDES THAT OF PROJECT AND LINE MANAGEMENT.

4.0 PROCEDURES

4.1 SCUBA EQUIPMENT

4.1.1 General

This section specifies requirements for the types, use, and maintenance of diving equipment. A wide variety of diving equipment is available throughout the world by an equally varied number of manufacturers. While this section sets forth minimum requirements for the type of equipment that must be used, it is not the intent of this section to limit, restrict, or specify the use of a particular manufacturer or diving equipment supplier. All equipment should fit comfortably and be sized for each individual diver. In general, it is expected that the individual diver who uses or controls items of diving equipment shall be responsible for maintaining this equipment in a safe and serviceable condition to the manufacturer's specifications. Equipment provided by MSL will be inspected, tested, maintained, and repaired by the responsible divers, under the D.O.'s direction. [Equipment maintenance](#) records (see Appendix D) will be available to the D.O. upon request.

Only equipment specifically designed for diving shall be [used](#). [Diving equipment must be approved](#) ~~or disapproved~~ by the D.O. prior to its first use.

Only MSL provided equipment for air supply and positive buoyancy compensation will be used during MSL training and diving projects.

Diving equipment shall be tested and repaired according to the manufacturer's recommended procedures and specifications, and as required in this SOP. If equipment is subjected to extreme use under adverse conditions, it requires more frequent testing and service.

The equipment used during SCUBA activities falls into two groups: required and recommended. The required equipment is mandatory for any diving which takes place. Based on the site conditions and the tasks to be completed, the recommended equipment is used as needed by the individual divers for each dive. All equipment will be owned by the MSL with the exception of the following (at the diver's preference/option), wet/dry suit, mask, fins, weight belt, dive timer, and knife.

4.1.2 Required SCUBA Equipment

All diving equipment must properly fit the individual. Required equipment is the minimum necessary to conduct safe routine diving operations. Each diver using SCUBA gear must have the following equipment:

Face mask

Swim fins

Exposure suit suitable for diving conditions

Buoyancy compensator (BC)

[Ballast or weight system](#) (see Sec. 4.2.5)

SCUBA regulator with first and second stages outfitted with a submersible pressure gauge readable by the diver during the dive

SCUBA cylinder as the primary breathing air supply

SCUBA cylinder harness, buoyancy compensator mount, or backpack with a harness that provides secure attachment to the SCUBA cylinder

Diving timepiece

Depth gauge

4.1.3 Recommended SCUBA Equipment

Recommended SCUBA equipment includes:

Snorkel

Sharp knife or shears

Low pressure inflator for the buoyancy compensator

An alternate air source (octopus) for the diving regulator

Whistle and light stick

Compass.

4.1.4 Other SCUBA Equipment

The addition of other diving equipment and scientific equipment should be weighted against the ability of the diver to complete the assignment. It may be simpler to complete a second dive than to carry additional equipment on one dive.

The additional diving or scientific equipment should not prevent the use of the basic safety equipment.

4.2 SCUBA EQUIPMENT SPECIFICATIONS

4.2.1 Face Mask

A face mask provides an air space between the eyes and the lens to allow clear vision underwater.

A mask must:

- have a tempered glass lens
- have a properly sealing and comfortably fitting skirt
- provide sealing access to the nostrils to allow ear equalization
- be held in place by a wide comfortable strap.

The mask must not leak because of holes or poor sealing to the diver's face.

Transparent skirt material, purge valves, and other accessories are optional.

Masks containing a prescription lens may be required for divers needing vision correction.

4.2.2 Swim Fins

Swim fins provide a wide surface area for greater propulsion with the legs.

A pair of fins must:

- fit the diver's feet when covered by the exposure suit
- be sized to the diver and his/her propulsion needs
- be secured snugly to each foot by a heel strap or other suitable means.

4.2.3 Exposure Suit

Exposure suits provide warmth and protection and allow safer working conditions for the diver. The exposure suit must be appropriate for the environment and the work, and:

allow the diver to move and swim comfortably

provide protection from cold before, during, and after the dive(s) to ensure that safe operations can be conducted

provide appropriate level of protection for the diver's activity. A more active or shorter duration dive may require less protection than longer dives or dives requiring less physical activity

exposure suits most often cover all but the diver's face and typically include the following:

- jacket
- pants
- hood
- boots
- gloves.

Some suits combine most of the above parts into one exposure system, or into fewer pieces.

The degree of thermal protection provided by the exposure suit is very much a personal decision. As the complexity of the suit increases, so does the need for training.

4.2.4 Buoyancy Compensators

A BC must:

- maintain the diver at the surface in a head-up position
- have an oral inflation device
- have an over-pressure relief device
- have a manually operated exhaust valve
- have corrosion resistant fasteners
- be removable with either hand.

A dry suit or other buoyancy-changing equipment shall be equipped with an inlet and an automatic, variable pressure exhaust valve(s).

A BC must be tested quarterly to verify that it can contain air above ambient pressure for 4 hours. The tests are documented on the Diving Equipment Service Form (Appendix D).

4.2.5 Ballast System, Weights and Harnesses

All SCUBA cylinder harnesses and weight belts must be equipped with a quick release corrosion-resistant buckle that can be removed with either hand. [All ballast systems \(e.g., integrated weight in BC\) shall allow for quick release and jettison of ballast/lead via a readily accessible mechanism.](#)

All harnesses, weight belts or assemblies, and straps used to attach equipment to the diver must be inspected and repaired or replaced, if necessary, prior to any diving operation. They must be adjusted to fit the individual diver.

All weight belts must fit with a minimum of excess material (e.g., 6 in. maximum) exposed beyond the buckle mechanism, and must have enough weight that the diver is neutrally buoyant at the surface at the end of the dive.

4.2.6 SCUBA Regulators

SCUBA diving regulators provide air from the cylinder to the diver at ambient pressure. They often are arranged with other hoses to provide air to the BC or a dry suit as well a pressure gauge to allow monitoring of cylinder air pressure during the dive. Each regulator must:

Be assembled, configured, and maintained in accordance with the manufacturer's specifications.

Be visually inspected for wear, corrosion, and proper function prior to and after each dive. Serviced by a qualified regulator repairman at least every 12 months or per manufacturer's specifications. The inspections or service are documented on the Diving Equipment Service Form (Appendix D).

Be removed from service if the regulator functions improperly, has worn hoses or other rubber parts, or has been contaminated from any source (i.e., fresh water, salt water, or hydrocarbons entering through the first or second stages). The regulator shall be cleaned of contaminants, repaired, inspected, and tested for proper function by a qualified regulator repairman prior to return to service.

Have a submersible pressure gauge that functions within the manufacturer's specifications.

4.2.7 Compressed Air SCUBA Cylinders

Each compressed air SCUBA cylinder must:

Bear a design specification of DOT 3AA, DOT 3AL, DOT Exxxx, or equivalent in accordance with the standards of the U.S. Department of Transportation

Bear a valid hydrostatic test date in accordance with the U.S. Department of Transportation regulations. The successful hydrostatic test is stamped into the shoulder of the cylinder.

Be visually inspected annually in accordance with the requirements of PSI or the equivalent. The inspections are documented on the Diving Equipment Service Form (Appendix D). A sticker is applied to the cylinder for ready reference of the inspection.

Be removed from service and turned over to a qualified air cylinder repairman if the cylinder has been contaminated from any source (i.e., salt water or hydrocarbons entering through an open valve). The cylinder and valve must be cleaned, inspected, and hydrostatically tested (when corrosion is found) prior to being placed back into service.

Be stored in a ventilated area per CGA standards for SCUBA cylinders.

Be secured from falling.

Be protected from excessive heat.

Be stored with 200 psi minimum pressure.

4.2.8 Depth Gauges and Timekeeping Devices

Divers are required to monitor their depth and dive duration. Each diver shall ensure that depth gauges and timekeeping devices are inspected and calibrated as follows:

Each depth gauge shall be ~~dead-weight tested, calibrated against a master reference gauge, calibrated with a measured tape, or cross-calibrated with another MSL diver's depth gauge every 12 months.~~ The inspections are documented on the Diving Equipment Service Form (Appendix D).

A depth gauge shall be ~~recalibrated or replaced tested~~ when a discrepancy exists in a depth gauge reading greater than two percent (2%) of full scale between any two gauges of similar range and calibration, as required by WAC 296-37-570 (7)(b).

Each timekeeping device shall be ~~calibrated to an alternate digital timekeeping device or replaced tested~~ every 12 months. The inspections are documented on the Diving Equipment Service Form (Appendix D).

A timekeeping device shall be ~~recalibrated or replaced tested~~ when a discrepancy exists in a timekeeping device reading of 2 min in a 4-h period between any two time keeping devices.

Each depth gauge and timekeeping device shall be inspected before diving operations begin, and then tested or calibrated before use if found out of tolerance.

4.2.9 Dive Knife or Shears

A knife or shears provides the diver with a means to cut fishing line, rope, or other entangling material. A ~~knife or shears~~ must:

- have a sharp edge

- have a suitable handle
- be retained in a sheath with a quick release fastener
- be the appropriate size for the expected use (e.g., if the diver is carrying lines of 1/4 in. or larger material, a blade 5 in. long may be required).

A diver may elect to carry more than one knife or shears ~~if their knife is often lost or shared for tasks.~~

4.3 EQUIPMENT SERVICE

Diving equipment rarely fails completely, but it can become out of tolerance because of corrosion and the rigors of diving activity. The Diving Equipment Service Form (Appendix D) provides a tracking mechanism for serviceability, inspections, and care of diving equipment. In addition, this form provides a method for replacing and retiring older equipment, which has exceeded its service life or fails to function to manufacturer's specifications.

4.4 EQUIPMENT AND FACILITIES REQUIRED AT DIVE LOCATIONS

Each dive location must be provided with the following equipment and facilities. [A checklist that can be used for planning of field operations that include diving is included in Appendix E.](#)

First aid and emergency equipment:

- A medical kit consisting of basic first aid supplies and any additional supplies necessary to treat minor trauma and illnesses resulting from hyperbaric exposure (see Appendix E).
- A copy of an American Red Cross Standard First Aid Handbook and Divers Alert Network (D.A.N.) Emergency Handbook.
- An oxygen cylinder (containing sufficient volume to provide 15 L/min flow during transportation to advanced aid), regulator, and transparent mask with tubing.

A diving ladder when the dive boat's freeboard is more than 18 inches.

A means by which a distressed diver can be safely and effectively removed from the water.

Diver's flag:

- For boat diving, the international dive flag "A" and/or a U.S. diver's flag shall be flown in a manner that allows all-round visibility and is consistent with Inland/ International Navigation Rules.
- [For shore diving, a standard U.S. diver's flag shall be flown in a manner that allows all-round visibility in the water in the vicinity of dive activity. The diver's flag can be towed by each dive team or anchored in a central spot if dive activity occurs over a limited area.](#)

A diver recall device effective for the anticipated conditions.

~~A cellular phone and/or VHF radio is required equipment on MSL boats, including during dive operations.~~

4.5 DIVE PLANNING

4.5.1 Diving Operation Planning

A written Diving Operations Plan shall be prepared by the D.S. for each diving operation that includes more than one dive. The Diving Operations Plan shall specifically address every diving and diving-support activity scheduled during the operation. A single-dive event requires only a daily dive plan (Section 4.5.3). The Diving Operations Plan will necessarily vary with the magnitude of the project, but dives should always be planned around the competency of the least experienced diver.

The Diving Operations Plan shall include:

Task Assignment

The scope of work for the diving operation, including a breakdown of the tasks and smaller work units that can be readily assigned to each dive team.

