COMPANY POLICY

This standard applies to diving and related support operations conducted in connection with all types of work and employments, including general industry, construction, ship repairing, shipbuilding, shipbreaking, and longshoring.

APPLICATION IN EMERGENCIES

An employer may deviate from the requirements of this standard to the extent necessary to prevent or minimize a situation which is likely to cause death, serious physical harm, or major environmental damage, provided that the employer:
1. Notifies the Area Director for the Occupational Safety and Health Administration within 48 hours of the onset of the emergency situation indicating the nature of the emergency and extent of the deviation from the prescribed regulations; and
2. Upon request from the Area Director, submits such information in writing.

EMPLOYER OBLIGATION

The employer must be responsible for compliance with:
1. All provisions of this standard of general applicability; and
2. All requirements pertaining to specific diving modes to the extent diving operations in such modes are conducted.

QUALIFICATIONS OF DIVE TEAM

• Each dive team member must have the experience or training necessary to perform assigned tasks in a safe and healthful manner.

Each dive team member must have experience or training in the following:
1. The use of tools, equipment, and systems relevant to assigned tasks;
2. Techniques of the assigned diving mode; and
3. Diving operations and emergency procedures.
• All dive team members must be trained in cardiopulmonary resuscitation and first aid (American Red Cross standard course or equivalent).
• Dive team members who are exposed to or control the exposure of others to hyperbaric conditions must be trained in diving-related physics and physiology.

ASSIGNMENTS

• Each dive team member must be assigned tasks in accordance with the employee's experience or training, except that limited additional tasks may be assigned to an employee undergoing training provided that these tasks are performed under the direct supervision of an experienced dive team member.
• The employer must not require a dive team member to be exposed to hyperbaric conditions against the employee's will, except when necessary to complete decompression or treatment procedures.
• The employer must not permit a dive team member to dive or be otherwise exposed to hyperbaric conditions for the duration of any temporary physical impairment or condition which is known to the employer and is likely to affect adversely the safety or health of a dive team member.

DESIGNATED PERSON-IN-CHARGE

• The employer or an employee designated by the employer must be at the dive location in charge of all aspects of the diving operation affecting the safety and health of dive team members.
• The designated person-in-charge must have experience and training in the conduct of the assigned diving operation.

SAFE PRACTICES

The employer must develop and maintain a safe practices manual which must be made available at the dive location to each dive team member.
The safe practices must contain a copy of this standard and the employer's policies for implementing the requirements of this standard.
For each diving mode engaged in, the safe practices must include:
1. Safety procedures and checklists for diving operations;
2. Assignments and responsibilities of the dive team members;
3. Equipment procedures and checklists; and
4. Emergency procedures for fire, equipment failure, adverse environmental conditions, and medical illness and injury.

PRE-DIVE PROCEDURES

The employer must comply with the following requirements prior to each diving operation, unless otherwise specified.

EMERGENCY AID

A list must be kept at the dive location of the telephone or call numbers of the following:
1. An operational decompression chamber (if not at the dive location);
2. Accessible hospitals;
3. Available physicians;
4. Available means of transportation; and
5. The nearest U.S. Coast Guard Rescue Coordination Center.

If conducting inland dive operation, the telephone or call numbers of the nearest local sheriff's office must be included on the Emergency Aid list.

FIRST AID SUPPLIES

1. A first aid kit appropriate for the diving operation and approved by a physician must be available at the dive location.
2. When used in a decompression chamber or bell, the first aid kit must be suitable for use under hyperbaric conditions.
3. In addition to any other first aid supplies, an American Red Cross standard first aid handbook or equivalent, and a bag-type manual resuscitator with transparent mask and tubing must be available at the dive location.

PLANNING AND ASSESSMENT

Planning of a diving operation must include an assessment of the safety and health aspects of the following:

1. Diving mode;
2. Surface and underwater conditions and hazards;
3. Breathing gas supply (including reserves);
4. Thermal protection;
5. Diving equipment and systems;
6. Dive team assignments and physical fitness of dive team members (including any impairment known to the employer);
7. Repetitive dive designation or residual inert gas status of dive team members;
8. Decompression and treatment procedures (including altitude corrections); and
9. Emergency procedures.

HAZARDOUS ACTIVITIES

To minimize hazards to the dive team, diving operations must be coordinated with other activities in the vicinity which are likely to interfere with the diving operation.