A diving assignment for each dive team to include:

- The tasks to be accomplished at each dive location and during each dive.
- The planned number of dives and dive depths. Bottom times and surface intervals are required.
- Equipment and facilities to be used.
- Anticipated diving conditions:
 - Distance from shore
 - Maximum depth
 - Maximum actual dive time (ADT).

The names of all L.D.s, divers, dive tenders, and other key persons involved in diving operation support, and the diving operation organization to include:

- Assignment of divers to teams that will operate under the direction of the D.S. or L.D.(s).
- Assignment of dive support personnel to each diving activity.
- Assignment of dive vessels to each diving activity.

The dive vessel operation during the diving activity and its crew or personnel involvement with the diving activity.

Safety

A description of any unusual hazards or environmental considerations that may affect the safety and performance of the diving operation and planned measures to minimize risks.

A description of the dive site location (latitude and longitude if known) available to those who might summon aid or assistance.

The location and means of access to communications equipment (telephone, VHF marine radio, or cellular telephone) with sources of emergency aid or assistance to include:

- On-site first aid treatment supplies, equipment, and instruction.
- The nearest operational hyperbaric chamber.
- The nearest hospital.
- The nearest available physician.
- The nearest U.S. Coast Guard Rescue/Coordination Center or its equivalent in foreign locations.
- Available means of rapid transportation to a source of emergency aid or assistance (see Appendix F).

Designation of a boat and crew for diver pickup if necessary.

Plan Review

The Dive Plan prepared by the D.S. or L.D. will be reviewed and approved by the D.O. and MSL Laboratory Manager.

4.5.2 Diver Assignments and Limitations

MSL PERSONNEL ASSIGNED AS DIVERS ON MSL PROJECTS MUST EACH HOLD A CURRENT, VALID MSL DIVING CERTIFICATE (see Section 8.2 and Appendix G).

Upon accepting a diving assignment, a diver shall ensure that his/her MSL certification to dive will not be invalidated during the assignment because of lapse of medical examination, CPR, or standard first aid certificates.

NO DIVER UNDER THE AUSPICES OF MSL MAY ENGAGE IN DIVES THAT REQUIRE PLANNED DECOMPRESSION. All diving activities shall be planned and conducted within no decompression limits of the U.S. Navy dive tables or more conservative "no decompression" limits as required by WAC 296-37-550 (2)(b).

~~IN NO CASE WILL DIVES BE AUTHORIZED TO DEPTHS EXCEEDING 100 FT.~~

4.5.3 Daily Dive Plan

A written Daily Dive Plan shall be prepared for each dive by the D.S. or L.D. for diving activities to be conducted under his/her supervision within the scope of the Diving Operations Plan. The Daily Dive Plan will, by necessity, vary with the amount of work to be completed. Dives should always be planned around the competency of the least experienced diver and field conditions.

The Daily Dive Plan shall include the following for each dive location:

- [Location, expected start and stop time for field activity, and return time](#)
Dive team assignments.

- Entry and exit procedures.
- Surface and underwater conditions and hazards.
- Scientific diving equipment.
- Thermal protection for above water and underwater.
- Air supply limits (including 300 psi mandatory surfacing pressure).
- Residual inert gas status of dive team members (repetitive dive status).
- No-decompression/repetitive dive profile.
- Signals between divers and between divers and support personnel.
- Coordination with other operations in the vicinity.
- An emergency plan summary.

4.6 SCUBA DIVING PROCEDURES

Diving shall be by dive team pairs unless the assigned task requires the use of another team member. Dive team members shall maintain a proper buddy system of visual or physical contact and communication so as to be capable of rendering immediate assistance to each other throughout the diving operation.

The L.D. shall monitor the dive duration and all other safety aspects of the diving operation.

A first-aid kit, appropriate emergency information, and diving tables shall be at the dive location. Communications equipment shall be at the dive location or nearby to summon emergency assistance. [A cellular phone and/or VHF radio should be available to facilitate initiation of emergency response and must be available if a public telephone is not readily available or diving is staged from a support vessel.](#)

The dive shall be terminated when a safety concern exists, any member of the diving operation requests termination, or any of the conditions outlined in Section 4.6.8 exist.

A dive flag shall be prominently displayed as required (see Section 4.4).

Support personnel are required for:

- Dives in current areas where there is a chance for the divers or the dive boat to be swept away from the dive location.
- Dives after sunset [and before sunrise.](#)

4.6.1 Solo Diving Prohibition

[Solo diving is prohibited.](#) All diving conducted under the auspices of MSL shall be planned and executed to ensure that every diver involved maintains constant, effective communication with at least one other comparably equipped certified scientific diver in the water. If the MSL diver will be diving with divers from another institution as their buddy, the chairperson of the Diving Risk Management Board must approve the activity. This buddy system is based upon mutual assistance, especially in the case of an emergency. If loss of effective communication occurs within a buddy team, all divers shall surface and re-establish contact.

4.6.2 Depth Limits

The MSL Diving Certificate will authorize the holder to conduct no-decompression diving within the limits of U.S. Navy dive tables.

4.6.3 Time Limits

All diving shall be conducted within the U.S. Navy no-decompression time limits. Use of more conservative limits and procedures than the U.S. Navy is recommended.

Dives requiring planned decompression stops are not allowed.

4.6.4 Ascent Limits

Ascent rates

- The proper technique is to use a depth gauge and dive timer for all ascents. The recommended ascent rate is 30 to 60 ft/min.
- The correct ascent rate is dictated by the dive tables used.
- Rates of ascent faster than 60 ft/min (or that specified by the diving table) should not be used. If the ascent rate exceeds 60 ft/min, it is required that the diver slow before reaching the 15 ft safety stop and allow the ascent time to catch up with him/her before continuing to the surface.

Ascent Precautionary Safety Stop

- Divers must make a 3 min safety stop at 15 ft before the end of each dive to help reduce the tissue gas load and prevent bubble formation, unless safety concerns dictate an immediate return to the surface or shore.

4.6.5 Environmental Limits

Diving in hazardous environments (e.g., cave diving, ice diving, wreck diving) will not be allowed under this SOP.

4.6.6 Equipment Limits

Use of surface supplied air, re-breathers, or other equipment more technical than the basic SCUBA apparatus with compressed air or mixed gas will not be allowed.

4.6.7 Pre-dive Procedures

Before commencing any diving activity, the D.S. or the L.D. shall ensure that the following actions are taken:

That a copy of the Dive Operations Plan and/or Daily Dive Plan is available to the MSL Laboratory Manager and MSL receptionist.

That a copy of this SOP is available to all dive team members and that they have been trained

to the current revision.

That a written Dive Operations Plan and/or Daily Dive Plan is completed and reviewed, and is available to all dive team members and persons required to support the diving activity.

That copies of the current U.S. Navy Decompression Tables and U.S. Navy Repetitive Dive Tables or other more conservative decompression schedules are available to all dive team members at each dive location.

That the diving operation is coordinated with any other activities in the area that may interfere with the diving operation and that may pose a hazard to the dive team.

That the dive team members are briefed on the Daily Dive Plan including:

- The tasks to be accomplished and work assignments for the members of each dive team.
- The safety procedures to be used during the diving operation.
- Any unusual hazards or environmental conditions that may affect the safety and performance of the diving operation.

That each diver is physically and mentally prepared to undertake his/her diving work assignment.

- A dive team member will not be required to dive ~~against his/her will~~ if they do not believe the dive can be completed safely.
- MSL will not permit a dive team member to dive for the duration of any temporary physical impairment or condition which is known to MSL and is likely to adversely affect that divers safety or health.

That each dive team member will be assigned a timekeeping device and submersible depth gauge or dive computer to log divers in and out of the water, and to maintain a depth-bottom time record of each dive for each diver. In addition, each diver will be responsible for keeping his/her own written depth-bottom time record.

That the operator(s) of the dive vessel or live-boat for diver pickup is briefed of the dive plan to ensure that:

- ~~No unplanned~~ operation of the vessel or live-boat will not endanger the dive team.
- The operation of the vessel or live boat will provide support to the dive team as planned.

That the diving equipment is inspected for completeness and proper working condition, and that the breathing air conforms to the specifications set forth in Section 7.1.

That all divers perform the following pre-dive safety checks:

- Review emergency signals and techniques (diver/diver, diver/surface).
- Review task-specific hand signals.
- Review Daily Dive Plan.
- Review dive tables and no-decompression limits, if appropriate.
- Functional check of both their own and their buddies diving equipment in the presence of the diving buddy. When the D.S. is present at the site, he will perform a final basic inspection prior to divers entering the water.

4.6.8 During Dive Procedures

Each diver shall understand and conform to the planned depth-bottom time profile.

The D.S. and L.D. shall ensure to the extent possible that all persons involved in the diving operation follow the Daily Dive Plan as written.

During the diving operation, the D.S. or L.D., dive team members, and support personnel shall each review the depth-bottom time records and use the current U.S. Navy Decompression Tables and U.S. Navy Repetitive Dive Tables (or more conservative tables) to ensure that the diving can be accomplished within no-decompression limits.

The D.S., L.D., or a dive team member shall terminate a dive or diving operation at his/her discretion, when a safety concern exists, or when:

- A diver requests termination.
- A diver fails to respond to communications or signals from a dive team member.
- Visual communication is lost between members of a SCUBA diving team.
- The diver would [lose free access](#) to the surface.
- A diver would exceed the no-decompression limits if the dive were continued.
- Adverse environmental conditions at the dive location compromise the safety of the dive team.
- Equipment fails on the dive vessel that compromises the support and dive team safety.
- Any diver's cylinder pressure drops below a level determined prior to the beginning of the dive that will allow the divers sufficient air supply to safely return to the exit point (this level is commonly [500 psi](#)). This pressure must allow for the required 3 min precautionary safety stop.

4.6.9 Post-Dive Procedures

After the completion of the diving operation, the dive team leader (D.S. or L.D.) shall:

- Check that each diver completes the standard Dive Log Form (Appendix H).
- Check that the depth-bottom time record for each diver is complete.
- Review each diver's depth-bottom time record and dive logs to ensure that U.S. Navy no-decompression limits have not been exceeded during the last dive or as a result of repetitive dives.
- Check the physical condition of each diver and inquire about any adverse physical problems, symptoms of decompression sickness, or equipment malfunctions.
- Instruct divers to be in the company of another diver for at least 3 h after the dive, if appropriate (depending on circumstances and the closeness to the no-decompression limits). Also, remind the diver of the location of the closest medical care and hyperbaric chamber ready for use.
- Instruct divers to remain awake for at least 1 h after a dive in a location where they may be observed and questioned.
- Alert divers to the hazards of flying after diving and [prevent/prohibit](#) divers from flying for a period of 24 h following the end of the last dive.
- Note any safety problem and pass that information up the safety chain of command.

- Submit a Diving Operations Report to the D.O. (Appendix C).

4.6.10 Diving Emergency Procedures

If a diver exhibits any symptoms of barotrauma, requires rescue, or requires first aid, the D.S., L.D., or most capable diver shall implement the following emergency procedures*:

Locate and rescue the victim.

Initiate first aid as covered in required first aid training.

Activate the emergency medical system (EMS) by calling **9-1-1** or by calling the U.S. Coast Guard Rescue Coordination Center on VHF CH 16.

Arrange for rapid transport of the injured diver to an emergency room (one with a hyperbaric chamber is preferred).

Ensure that all medical personnel understand that the victim was diving and the dive profile for the activity.

Notify the D.O. and the MSL Laboratory Manager immediately as specified by the off-normal event reporting system.

[Do not break down the diving gear, especially the air supply system, until after the D.O. or other investigating officials have inspected it.](#)

- * More detailed emergency procedures are outlined in Appendix F.

4.6.11 Diving Incident / Accident Reporting

[Any diving incident or accident, whether or not resulting in injury or casualty, shall be reported immediately to the D.O. and the MSL Laboratory Manager. Illnesses that may have been caused or exacerbated by work activities must also be reported to the MSL Laboratory Manager. Boat accidents are also reported to the MSL Laboratory Manager and state agencies, as specified in the Boat Operations subject area. It is also the responsibility of the MSL Laboratory Manager notify the single point contact at PNNL \(509-375-2400\) who will activate the Event Discovery and Response system.](#)

4.6.12 Variance Procedures

[Guidance for SOP variances is found in PNNL MA 43-AD 6.0 Variances and the Requesting SBMS Variances subject area.](#)—The intent is to revise the SOP on a schedule with the standard PNNL variance procedure to apply to any changes. If this SOP is found lacking, the process of variances will allow it to remain useful until it is reissued.

This SOP has two types of variances that can occur:

- operational variance
- interim variance.

[Both types of variances are designed to maintain or improve the level of safety provided by the SOP.](#)

[To be implemented, variances require](#) agreement in advance by the Diving Safety Board and the Diving Risk Management Board.

An operational variance would apply temporarily for the duration of one project to provide an equivalent level of safety using means different from those listed in the SOP. As discussions occur with the client, alternate methods of completing research diving tasks can be explored. This type of variance can allow a controlled method of improving this SOP over time based on agreement by the Diving Safety Board and Diving Risk Management Board.

An interim variance occurs when an error is found in the SOP and the variance provides a permanently improved level of safety until the SOP can be reissued. A deficiency in the SOP that allowed diving with less than the intended level of safety would be resolved by an interim variance until the next SOP issuance.

The variance is initiated by completion of an internal variance request and approval form (Appendix K). When approvals have been obtained, then the variance takes effect. The variance request is reviewed by the Diving Risk Management Board and the Diving Safety Board, with unanimous agreement required for approval.

4.6.13 Emergency Deviation Procedures

Any deviation from this SOP that is necessitated by an emergency situation shall be reported within 24 hours to the D.O. and MSL Laboratory Manager.

The D.S. shall submit a written report to the Diving Safety Board detailing the nature of the emergency and the extent of the deviation.

The Diving Safety Board will review the deviation event during the next meeting.

4.6.14 Appeals Procedures

The Diving Safety Board shall convene when necessary to hear the following appeals:

Variations and deviations reviews from this SOP

Eligibility of:

- Diving projects
- Proposed revisions to the SOP.

Reinstatement of MSL diving certification (see Section 8.2.3).

4.7 SNORKELING PROCEDURES

The same planning requirements (Sec. 4.5) and the same roles, responsibilities and authorities (Sec. 3.0) apply to snorkeling as to diving activities. Snorkeling is distinct from SCUBA diving in that it does not include the use of an air cylinder and regulator system to provide breathing air. Absence of an air supply system makes snorkeling a water surface-oriented activity. With snorkeling gear, a person can complete only short duration, shallow depth dives below the surface while holding his/her breath. Snorkeling, nevertheless, does involve above-normal risks that are minimized by adherence to standard oversight and safety procedures outlined in this section. While training requirements for snorkeling are less rigorous than those for diving, adequate snorkeling skills and a safe snorkeling environment are a requirement of this SOP.

The D.O. will have responsibility for supervising all snorkeling activity. The D.O. will review the Daily Dive Plan or Diving Operations Plan and discuss with the D.S. or L.D. the snorkeling activity and potential associated safety hazards. Following completion of the snorkeling activity, the D.O. will review the Diving Operations Report.

The D.O. will be responsible for certification of staff for snorkeling activity. A self evaluation form will be completed by each applicant and reviewed by the D.O. for completeness and acceptable responses. In addition, certification for snorkeling will include an in-water skills evaluation during which the staff member completes the following:

- a surface snorkel of 1000 feet using a mask (keeping face in the water) and snorkel for breathing
- complete submergence of head and effective clearing of snorkel without removing equipment from mouth (to be completed twice)
- at surface, remove and replace mask
- free-dive to a depth of 10 feet or greater and retrieve object from bottom, bring to surface, clear snorkel without removal from mouth, repeat
- perform, recognize, and respond to standard surface hand signals.

A diver's flag (standard U.S. diver's flag) is required to be prominently displayed during a snorkeling activity. Solo snorkeling is allowed if a support person must be available at the snorkel site. The support person may be a-outfitted with ~~diving~~ snorkeling gear, and participating as a buddy or partner, or located in a boat within 100 ft of the snorkeler. A public telephone, cellular telephone, and/or VHF radio should be available-at the site. ~~to the boat operator in support of snorkeling activity.~~

4.7.1 Limitations

Snorkeling operations will be limited by the following conditions:

- snorkeling must occur within 100 meters of shore or a support vessel
- snorkeling will not be allowed in hazardous environments such as caves, under ice, high current situations, or areas of high vessel traffic.
- snorkeling will be conducted during daylight hours

4.7.2 Equipment

Equipment requirements for snorkeling may be site and project specific. The basic equipment requirements for snorkeling are related to safety, maintenance of body temperature, underwater visibility, buoyancy, and completion of project activities. The following equipment is required for snorkeling activity:

- a face mask
- swim fins
- exposure suit suitable for environmental conditions
- a buoyancy compensator
- a weight belt/ballast system
- a snorkel
- a whistle.

A weight belt will not be required if an exposure suit is not required for the site. Equipment specifications for snorkeling gear are similar to those outlined for diving gear in Section 4.2.

4.7.3 Preparation Procedures

Before commencing any snorkeling activity, the D.S. or the L.D. shall ensure that the following actions are taken:

- A written Daily Dive Plan and/or Diving Operations Plan is completed, approved by the MSL Laboratory Manager and the D.O., and is available to all persons participating and supporting the snorkeling activity.
- The snorkeling operation is coordinated with any other activities in the area that may interfere with the snorkeling operation and that may pose a hazard.
- All persons associated with the activity review the Daily Dive Plan and/or Dive Operations Plan to discuss task and work assignments, safety procedures, and unusual hazards or environmental conditions that may affect the safety and performance of the operation.

4.7.4 Post-operation Procedures

After completion of the snorkeling operation, the snorkel team leader (D.S. or L.D.) shall:

- submit a Diving Operations Report to the D.O. (Appendix C)
- note any safety problems and pass that information up the Safety Chain of Command (Section 3.4.2)

5.0 RECORDS

5.1 RECORD KEEPING

The D.O. shall maintain a central file of equipment and training records, diver logs, and operation reports conducted under MSL auspices.

The D.S., L.D., and divers shall be responsible for the timely submission of records, logs, and reports to the D.O. as required in this section.

5.2 REQUIRED RECORDS

The D.O. shall retain the following records and documents:

Administrative Records

- A current copy of the MSL Safe Diving Practices SOP.
- Current copies of other Diving and Boating SOPs [applicable to current dive operations](#).
- Minutes of Diving Safety Board meetings.
- Minutes of Diving Risk Management Board meetings.
- Reports from advisors.
- Correspondence from PNNL pertaining to MSL diving operations.

Diving Operations Records

- Diving Operations Plans (see Section 4.5.1)
- Daily Dive Plans (see Section 4.5.3)
- Diving Operations Report forms (Appendix C)
- Diving Equipment Service forms (Appendix D)

The D.O. will maintain records for the following MSL diving equipment, which requires regular documented testing, service, and inspection:

Inspection Records

- Medical kits
- Oxygen kits
- Compressed air cylinders
- SCUBA regulators
- Depth gauges
- Dive timers
- Buoyancy compensators
- Breathing air tests of purchased or supplied compressed air.

Certification Records (for each MSL certified diver)

- Copy(s) of national diver certifications
- MSL Diving Knowledge Exam
- MSL Open water Dive Skills Qualification evaluation
- MSL Diving Certificates (Appendix G)
- Dive Log forms (Appendix H)

- Diving Work History forms (Appendix I)
- Medical Examination Report forms (Appendix J)
- Safety Training Records (Appendix A)
- Commendation or disciplinary reports

Copies of training records will be sent to PNNL, Laboratory Training Records (mailstop P7-64).

5.3 RECORDS AVAILABILITY

- 5.3.1 MSL shall make available, on the advice of legal counsel, all records and documents required in this SOP upon receiving a written request from an official who is authorized to investigate a casualty and represents:
- U.S. Department of Energy
 - Washington State Department of Labor and Industry
 - Occupational Safety and Health Administration
 - Department of Labor
 - National Institute of Occupational Safety and Health
 - Department of Health and Human Services
 - United States Coast Guard
- 5.3.2 The D.O. shall retain documents and records required by this SOP for 5 years per WAC 296-37-575.

If Battelle's legal counsel requests that files be retained for a particular project, the D.O. will retain all records, reports, and documents pertaining to that project until he is directed to release them.

After the expiration of the retention period, all records shall be forwarded to the National Institute for Occupational Safety and Health, Department of Health and Human Services at:

National Institute for Occupational Safety and Health
Department of Health and Human Services
Surveillance Branch
Mail Stop R-18 Ridge
PHS CDC NIOSH
4676 Columbia Park Way
Cincinnati, Ohio 45226

- 5.3.3 The D.O. shall make records available to PNNL management and MSL divers upon request.

6.0 QUALITY CONTROL

To confirm SOP compliance, reviews and surveillance are regularly provided by a safety representative from the MSL and a MSL Quality Assurance representative. This section is general guidance for their actions. They will provide their review to the MSL Laboratory Manager.

6.1 MSL QUALITY ASSURANCE

To provide advice to the MSL Laboratory Manager on the status of the SOP and its implementation, the MSL Quality Assurance representative will conduct periodic reviews and surveillance of the diving operations. The timing of activities should be scheduled to provide information prior to Board meetings.

6.2 MSL LABORATORY SAFETY

6.2.1 Quarterly Walk-Through

The MSL Laboratory Safety walk-through typically occurs on a quarterly basis. During these safety inspections, diving equipment will be checked to ensure that it is properly stored.

6.2.2 Specific Compressed Gas Inspections

The diving program's SCUBA cylinders will be included in inspections of compressed gases at MSL.

6.3 FACILITIES STAFF INSPECTIONS

6.3.1 Quarterly Inspections

Quarterly inspections conducted by the Facilities Staff include many diving programs items, such as first aid kits and oxygen kits.

6.3.2 Alarm Testing

MSL-wide communications systems, alarms, and site emergency plan are reviewed on a routine schedule and records are kept.

7.0 SAFETY

7.1 BREATHING AIR

7.1.1 Compressed Air Standards

Compressed air used by divers shall contain:

- An oxygen (O₂) level greater than 20% but less than 22% by volume
- A carbon monoxide (CO) level less than 10 ppm
- A carbon dioxide (CO₂) level less than 500 ppm
- A hydrocarbon (HC) level less than 25 ppm (optional)
- An oil mist level less than 5 milligrams per cubic meter (not required for oil-free compressors)
- No noxious or pronounced odor.

7.1.2 Breathing Air for Cylinders

Breathing air for diving cylinders used by MSL divers shall be obtained from [commercial](#) sources and shall meet the above standards.

Compressed air storage cylinders shall be designed, constructed, and maintained in accordance with DOT and CGA standards.

Annual visual inspections will be conducted per PSI standards with a inspection summary retained in the files.

7.1.3 Breathing Air Tests

Air will be obtained, whenever possible, from a supplier that maintains a compressor inspection program and obtains air quality analysis every six (6) months and after every repair or modification to the compressor. If the supplier routinely used for MSL air fills does not maintain a compressor inspection program resulting in semi-annual air quality analysis, MSL will coordinate sampling and fund analysis of the air.

The D.O., D.S., or L.D. shall review results of breathing air analyses (i.e., the independent laboratory certificate) to verify that the compressor output meets the requirements of Section 7.1.1 for quality and quantity by means of samples taken at the connection point to the distribution system. Copies of air analyses shall be retained in the MSL dive files.

The D.S. or L.D. shall ensure that, prior to commencement of diving operations, divers check each breathing supply system for the presence of a noxious or offensive odor and oil mist (per Section 4.2).

7.1.4 Mixed Gas

Mixed gas, or nitrox, diving will be allowed after MSL divers complete all training requirements. The training requirements specific to mixed gas diving are completion of a course in mixed gas from a

nationally recognized organization and a check out dive with the D.O. using nitrox.

Compressed air standards and monitoring outlined in Section 7.1.2 and 7.1.3 will be applicable to nitrox air supply, with the exception of the percent oxygen in the nitrox mixture.

All dives using nitrox will be limited to no-decompression limits of standard nitrox dive tables (i.e., 130 ft for 20 minutes from NOAA and NAUI tables for 32% oxygen enriched air).

8.0 TRAINING REQUIREMENTS

8.1 GENERAL POLICY

All MSL diving certifications shall be issued by the D.O. or his/her designee. Only PNNL employees who will be diving under MSL auspices shall be eligible for MSL diver certification.

8.2 MSL DIVING CERTIFICATION

8.2.1 Initial MSL Diver Certification

PNNL personnel must receive training on this SOP and receive a MSL DIVING CERTIFICATE (Appendix G) prior to conducting any diving-related activity on behalf of MSL.

To apply for a diving certificate, an individual shall provide the following materials to the D.O.:

- Certificate of Training in the use of SCUBA issued by one of the following agencies or their equivalent* shall be considered as adequate evidence of completion of such training:

Professional Association of Diving Instructors (PADI)
National Association of Underwater Instructors (NAUI)
National Association of Skin Diving Schools (NASDS)
National Aquatics Council (YMCA)

- * A Certificate of Training issued by an agency not listed above may be accepted by the D.O. upon establishment that the standards for such certification are at least equal to those of the listed agencies.
- Dive logs for dives made during the previous 12 months or more, if necessary, to properly and accurately document diving experience. These logs shall contain the information indicated on the Dive Log Form (Appendix H)
- Diving Work History Form (Appendix I) that describes previous diving experience, underwater skills, and the average number of dives made per quarter since first certified and during the previous year
- Results of medical examination on a Medical Examination Form for divers (Appendix J)
- A current certificate of training in standard first aid and cardiopulmonary resuscitation
- Records of SCUBA equipment inspection, maintenance, and repairs (see Section 4.2 and 4.3 and Appendix D).
- Successfully complete the open water dive(s) with the D.O. and demonstrate proficiency in the skills listed in Appendix L. This dive will only be conducted after the satisfactory completion of the diver's medical examination.

- Score 80% or better on each section of the written knowledge evaluation (see Appendix M). This written evaluation will be reviewed and revised every 3 years, or as otherwise recommended, by the Diving Safety Board.
- Attend a rescue diver techniques course and scuba oriented Oxygen Administration Course as soon as practical, but within the first 12 months of MSL certification. The minimum course content of a rescue diver techniques course is outlined in Appendix O.

The D.O. will review the above materials and, if acceptable, will issue a Diving Certificate to the individual (Appendix G). The Diving Certificate will be transmitted to the applicant in writing.

8.2.2 Maintenance of MSL Diving Certification

To maintain their MSL Diving Certification, divers must accomplish the following:

- Pass an annual medical examination which meets the required standards outlined in Appendix N; Diving Certificates shall expire one year from the date of the last medical examination. Divers will normally be expected to pass a medical examination 30 days prior to the expiration date of their last medical examination. NO INDIVIDUAL WILL BE ALLOWED TO DIVE ON PROJECTS UNDER THE AUSPICES OF MSL IF HE/SHE HAS NOT PASSED AN APPROPRIATE MEDICAL EXAMINATION WITHIN THIS 30 DAY PERIOD DOES NOT HAVE A CURRENT MEDICAL EXAM. If a diver anticipates being on assignment in a remote location where he may not obtain an adequate medical examination at the time his/her last medical examination will lapse (including the 30 day period), the diver must pass a diver's medical examination prior to beginning work at that location.
- Maintain diving currency; during a 3 month period, each certified diver shall make a minimum of three dives with a cumulative ADT of 1 h. All dives made by certified divers for research, work, or training shall contribute to meeting this requirement and must be recorded on Dive Log Forms (see Appendix H). Dive Logs shall be submitted every quarter to the D.O. Failure to file logs with the D.O. for a 6-month period may be cause for revocation of a diver's MSL diving certification.
- Complete a ~~nationally recognized certification~~ course in rescue diver techniques (approved by the D.O.) within the first year of acceptance to the MSL Diving Program. Skill improvement training and/or refresher training must occur at least once every two years after initial rescue diving training.
- Complete a scuba oriented oxygen administration course within the first year of acceptance to the MSL Diving Program and every other year thereafter.
- Complete aquatic and knowledge skills refresher training in alternate years from rescue diver refresher training.
- Maintain diving equipment in good working condition. Divers must provide the D.O. with

evidence that the diving gear maintained by the individual is in proper working condition.

- Maintain certification in cardiopulmonary resuscitation (CPR) and standard first aid; divers must take refresher courses in CPR and standard first aid before or when the period of certification has lapsed and before accepting a new diving assignment under the auspices of MSL or making quarterly currency dives. Evidence of recertification must be provided to the D.O. to maintain MSL diving certification. If CPR or first aid certification lapse, an extension for a maximum of 90 days may be issued at the discretion of the D.O. while the diver arranges another course.

A diver who has been hospitalized because of injury or illness or diagnosed to have a medical condition that would constitute an unacceptable hazard to health and safety will [report his/her condition to the D.O. and will](#) be immediately suspended from all diving or diving-related activity conducted under the auspices of MSL until such a time that a medical examination or doctor's clearance is provided to the D.O. and placed in the records.

8.2.3 Reinstatement of MSL Diving Certification

Failure to comply with all the specifications outlined in Section 8.2.2 or other safety aspects of this SOP will result in revocation of the diver's certificate.

Reinstatement of a revoked certification will be at the D.O.'s discretion, and will require that the diver, at a minimum, meet all of the specifications in Section 8.2.2 and be retrained on the SOP.

9.0 REFERENCES

9.1 GENERAL REFERENCES

Event Discovery and Response. Subject Area from Battelle Pacific Northwest Laboratories, Richland, Washington.

~~PNNL MA 43. 1991. Industrial Hygiene, Occupational Safety, and Fire Protection Programs. Battelle Pacific Northwest Laboratories, Richland, Washington.~~

9.2 GENERAL DIVING REFERENCES

Diving Safety Manual (Fifth Revision). 1988. University of Washington, Environmental Health and Safety Department, Seattle, Washington.

NOAA Diving Manual. 1992. NOAA. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.

U.S. Navy Diving Manual, Volume 1. 1977. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. (Stock Number 008-046-00131-6)

WAC 296-37 Safety Standards For Commercial Diving Operations. 1991. State of Washington, Department of Labor and Industries, Olympia, Washington.

9.3 SELECTED DIVING MEDICINE REFERENCES

Diving and Subaquatic Medicine. 1990. C. Edmonds, C. Lowery and J. Pennefather. Diving Medical Center, Mosman, N.S.W. Australia. (Available from Best Publishing Company, P.O. Box 30100, Flagstaff, AZ 86004)

Medical Examination of Sport SCUBA Divers. 1990. Jefferson Davis, M.D. (ed.). Best Publishing Company, P.O. Box 30100, Flagstaff, AZ 86004

New Science of Skin and Scuba Diving. 1985. Associated Press, NY

SCUBA Diving in Safety and Health. 1980. C.W. Deuker. Madison Publishing Associates, Diving Safety Digest, P.O. Box 2735, Menlo Park, CA 94026

The Physician's Guide to Diving Medicine. 1989. C.W. Shilling, C.B. Carlston and R.A. Mathias. Plenum Press, New York, NY (Available through the Undersea and Hyperbaric Medical Association, Bethesda, MD)

APPENDIX A
MSL SAFETY TRAINING RECORD
INDIVIDUAL TRAINING ASSIGNMENT FORM

Trainee: Course Title and No.:

Payroll No.: Project/Organization No.:

Training Conducted By/

Reading Assigned By: Date:

Required training and method(s) used are indicated below. Please use permanent ink when indicating completion.

Title/Subject/Document	Rev. No.	Method Used*	Sign and Date When Completed

* Method: O = On-The-Job Training OJT Plan No.: N/A
 B = Briefing Session
 R = Reading Assignment

Responsible Manager: Sign and date below when this form has been reviewed for completeness and forward a copy (either original or reproducible) to the Laboratory Training Coordinator.

Signature:

APPENDIX B
CHAPTER 296-37 WAC

APPENDIX C
DIVING OPERATIONS REPORT

Client

Date(s) of Diving Operations _____ Dive Number

Purpose

Personnel and Responsibilities

Diving Supervisor

Lead Diver

Divers

Support Personnel

Evaluation of the Operations

Equipment used:

Equipment
problems:

Successful
procedures:

Abandoned
procedures:

Additional
training needed:

Communication
problems:

Other:

APPENDIX D
DIVING EQUIPMENT SERVICE FORM

Equipment description / model

Equipment serial number _____ Manufacturer

Person responsible
for care/service _____ phone

Rate/frequency of inspection

Service performed*

Service date

Inspection/testing
conducted*

Inspection/testing date

Findings:

Next planned service date

Comments:

_____ Completed by
Date

*If service/testing/inspection is performed off-site, a receipt must be stapled to the back of this form or maintained in dive records.

APPENDIX E

FIELD GEAR CHECK LIST AND DIVING FIRST AID KIT SUPPLIES

safety gear

dive flag
 first aid kit
 oxygen kit
 cell phone or radio
 diver recall device

field gear

anchors and/or cinder blocks
 buoys and floats
 stakes
 sledge hammer
 flags
 rope, twine, duct tape
 trowels
 sewing kit
 100 m tapes
 film for Nikonos
 camera, strobe, and film
 small floats
 inner tube w/ basket
 shovels or trowels
 1 m² quadrats (3 or 4)
 0.25 m² quadrats (3 or 4)
 sample containers
 video camera & housing
 w/ charged batteries & film
 plastic buckets
 coolers
 compass
 pencils
 data sheets
 Rite N Rain paper
 clip boards
 dGPS

personal gear

hot drinks/thermos
 towel
 warm coat and hat
 candy
 swim suit
 dry bag
 extra lead weights

boat and safety gear

VHF radio
 cellular phone
 life vests/personal floatation devices
 boat safety kit with tools and spare parts
 fire extinguisher
 anchor and line
 horn or whistle
 2 sets of signal pipes/diver recall device
 Mustang survival suit
 dive ladder
 extra ropes to hang dive gear from boat
 gas tank
 spare oil
 charts
 paddle(s) or oar(s)
 registration
 trailer and lights (check)
 bailer bucket
 rubber boots
 boat hook
 first aid kit

personal dive gear

wet suit, hood, gloves, booties
 mask and snorkel
 fins
 weight belt
 knife
 BC
 regulator and tank(s)
 Watch/timer

other essentials

approved dive plan
 dive tables

misc. items to consider

bull horn w/ batteries
 repair kit and tools
 dive bags
 dive log sheet
 extra mask, fins, etc.
 cold drinks
 visor cap
 tide table
 site maps
 sun screen

APPENDIX E (contd.)**DIVING FIRST AID KIT SUPPLIES**

A waterproof first aid kit with the following supplies shall be available at all dive sites:

Required items

Exam gloves
 Sterile compress pads
 Roller gauze bandage (2 inch)
 Assorted band aids
 Adhesive tape (1 inch)
 Assorted gauze pads (sterile)
 Triangular bandages
 Providone-Iodine prep pad
 Matches (Water proof)
 Scissors (bandage type)
 Tweezers
 Safety Glasses
 Assorted safety pins and needles
 Small flashlight
 Fresh water (Small bottle)
 Antiseptic soap
 Emergency phone numbers
 Quarters (for pay phone)
 Oxygen, cylinder, regulator, and mask
 Pocket mask for CPR
 Paper and pencil
 First aid books

- American Red Cross Standard First Aid Handbook
- Divers Alert Network (D.A.N.) Emergency Handbook

Recommended items

Sterile sponges
 Space blanket
 Baking soda
 Elasticized wrap
 Q-tips
 Bag mask
 Razor blades (single edge)
 Kling roller gauze
 Eye irrigating solution
 Pocket Knife
 Ear drying solution

APPENDIX F

EMERGENCY PROCEDURES

F.1 EMERGENCY RESCUE PROCEDURES

The purpose of this SOP section is to provide information for emergency assistance to all persons engaged in scientific or research diving operations under MSL auspices. This information is presented as recommendations for dive location emergency aid and/or assistance, and for the rapid summoning of medical and/or law enforcement agency assistance for the injured.

The MSL divers shall be responsible for examining all the emergency information in this appendix to ensure that it remains applicable to the planned diving operation, and to update or supplement the information as required.

During all diving emergencies, first activate the Emergency Medical System (EMS) by calling **9-1-1**, and then contact the MSL Laboratory Manager and D.O., as soon as possible.

F.1.1 Missing Diver

In the event of a missing MSL diver or presumed fatality, immediately notify the appropriate law enforcement agency, and organize a search. Do not undertake a search where weather, current, or depth conditions may compromise search group safety. MSL personnel should not participate in the search and recovery group, unless specifically directed by the Diving Supervisor. The MSL Laboratory Manager also should be contacted immediately. All diving equipment involved in a MSL diving accident shall be left in an as-found condition.

F.1.2 General

Essential elements in providing an injured diver with the best chance of survival are prompt first aid measures, particularly basic CPR.

While the main concern is for the injured, the rescuer should not further complicate the situation by overexerting him/herself or by taking unnecessary risks which could result in the rescuer also needing assistance.

1. The majority of diving accidents occur during ascent or near the surface, so dive team members should be prepared to effect in-water rescues.
2. Place a marker at the site to aid with the search. Locate the diver by conducting a search starting at the last known location.
3. Limited first aid is all that can be attempted in water, so the injured diver must be safely extricated as soon as possible.
 - a. The injured diver must be made buoyant and relieved of all carried or attached items.

- b. An open airway should be maintained during rapid transit to the beach or support vessel. Mouth-to-mouth should be done with the proper technique to provide dry, effective resuscitation. Equipment of the injured and the rescuer should be removed as needed to aid with the rescue.
- c. When exiting the water, it is critical to avoid rough handling of injured body regions or persons in shock.
- d. If possible, emergency aid should be sought concurrently with the rescue. If alone, the rescuer should not leave the injured diver.
- e. A diving accident must be handled as the situation demands. Specific procedures may need to be modified to fit the situation.

F.1.3. Conscious Diver

A conscious diver must receive continual positive verbal support as well as help in attaining buoyancy and assistance to safety.

1. Use the sequence Reach, Throw, Row, then Go as guidance to provide aid to a conscious person in the water.
2. Quiet behavior.

Talk to them in positive conversational tones all the time while you inflate the B.C., relieve them of carried or attached items, and use a tired-swimmers assist to direct them to safety. Firm physical contact (e.g., Do-Se-Do tow) and support can be very reassuring. Maintain eye contact during the swim to the beach or vessel.

3. Struggling/panicky behavior

Due to panic or injury, this diver may be extremely dangerous to the rescuer. A rescue in this case requires proper training and frequent practice to be safe for the rescuer. Remember that the panicky diver will run out of energy, so wait until they calm down.

- a. Use any method possible to lend assistance without coming into direct contact. Talk them back into control, push an inflated B.C. into their hands, etc.
- b. If direct contact is used, the rescuer should have his/her B.C. deflated, regulator in his/her mouth, and approach from behind so he can descend to escape.

F.1.4 Unconscious Diver

When approaching a supposedly unconscious diver, shake them first to make sure that they are indeed in trouble.

1. The rescuer should quickly assess the buoyancy system of the unconscious diver (i.e., air volume in dry suit and BC). The unconscious diver is then guided to the surface with a firm grip. The rescuer should try to keep a normal ascent rate while the expanding air in the lungs automatically vents. The BC and dry suit of the unconscious diver may need to be manually vented by the rescuer. An unconscious diver at the surface should have the weight belt removed and dropped well clear of the diver.
2. If the diver is on the surface, roll him/her face up, remove his/her weight belt (if not already accomplished) to establish buoyancy, establish an open airway, and check for breathing. Start assessment, open the airway, and shout for help. During artificial respiration (AR), start removing the victim's and your own SCUBA as needed. This will make the AR easier and the towing faster while going to the nearest location where CPR can be started.
3. Periodically throughout the rescue, call for help. One never knows who might be nearby.
4. When the victim is out of the water and in a place where CPR can be started, move the victim's hood aside and check the carotid artery for a pulse. If there is no pulse, indicating no circulation, start CPR. This can be done through the suit if need be. A rescue should be done with speed.
5. Continue to monitor vital signs and administer first aid and CPR, as required. In most accidents, the injured should be treated for shock and kept warm. If you are a lone rescuer, do not leave the injured, but as soon as possible request emergency assistance at the scene, or transport for medical treatment (Call **9-1-1**). Continue CPR as long as is necessary, and attend to the injured until competent help arrives. If barotrauma is indicated or suspected, the injured should be kept flat, treated for shock, and the airway open should be kept open. For the severely ill, do not administer anything by mouth, with the exception of water if the person is thirsty and well enough to drink. Administration of oxygen to the injured victim will increase the chances of survival no matter what the problem. Experience has shown that prompt EMS care for any diving accident is critical.
6. When medical assistance and/or transportation to hospital or recompression treatment does arrive, the EMS staff should be provided in writing with: personal identification, dive profile, symptoms, time of rescue, time treatment was started, progression of symptoms, and any other pertinent information.

F.2 COMMUNICATIONS

F.2.1 General

It can not be over-emphasized that obtaining rapid access to emergency care and treatment facilities is imperative.

1. Contact the appropriate authorities immediately and (if conditions allow) concurrently with any rescue operations. State your exact location, the nature of the emergency, and request medical assistance and/or transportation as necessary. If the telephone line is busy, call the operator

and state that you have a life or death situation and request a clear line.

2. Since hospital treatment, and particularly hyperbaric facilities, may be limited or located a some distance from the dive location, it is important that a communication system be available at or near the dive location. This is to allow for immediate contact with some mode of transportation for emergency treatment.
3. Once communication is established, it should be maintained or available for call-back in case further instructions or directions to the location of the injured are needed.

F.2.2 Police and Fire Departments

In case of a diving emergency at MSL, call **9-9-1-1** first. In other areas, telephone **9-1-1** first, then try the nearest law enforcement agency or recognized emergency aid unit. You must indicate to the responding unit that his/her injury *could be* the result of a diving incident and that the person may need to be transported to a hyperbaric treatment facility as soon as possible.

F.2.3 MSL Laboratory Manager and D.O.

After initiation of emergency response assistance, the MSL Laboratory Manager (phone 360.681.3602 or 360.683.4151) and D.O. should be contacted as soon as possible.

F.2.4 U.S. Coast Guard

In the case of shore-based, small boat, or ship-at-sea diving emergencies with marine radio (VHF) availability, call the nearest Coast Guard station for emergency assistance. The Coast Guard's Seattle Operations Center for coordination of rescue efforts can be reached at 260.220.7001. A CB radio is not capable of contacting the Coast Guard and therefore not recommended. As a last resort, a CB can be used to contact someone who can relay the message. From a cellular phone, *CG will reach the U.S. Coast Guard emergency response.

F.2.5 Diving Alert Network (DAN)

DAN operates as a 24 hours, 7 days a week emergency consultation service for diving accidents, and as a clearinghouse for information on diving accidents and diving accident treatment (phone 1.800.446.2671 or 919.684.8111). This service provides help to the diver and/or physician on the diagnosis, immediate care, transportation, and hyperbaric treatment facility location. DAN is located at F.G. Hall Lab., Duke University Medical Center, and is sponsored by public memberships, NOAA, NIOSH, DOE, and Undersea Medical Society.

F.3 **EVACUATION SYSTEMS AND METHODS**

F.3.1 General Evacuation Information

Coordination of a diving medical emergency evacuation from a remote area to a suitable hyperbaric chamber is often a complex operation involving several organizations. Successful evacuation

involves careful review beforehand of the steps necessary and their appropriateness to the circumstances at hand.

An alternative route for evacuation is often necessary for reasons of weather, systems overload, communications, mechanical failure or human error. A backup plan is then necessary. This alternative route, often slower than the first, should be less affected by weather or communication problems (e.g., a car is a good example). In executing an alternative plan, intermediate hospitals/facilities become extremely useful because of patient stabilization, medical consultation, and communications to a wide variety of emergency evacuation units.

F.3.2 Evacuation Decision

The decision to evacuate is often made based on the symptom's severity or symptom history. The evacuation's urgency is a separate decision. Understandably, many evacuation agencies prefer to deal with medically responsible individuals (EMT's, paramedics, nurses, doctors, etc.), though many successful evacuations have been carried out by laymen. When a laymen is involved in requesting transport, it is important that careful, complete, and concise information relating the pertinent circumstances surrounding the accident and the victim's condition be conveyed to the evacuation agency. When explaining the victim's condition, one should relate only what has been observed (i.e., he's unconscious, he has weakness in this arm, etc). One should not relate a diagnostic opinion such as decompression sickness or air embolism.

F.3.3 Air Evacuation

F.3.3.1 General Air Evacuation

While air evacuation is one means of evacuation for serious diving accidents, the following are some limitations:

- a. Weather may preclude take-off, landing, or even locating the accident site, and it may render a helicopter basket rescue too dangerous.
- b. Distances between home base, the rescue site, and a treatment center can place a helicopter at a disadvantage due to fuel, time, or both.
- c. Unsuitable landing conditions may require the patient be transported to an intermediate location.
- d. Unpressurized transport of a diving accident victim at an altitude higher than 1000 feet is not recommended. Given the choice, many knowledgeable individuals would choose to delay instead of traveling over higher terrain.

F.3.3.2 Air Evacuation Agencies

- a. U.S. Coast Guard (USCG) - The U.S. Coast Guard Rescue Coordination Center (RCC) coordinates emergency evacuation in and around the Puget Sound area (phone 800.982-8813 ext. 7001 or 206.220.7001). The RCC efficiently handles all necessary evacuation logistics including announcement of impending arrival, choice of landing site, and permission to land. They will also verify whether ambulance transport has been arranged. In cases of life-threatening emergencies, the RCC will direct the helicopter to the nearest treatment facility.
- b. Canadian Coast Guard (RCC-Victoria) Aircraft and Marine Distress works with the USCG RCC to coordinate any military or civilian evacuation agency (phone: 800.567.5111). RCC also handles evacuation from British Columbia and Yukon Territory to appropriate facilities, and they will evacuate diving accidents to Fleet Diving Unit Victoria or Vancouver Hospital.

F.3.4 Ground Evacuation

Ground transport is the most reliable and sometimes the fastest transportation mode. It is especially useful in transport to an intermediate medical facility. Local ambulance is the primary vehicle, and appropriate local phone numbers should be obtained. The emergency dispatch number **(9-1-1)** works in all of Washington state and in most regions of the United States.

State or local police are also a useful transportation information source, although transportation is not their primary responsibility. [Washington State Police transportation coordination center phone: 425. 455.7700.] Using state/local police requires careful situation examination including the patient's condition and what you are requesting them to do for you. Examples could be:

- a. Short distance transport.
- b. Assistance in evacuation.
- c. Securing transport.

F.3.5 Boat Evacuation

Boat transport is likely to be an intermediate route of evacuation. If a decompression chamber is close at hand, however, a boat may serve as a primary vehicle. In the Pacific Northwest, use of Washington State ferries may be required (e.g., due to inclement weather for flying).

F.3.6 On Site Pick-up

1. The evacuation agency will want as much information as possible about the patient's condition and the dive profile (i.e., vitals, gender, age, etc., nature of injury, nature of accident).
2. Where possible, best results are obtained if the patient is delivered to the nearest hospital because:
 - a. The patient can be stabilized.
 - b. A physician evaluation is available.
 - c. Medical consultation and evacuation agency communication are in place.

- d. Parking lots and open fields provide easily accessible landing sites.
3. Remote pick-ups require communications and accurate locations.
 - a. Communications can be established through VHF FM CH 16, HF MB 2182, ship to shore patch, other VHF FM channel, or cellular phone. CB radio is not reliable.
 - b. Location of Ground Site Requires:
 - Coastal navigation fix.
 - Coordinates.
 - Location from prominent landmarks.
 - Description of boat.
4. Helicopter Evacuation Procedures - Each helicopter evacuation is different, and each one presents its own problems. But knowing what to expect and the procedures to follow can save time, effort, and perhaps a life.
 - a. Try to establish communications with the helicopter. If your boat is unable to furnish the necessary frequency, try to work through another boat.
 - b. Maintain speed of 10 knots unless directed otherwise by the helicopter pilot; do not slow down or stop.
 - c. Maintain course with wind about 20 degrees off port bow.
 - d. Put all antennas down (if possible without losing communications) and remove other obstructions that might tangle lines.
 - e. Secure all loose objects on/around decks.
 - f. Provide flat surface for stretcher.
 - g. To prevent electric shock, always let the lifting device (stretcher) touch the boat or water before handling it.
 - h. Do not secure lifting device or cable to boat.
 - i. Place life jacket on patient.
 - j. Tie patient in basket, face up.
 - k. If patient cannot communicate, place in the stretcher as much information as you can about him/her, such as name, address, what happened, and what treatment has been given.
 - l. If a patient is a diving accident victim, ensure that the flight crew is given the dive profile for the day, time of injury, sequence and times of symptoms, and treatment/medication given.

Also, be sure that the flight crew is knowledgeable of medical procedures for diving injuries and that they will deliver the victim to a hyperbaric facility.

F.4 SELECTION OF DIVING TREATMENT FACILITIES

The ultimate destination of a diving accident victim is a hyperbaric facility. You may be required to direct the evacuation agency to a facility with a hyperbaric chamber, or as in the case of the Coast Guard, the ultimate destination is the decision of the RCC. The agency or individual responsible for the evacuation should inform this treatment center of their intention to transport, expected time of arrival, and the condition of the patient.

F.4.1 Puget Sound Treatment Center

Virginia Mason Hospital is the primary diving accident treatment center in the Northwest United States 206. 624.1144 ext. 245.

Boeing Field 5 miles from Virginia Mason Hospital: 206.344.7392

Harborview Hospital helipad 1/4 mile from Virginia Mason Hospital: 206.223.3074

Seattle Waterfront 3/4 mile from Virginia Mason Hospital.

F.4.2 British Columbia Treatment Centers

Primary treatment centers in British Columbia are:

1. Vancouver General Hospital
Emergencies 604.875.4995
Hyperbaric Unit 604.875.4007
Vancouver International Airport (6 miles distant)
Helipad Boat Dock
Fall Creek Coast Guard Station (1 mile distant)
2. Victoria B.C. Fleet Diving Unit
Commanding Officer 604.388.2379
Victoria International Airport (19 miles distant)
Helipad Canadian Air Force Base (4 miles distant)
Boat Dock at facility

F.4.3 Required Transportation Information

Once an ultimate destination is determined, either the party requesting transportation or the evacuating agency must:

1. Announce the impending arrival and ETA to the receiving institution.
2. Choose a landing site or transfer point.
3. Request permission to land or dock.
4. Arrange for transport from drop off point to the receiving institution.
5. Inform customs and immigration if crossing an international border.

F.4.4 Final Ground Transportation

Transport from landing, docking, or transfer site to the final destination is usually handled by ambulance. Transportation should be coordinated through emergency dispatch (**9-1-1**), who will make a determination of appropriate medical transportation based on the patient's condition. It is normally the responsibility of the transporting agency to contact the ambulance company and arrange schedules. However, if one is not familiar with the local aid units, he may request assistance from the receiving hospital or institution.

Ambulance units for the Virginia Mason Hospital are:

Emergency Dispatch/Medic 1: **9-1-1**
 (particularly if condition is life-threatening or if electronic monitoring is required)
 American Medical Response: 206.322.0330
 (Under normal circumstances)

The Virginia Mason Hospital often takes the responsibility of notifying the ambulance units.

F.4.5 Customs and Immigration

Customs and immigration usually do not delay patient transport if this transport is carried out by a recognized transportation agency. During air evacuation, the pilot is responsible for contacting customs and immigration and this is usually done when a flight plan is filed.

F.5 EMERGENCY TELEPHONE NUMBERS

Clallam County Sheriff	9-1-1 or 360.452.7836
Jefferson County Sheriff	9-1-1 or 360.385.3831
Washington State Patrol	9-1-1 or 206.455.7700
Virginia Mason Hospital (Emergency Room)	206.583.6433
U.S.C.G. Rescue Coord. Ctr, Seattle	800.982.8813 ext. 7001
U.S.C.G. Rescue Coord. Ctr, WA & OR	206.220.7001
Rescue Coord. Center, British Columbia	800.567.5111 or cell *311
Diving Alert Network (DAN)	1.800.446.2671 or 919.684.8111
MSL Diving Officer (Liam Antrim)	w: 360.681.3655 h: 360.683.2305
MSL Laboratory Manager (Dick Ecker)	w: 360.681.3647 h: 360.681.3245
MSL Operations Manager (Jim Nimmo)	w: 360.681.3612 h: 360.683.6813
Special Coast Guard Cellular Phone Number Single Point Contact (SPC) at PNNL	*CG (star C G) 509.375.2400

F.6 EMERGENCY RADIO FREQUENCIES

U.S. Coast Guard	VHF CH 16
Canadian Coast Guard	VHF CH 16
Citizen Band	(CB)CH 9

F.7. EMERGENCY FIELD MANAGEMENT FLOW CHART

An emergency field management flow chart is provided for first aid treatment decision making, based on information from Richard Dunford, Operations Director, Virginia Mason Hospital Hyperbaric Treatment Center

F.7.1 Guidelines for Decision Making

1. Accurate diagnosis is sometimes difficult for a diving accident; signs and symptoms may be equivocal, difficult to define, wax and wane, and change in location and nature and sometimes in character.
2. Several independent problems are often present together.
3. Delays in treatment bring risk of further involvement, render existing conditions more difficult to resolve, and may contribute to recurrence of symptoms after treatment.

F.7.2 Decompression Sickness

1. Decompression sickness (DCS) tends to progress from minor to major involvement. However, DCS may diminish in severity or show no change.
2. The magnitude of exposure (or closeness to table limits) is not a reliable guide to the severity of the potential involvement. Even decompression profiles well within the decompression limits have resulted in DCS.
3. Denial or fear of potential hassle, embarrassment, errors in judgement, etc. precipitate many unnecessary delays.
4. Decompression sickness symptoms onset
 - within 1 hour after the dive - symptoms appear in 50%
 - within 6 hours after the dive - symptoms appear in 90%

F.8 PNNL OFF-NORMAL EVENT REPORTING PROCEDURES

Any diving incident or accident shall be considered an off normal event, as defined in Section 2.0, and must be reported to Line Management as soon as possible. In every case, when there is injury or circumstances requiring immediate medical or other emergency aid, the safety of personnel is the first consideration. When the immediate emergency is under control, a call must be made to MSL Line Management, Safety Officer, or Operations Manager. If none of these contacts can be reached, a call shall be placed to the Single Point Contact (509-375-2400). This call can be made by the D.O. or his/her designee but must be someone familiar with the occurrence who is able to relay accurate information about the situation.

EMERGENCY FIELD MANAGEMENT FLOW CHART

APPENDIX G

MSL DIVING CERTIFICATE

This document certifies that _____ has successfully completed all necessary medical evaluations and training as required by the Safe Diving Practices SOP, and is hereby certified to participate as a scientific diver under the auspices of Battelle / Marine Sciences Laboratory. This certificate shall be valid for one year from the date of the last medical review.

MSL Diving Officer

Date

MSL Laboratory Manager

Date

APPENDIX H
DIVE LOG FORM

Dive Site _____ Date _____

Diver's name _____

Dive buddy _____

Lead Diver _____

Support personnel _____

Purpose of Dive _____

Time-Depth Record

Notes:

Repet. Group Start _____

Visibility _____

Time in _____

Surface conditions _____

Psi in _____

Safety stop _____

Time out _____

Psi out _____

Maximum Depth _____

Total Dive Time _____

End Repet. Dive Group
(tables used _____)

Observations:

APPENDIX I

DIVING WORK HISTORY FORM

Name _____ Date _____

Date of Last Diving Physical _____

First Aid Card* No _____ Yes _____ Date _____

CPR Card* No _____ Yes _____ Date _____

Date and Place of Certification _____

Type of Diving Certification & No.* _____

Avg. Number of Dives/3 Month Period During the Past Year _____

Advanced Diving Training (e.g., instructor, dive master, rescue diver, etc.)

Course _____ Date _____

Scientific Diving Assignments: No. Dives Last Year _____

Project _____

Assignment(s) _____

Project _____

Assignment(s) _____

Project _____

Assignment(s) _____

Recreational Diving:

No. of Dives Last Year _____ General Region _____

Activities While Diving _____

* Attach Copies of SCUBA, CPR, and First Aid Certification Card.

APPENDIX J
MEDICAL CLEARANCE FORM

APPENDIX K

VARIANCE REQUEST AND AUTHORIZATION FORM

Variance # _____ Variance Type: ___ Permanent ___ Temporary
Start Date _____ End Date _____

1) Identification of relevant requirement:

2) Description of subject/operation affected by requirement: (provide background for variance request; describe project operation, activity; how they are affected by the required procedure and why required procedure can not be met)

3) Describe the variance approach: (Analyze the approach and describe how it will satisfy the required procedure.)

4) List required actions: (List actions to be taken based on the analysis of the approach in step 3.)

5) Controls for equivalent level of safety:

Initiator Name: _____ Phone: _____ Date: _____

Approvals:

MSL Laboratory Manager: _____ Date: _____

PNNL Safety Representative: _____ Date: _____

Dive Officer: _____ Date: _____

Dive Safety Board Member: _____ Date: _____

Dive Safety Board Member: _____ Date: _____

APPENDIX L**SCUBA OPEN WATER SKILLS EVALUATION**

Name

Recognized Diving Card Number

Date of Current Medical Clearance

The MSL Diving Program requires an initial open water skills dive. The applicant for certification must satisfy the following requirements in the presence of the Diving Officer.

Initial and Every Two Year Skill Requirements:

Open water dive skills

Scores are P = pass, R = repeated to pass, F = unsuccessful

1. ___ Assemble, adjust, and don equipment
2. ___ Perform pre-dive functional equipment check for self and buddy
3. ___ Enter and exit water using proper technique:
 - a. Shore
 - b. Boat (small boat)
4. ___ Snorkel 1000 feet with SCUBA in position.
5. ___ At surface, alternate breathing between snorkel and regulator (twice), with face submerged, without choking
6. ___ At surface on snorkel, remove and replace (in turn):
 - a. mask
 - b. fins
 - c. weight system
 - d. SCUBA unit
7. ___ Perform surface buoyancy check and achieve neutral buoyancy: (equalize ears and air spaces during descent and ascent)
 - a. at surface pre-dive
 - b. at surface post-dive
 - c. at 20 ft to 40 ft depth be able to hover off the bottom without support and with minimum movement
8. ___ Perform, recognize, and respond to standard surface and underwater hand signals:

level off, low on air, out of air, I want to buddy breath, danger, ok, up, down.

While at a depth of 20 ft to 40 ft complete skills 9 to 13.

9. ___ Repeatedly flood and clear mask of water while breathing from SCUBA (1 inch maximum remaining water in mask)
10. ___ Repeatedly remove, recover, replace, and clear regulator of water using two methods. One recovery is with regulator behind shoulder.
11. ___ Buddy breathe with another diver. Be both donor and receiver of air. Skill starts on bottom and then proceeds to surface after 2 minutes either using buddy breathing or octopus regulator.
12. ___ Perform a controlled emergency swimming ascent at near normal rate of ascent with all equipment in place.
13. ___ Prevent exhaustion of air supply by monitoring the pressure gauge and ending the dive as required for safe ascent with the 3 minute stop at 15 feet.
14. ___ Transport a buddy simulating exhaustion 100 yards while maintaining eye to eye contact (both divers are in full SCUBA equipment).
15. ___ Bring a diver simulating unconsciousness to the surface from a depth of 30 feet; remove victims weight system (if necessary), mask, and snorkel; assess diver's conditions and tow diver 200 yards.

Signature of Diving Officer indicates completion of skills as checked.

D.O.

Date

Place

APPENDIX M**DIVING CERTIFICATION WRITTEN EXAM**

Described below is the written diving exam. To pass the examine, all three segments must be completed satisfactorily*.

1. General Diving Knowledge
 - a) Diving Physics
 - b) Diving Medical Aspects
 - c) Marine and Freshwater Diving Environment
 - d) Rescue and Safety Procedures
 - e) Diving Equipment

2. Diving Tables Using U.S. Navy or More Conservative Tables
 - a) Single Dive Problems
 - b) Two Dive Problems
 - c) Minimum Surface Interval Problems
 - d) Decompression Problems for Single and Multiple Dives

3. MSL Policy Using Current Safe Diving Practices SOP
 - a) Terms Definition
 - b) Authority and Responsibility
 - c) Equipment and Skill Maintenance
 - d) Policy for Safety

* Must pass each segment with 80% correct answers.

APPENDIX N

MEDICAL STANDARDS FOR DIVING PHYSICAL

N.1 Diver's Medical Requirements

N.1.1 General

1. Dive team members are required to pass an annual diving physical examination. The examining physician must declare the diver medically fit to engage in diving activities.
2. All medical evaluations shall be performed by, or under the direction of, a licensed physician, preferably one trained in hyperbaric or undersea medicine.
3. The diver should be free of any chronic disabling disease and be free of any conditions (Table N.1) contained in the list of conditions for which abstinence from diving is generally recommended. These restrictive standards are not meant as absolute decision criteria; the professional judgement of the examining physician(s) and the D.O. can be used to evaluate the severity of the conditions and to make a determination on a case-by-case basis, based on signs, symptoms, and risk factors. For example, a recovered alcoholic may not be at risk as a diver.

N.1.2 Frequency of Medical Evaluation

Medical evaluation shall be completed:

1. before a diver may begin diving;
2. thereafter, at annual intervals;
3. after any injury, illness, or surgery requiring hospital admission or debilitation;
4. after any episode of unconsciousness;
5. after any diving accident resulting in injury to the diver.

N.1.3 Information Provided To Examination Physician

Battelle/Marine Sciences Laboratory (MSL) shall provide a copy of the medical evaluation requirements of this SOP to the examining physician.

N.1.4 Content of Medical Examinations

Medical examinations conducted initially and at the intervals specified in section N.1.2 shall consist of the following:

1. medical information release to the Diving Officer (D.O.),
2. general medical history,
3. diving - related medical history,
4. diving physical examination and completion of Medical Evaluation of Fitness for SCUBA Diving Report ,
5. The tests indicated in section N.1.6, and

6. Any additional test the physician may consider necessary.

N.1.5 Conditions Which Restrict MSL Diving
(adapted from Davis 1986*)

It is recommended that any examining physician have Davis (1986) available. (Bracketed numbers are pages in Davis which explain the condition). The conditions are included in Table N.1.

* Medical Examination of Sport SCUBA Divers. 1990. Jefferson Davis, M.D. (ed.). Best Publishing Company, P.O. Box 30100, Flagstaff, AZ 86004

TABLE N.1 CONDITIONS WHICH RESTRICT MSL DIVING, Pg 1 of 3

(Bracketed numbers are pages in Davis 1986* which explain the condition)

* Medical Examination of Sport SCUBA Divers. 1990. Jefferson Davis, M.D. (ed.). Best Publishing Company, P.O. Box 30100, Flagstaff, AZ 86004

Ears

1. Tympanic membrane perforation or aeration tube. (7)
2. Inability to autoinflate the middle ears. (6,7,8)
3. External ear exostoses or osteomas adequate to prevent external ear canal equilibration. (4)
4. Meniere's disease or other chronic vertiginous condition, status post-surgery, such as subarachnoid endolymphatic shunt for Meniere's disease. (11)
5. Stapedectomy and middle ear prosthesis. (9)

Jaw

6. Chronic mastoiditis or mastoid fistula. (5)
7. Any oral or maxillofacial deformity that interferes with retention of the regular mouthpiece.

Vision

8. Corrected near visual acuity not adequate to see cylinder pressure gauge, watch, and compass underwater. Uncorrected visual acuity not adequate to see the diving buddy or locate the boat in case corrective lenses are lost underwater. (13)
9. Radial keratotomy or other recent ocular surgery. (14)

Mental stability

10. Claustrophobia of degree to predispose to panic.
11. Suicidal ideation. (16)
12. Significant anxiety states. (16)
13. Psychosis. (18)
14. Severe depression. (16)
15. Manic states. (16)

Drug use

16. Alcoholism. (19,20)
17. Mood-altering drug use. (19,20)

Motivation

18. Improper motivation for diving. (16,17,18)

Central Nerves System

19. Episodic loss of consciousness. (1,22)
20. History of seizure. History of seizures in early childhood must be evaluated individually. (21)
21. Migraine. (20)
22. History of cerebrovascular accident for transient ischemic attack. (23)
23. History of spinal cord trauma with neurologic deficit, whether fully recovered or not. (23)

TABLE N.1 CONDITIONS WHICH RESTRICT MSL DIVING, Pg 2 of 3

- 24. Any degenerative or demyelinating CNS process. (25)
- 25. Brain tumor with or without surgery. (24)
- 26. Intracranial aneurysm or other vascular malformation. (24)
- 27. History of neurological decompression sickness with residual deficit. (23,24)
- 28. Head injury with sequelae. (21)
- 29. History of intracranial surgery. (24)

Blood Disease

- 30. Sickle cell disease. (34)
- 31. Polycythemia or leukemia. (34)
- 32. Unexpected anemia. (34)

Cardiac

- 33. History of myocardial infarction. (28,29,30)
- 34. Angina or other evidence of coronary artery disease. (29)
- 35. Unrepaired cardiac septal defects. (33)
- 36. Aortic stenosis or mitral stenosis. (32)
- 37. Complete heart block. (31)
- 38. Fixed second degree heart block. (31)
- 39. Exercise induced tachyarrhythmias. (31,32)
- 40. Wolf-Parkinson-White (WPW) Syndrome with paroxysmal atrial tachycardial or syncope. (31)
- 41. Fixed-rate pacemakers. (33)
- 42. Any drugs which inhibit normal cardiovascular response to exercise. (31)
- 43. Peripheral vascular disease, arterial or venous, severe enough to limit exercise tolerance. (33,41)
- 44. Hypertension with end-organ finding - retinal, cardiac, renal, or vascular. (30)

Pulmonary

- 45. History of spontaneous pneumothorax. (36)
- 46. Bronchial asthma. History of childhood asthma requires special studies. (7,35)
- 47. Exercise or cold air induced asthma. (36,37)
- 48. X-ray evidence of pulmonary blebs, bullae, or cysts. (36,37)
- 49. Chronic obstructive pulmonary disease. (37)

Diabetes

- 50. Insulin-dependent diabetes mellitus. Diet or oral medication-controlled diabetes mellitus if there is a history of hypoglycemic episodes. (38)

Hernia

- 51. Any abdominal wall hernia with potential for gas-trapping until surgically corrected. (41)
- 52. Periesophageal or incarcerated sliding hiatal hernia. (39)
- 53. Sliding hiatus hernia if symptomatic due to reflex esophagitis. (39)

TABLE N.1 CONDITIONS WHICH RESTRICT MSL DIVING, Pg 3 of 3

Pregnancy

54. Pregnancy. (1,45)

Others

55. Osteonecrosis. A history with a high risk of dysbaric osteonecrosis.

56. Any condition requiring ingestion of the following medications:

antihistamines, bronchodilator, steroids, barbiturates, phenytoin, mood-altering drugs, insulin.

N.1.6 Medical Laboratory Requirements

MSL diving medical examination laboratory requirements for initial and re-examination include:

1. Chest X-ray (initial and every 24 months recommended)
2. Vision
 - Visual acuity
 - Ishihara color vision (initial only)
 - Ocular tension (over 40 - annually)
3. Urinalysis
4. Complete blood count (CBC)
5. ChemPlus (14 hour fasting)
6. Blood type and Rh factor (initial only)
7. Sickle cell anemia test (initial only)
8. Pulmonary function test (Vital capacity)
9. Stress test (submaximal treadmill or stress test)
10. Electrocardiogram (resting; initially at age 35 and annually after age 40.)
11. Hearing test

N.1.7 Physician's Written Report

1. After any medical examination, MSL shall obtain a written report prepared by the examining physician, which shall contain the examining physician's opinion of the individual's fitness to dive. This will be reviewed by the D.O. who shall recommend whether the individual should be certified unconditionally, be required to undergo further testing, or be rejected.
2. The D.O. shall provide the individual with a copy of the physician's written report.

APPENDIX N-1, page 1 of 1

DIVING MEDICAL EXAM OVERVIEW FOR THE EXAMINING PHYSICIAN

TO THE EXAMINING PHYSICIAN:

This person, _____, requires a medical examination to assess his / her fitness for certification as a Scientific Diver for the Battelle/Marine Sciences Laboratory (MSL). His / her answers on the Diving Medical History Form (attached), could indicate potential health or safety risks as noted. Your evaluation is requested on the attached SCUBA Diving Medical Evaluation Report. If you have questions of a general nature about diving medicine, you may wish to consult one of the references on the attached list or contact one of the physicians with expertise in diving medicine whose names and phone numbers appear on another attached list. Please contact the MSL Diving Officer if you have any questions or concerns about diving medicine or the MSL standards. Thank you for your assistance.

MSL Diving Officer _____

Date _____ Phone _____

BATTELLE / Marine Sciences Laboratory
1529 West Sequim Bay Road
Sequim, Washington 98382-9055

Switch Board (360) 683-4151

APPENDIX N-2, page 1 of 2

MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING REPORT

Name of Applicant (please print) _____

Date (Mo/Day/Year) _____

TO THE PHYSICIAN:

This person is presently a certified diver desiring to engage in diving with self-contained underwater breathing apparatus (SCUBA) at Battelle/Marine Sciences Laboratory. This is an activity which puts unusual stress on the individual in several ways. Your opinion on the applicant's medical fitness is requested. SCUBA diving requires heavy exertion. The diver must be free of cardiovascular and respiratory disease. An absolute requirement is the ability of the lungs, middle ear, and sinuses to equalize pressure. Any condition that risks the loss of consciousness should disqualify the applicant.

RECOMMENDATION:

[] APPROVAL:

I find no medical condition(s) which I consider incompatible with diving.

[] FURTHER TESTING REQUIRED:

I have encountered a potential contraindication to diving. Additional medical tests must be performed before a final assessment can be made.

Further Tests: _____

[] REJECT:

This applicant has medical condition(s) which, in my opinion, clearly would constitute unacceptable hazards to health and safety in diving.

Date _____ Signature _____

Name (Print) _____

Address _____

Telephone Number _____

APPENDIX N-2, Page 2 of 2

I have discussed with the patient any medical condition(s) which would not interfere with diving but which may seriously compromise subsequent health. The patient understands the nature of the hazards and the risks involved in diving with these conditions.

My familiarity with applicant is:

- With this exam only
- Regular Physician for ____ years
- Other (describe) _____

My familiarity with diving medicine is:

- With this exam only
- Hyperbaric Physician for ____ years
- Other (describe) _____

Date _____ Signature _____

M.D. s name (printed) _____

APPLICANT'S RELEASE OF MEDICAL INFORMATION FORM

I authorize the release of this information and all medical information subsequently acquired in association with my diving exam to the Battelle / Marine Sciences Laboratory Diving Officer at Sequim, WA and HANFORD ENVIRONMENTAL HEALTH FOUNDATION on (date) _____ .

Signature of Applicant _____

Applicant s printed name _____

APPENDIX N-3, page I of 4

DIVING MEDICAL HISTORY FORM
(To Be Completed By Applicant-Diver)

Name _____ Gender ____ Age ____ Wt. ____ Ht. ____
 Date (Mo/Day/Yr) _____

TO THE APPLICANT:

SCUBA diving makes considerable demands on your physical and emotional condition. Diving with particular defects amounts to asking for trouble not only for yourself, but to anyone coming to your aid if you get into difficulty in the water. Therefore, it is prudent to meet certain medical and physical requirements before beginning in the Battelle/MSL program. Your answers to the questions are more important, in many instances, in determining your fitness than what the physician may see, hear or feel when you are examined. Obviously, you should give accurate information or the medical screening procedure becomes useless.

This form shall be kept confidential. If you believe any question amounts to invasion of your privacy, you may elect to omit an answer, provided that you shall subsequently discuss that matter with your own physician and he/she must then indicate, in writing, that you have done so and that no health hazard exists.

Should your answers indicate a condition(s) which might make diving hazardous, you will be asked to review the condition(s) with your physician. In such instances, his/her written authorization will be required in order for further consideration to be given to your application. If your physician concludes that diving would involve undue risk for you, remember that he / she is concerned only with your well-being and safety. Respect the advice and the intent of this medical history form.

- | | | |
|--------------------------|--------------------------|---|
| <input type="checkbox"/> | <input type="checkbox"/> | 1. Have you ever had epilepsy (seizure)? |
| <input type="checkbox"/> | <input type="checkbox"/> | 2. Do you faint or have blackout spells? |
| <input type="checkbox"/> | <input type="checkbox"/> | 3. Have you ever been addicted to drugs? |
| <input type="checkbox"/> | <input type="checkbox"/> | 4. Do you have diabetes? |
| <input type="checkbox"/> | <input type="checkbox"/> | 5. Do you suffer from motion sickness or sea / air sickness? |
| <input type="checkbox"/> | <input type="checkbox"/> | 6. Are you prone to claustrophobia? |
| <input type="checkbox"/> | <input type="checkbox"/> | 7. Have you ever had a nervous breakdown? |
| <input type="checkbox"/> | <input type="checkbox"/> | 8. Are you pregnant? |
| <input type="checkbox"/> | <input type="checkbox"/> | 9. Do you suffer from menstrual problems? |
| <input type="checkbox"/> | <input type="checkbox"/> | 10. Do you get anxiety spells or hyperventilation? |
| <input type="checkbox"/> | <input type="checkbox"/> | 11. Do you get frequent sour stomachs, nervous stomachs or vomiting spells? |
| <input type="checkbox"/> | <input type="checkbox"/> | 12. Have you ever had a major operation? |
| <input type="checkbox"/> | <input type="checkbox"/> | 13. Are you presently being treated by a physician? |
| <input type="checkbox"/> | <input type="checkbox"/> | 14. Are you taking medication regularly? |
| <input type="checkbox"/> | <input type="checkbox"/> | 15. Have you ever been rejected or restricted from sports? |
| <input type="checkbox"/> | <input type="checkbox"/> | 16. Do you have frequent and severe headaches? |

APPENDIX N-3, page 2 of 3

- Yes No 17. Do you wear dental plates?
- Yes No 18. Do you wear glasses or contact lenses?
- Yes No 19. Do you have any bleeding disorders?
- Yes No 20. Have you ever had any problems with alcoholism?
- Yes No 21. Have you ever had any problems relating to diving?
- Yes No 22. Do you suffer from nervous tension or emotional problems?
- Yes No 23. Do you sometimes take tranquilizers?
- Yes No 24. Have you ever had a perforated ear drum(s)?
- Yes No 25. Do you have hay fever?
- Yes No 26. Do you have frequent sinus trouble, frequent drainage from the nose, post-nasal drip, or stuffy nose?
- Yes No 27. Do you get frequent earaches?
- Yes No 28. Do you have drainage from your ears?
- Yes No 29. Do you have difficulty with your ears in airplanes or mountains?
- Yes No 30. Have you ever had ear surgery?
- Yes No 31. Do you have ringing in your ears?
- Yes No 32. Do you get frequent dizzy spells?
- Yes No 33. Do you have any hearing problems?
- Yes No 34. Do you have trouble equalizing pressure in your ears?
- Yes No 35. Have you ever had asthma?
- Yes No 36. Have you ever had wheezing attacks?
- Yes No 37. Do you have a chronic or recurrent cough?
- Yes No 38. Do you frequently raise sputum?
- Yes No 39. Have you ever had pleurisy?
- Yes No 40. Have you ever had a collapsed lung (pneumothorax)?
- Yes No 41. Do you have lung cysts?
- Yes No 42. Have you had pneumonia?
- Yes No 43. Have you ever had tuberculosis?
- Yes No 44. Do you get shorter of breath than most people?
- Yes No 45. Have you ever been told that you have a lung problem or abnormality?
- Yes No 46. Do you ever spit blood?
- Yes No 47. Do you ever have breathing difficulty after eating particular foods, after exposure to particular pollens or animals?
- Yes No 48. Are you subject to bronchitis?
- Yes No 49. Have you ever had subcutaneous emphysema (air under the skin)?
- Yes No 50. Have you ever had an air embolism after diving?
- Yes No 51. Have you ever had rheumatic fever?
- Yes No 52. Have you ever had scarlet fever?
- Yes No 53. Have you ever been told you have a murmur?
- Yes No 54. Have you ever been told you have a large heart?
- Yes No 55. Have you ever had high blood pressure?
- Yes No 56. Have you ever had angina (heart pains or pressure in the chest)?
- Yes No 57. Did you ever have a heart attack?
- Yes No 58. Do you ever have low blood pressure?

APPENDIX N-3, page 3 of 3

- Yes No 59. Do you have recurrent or persistent swelling of the legs?
Yes No 60. Have you ever had pounding, rapid heartbeat or palpitations?
Yes No 61. Have you ever had dizziness or fainting spells?
Yes No 62. Do you get fatigued or short of breath easily?
Yes No 63. Have you been told you had an abnormal EKG?
Yes No 64. Do you suffer from joint problems, dislocations or arthritis?
Yes No 65. Have you ever had back trouble or back injuries?
Yes No 66. Have you ever had a ruptured or slipped disk?
Yes No 67. Do you have any limiting physical handicaps?
Yes No 68. Do you suffer from muscle cramps?
Yes No 69. Do you have varicose veins?
Yes No 70. Do you have any amputations?
Yes No 71. Have you ever had a head injury causing unconsciousness?
Yes No 72. Have you experienced any paralysis?
Yes No 73. Have you ever had an adverse reaction to medication?
Yes No 74. Do you smoke?
Yes No 75. Have you ever had any other medical problems not listed?
If so, please list or describe below.

APPENDIX N-4, page 1 of 1

DIVING PHYSICIANS

Recommended Physicians with Expertise in Diving Medicine

1. Dr. Edmond Kay
13030 Military Road South
Seattle, WA 98168
(206) 242-6500
regional consultant to NOAA and Divers Alert Network

APPENDIX O**COURSE OUTLINE FOR RESCUE DIVER TECHNIQUES**

The following outline provides the minimum course content that will be covered in a rescue diver techniques course appropriate for initial certification and refresher training of MSL divers.

Preparation

- Prevention of accidents: attitude, planning, good habits

Problem Recognition

- Early signs of difficulty
- Behavioral changes with stress
- Progression of problems
- Pattern breakers

Safety equipment

- List of equipment: first aid, communication, rescue
- Training
- Equipment readiness

Rescue Scenarios

- Lost diver: location techniques, safety procedures
- Unconscious or conscious submerged diver
- Unconscious or conscious diver at surface
- Self rescue

Assisting a diver at the surface

- Identification of rescue need
- Calming a struggling diver
- Approaching the diver
- Surface management
- Tow techniques

Assisting a conscious diver underwater

- Out of air
- Entanglement
- Buoyancy control problems
- Local concerns (current, waves, tide)

Assisting an unconscious diver underwater

- Approach and contact
- Gear management
- Positioning and holds
- Ascent control
- Surface management and tow techniques

In water resuscitation

- Assessment
- Techniques
- Problems

Exiting the water and onshore response

- Carries and lifts
- Problems
- First Aid response

In addition to a classroom review of these topics, rescue diver techniques training includes in-water practice and review of these techniques. Each diver should have the opportunity to perform a variety of rescue techniques during practice scenarios. This practice should occur with the entire dive team participating, if possible.