DIVE TEAM BRIEFING

Dive team members must be briefed on:

1. The tasks to be undertaken;
2. Safety procedures for the diving mode;
3. Any unusual hazards or environmental conditions likely to affect the safety of the diving operation; and
4. Any modifications to operating procedures necessitated by the specific diving operation.

Prior to making individual dive team member assignments, the employer must inquire into the dive team member's current state of physical fitness, and indicate to the dive team member the procedure for reporting physical problems or adverse physiological effects during and after the dive.

EQUIPMENT INSPECTION

The breathing gas supply system including reserve breathing gas supplies, masks, helmets, thermal protection, and bell handling mechanism (when appropriate) must be inspected prior to each dive.

WARNING SIGNAL

When diving from surfaces other than vessels in areas capable of supporting marine traffic, a rigid replica of the international code flag “A” at least one meter in height must be displayed at the dive location in a manner which allows all-round visibility, and must be illuminated during night diving operations.

PROCEDURES DURING DIVE

The employer must comply with the following requirements which are applicable to each diving operation unless otherwise specified.

WATER ENTRY AND EXIT

- A means capable of supporting the diver must be provided for entering and exiting the water.
- The means provided for exiting the water must extend below the water surface.
- A means must be provided to assist an injured diver from the water or into a bell.

COMMUNICATIONS

An operational two-way voice communication system must be used between:
1. Each surface-supplied air or mixed-gas diver and a dive team member at the dive location or bell (when provided or required); and
2. The bell and the dive location.

An operational, two-way communication system must be available at the dive location to obtain emergency assistance.

DECOMPRESSION TABLES

Decompression, repetitive, and no-decompression tables (as appropriate) must be at the dive location.

DIVE PROFILES

A depth-time profile, including when appropriate any breathing gas changes, must be maintained for each diver during the dive including decompression.

HAND-HELD POWER TOOLS AND EQUIPMENT

- Hand-held electrical tools and equipment must be de-energized before being placed into or retrieved from the water.
- Hand-held power tools must not be supplied with power from the dive location until requested by the diver.

WELDING AND BURNING

A current supply switch to interrupt the current flow to the welding or burning electrode must be:
1. Tended by a dive team member in voice communication with the diver performing the welding or burning; and
2. Kept in the open position except when the diver is welding or burning.
- The welding machine frame must be grounded.
- Welding and burning cables, electrode holders, and connections must be capable of carrying the maximum current required by the work, and must be properly insulated.
- Insulated gloves must be provided to divers performing welding and burning operations.
- Prior to welding or burning on closed compartments, structures or pipes, which contain a flammable vapor or in which a flammable vapor may be generated by the work, they must be vented, flooded, or purged with a mixture of gases which will not support combustion.

EXPLOSIVES

- Employers must transport, store, and use explosives in accordance with the applicable provisions of §1910.109 and §1926.912 of Title 29 of the Code of Federal Regulations.
- Electrical continuity of explosive circuits must not be tested until the diver is out of the water.
- Explosives must not be detonated while the diver is in the water.

TERMINATION OF DIVE: THE WORKING INTERVAL OF A DIVE MUST BE TERMINATED WHEN:
1. A diver requests termination;
2. A diver fails to respond correctly to communications or signals from a dive team member;
3. Communications are lost and can not be quickly re-established between the diver and a dive team member at the dive location, and between the designated person-in-charge and the person controlling the vessel in liveboating operations; or
4. A diver begins to use diver-carried reserve breathing gas or the dive-location reserve breathing gas.

POST-DIVE PROCEDURES

The employer must comply with the following requirements which are applicable after each diving operation, unless otherwise specified.

PRECAUTIONS

After the completion of any dive, the employer must:
1. Check the physical condition of the diver;
2. Instruct the diver to report any physical problems or adverse physiological effects including symptoms of decompression sickness;
3. Advise the diver of the location of a decompression chamber which is ready for use; and
4. Alert the diver to the potential hazards of flying after diving.

For any dive outside the no-decompression limits, deeper than 100 fsw or using mixed gas as a breathing mixture, the employer must instruct the diver to remain awake and in the vicinity of the decompression chamber which is at the dive location for at least one hour after the dive (including decompression or treatment as appropriate).

RECOMPRESSION CAPABILITY

A decompression chamber capable of recompressing the diver at the surface to a minimum of 165 fsw (6 ATA) must be available at the dive location for:
1. Surface-supplied air diving to depths deeper than 100 fsw and shallower than 220 fsw;
2. Mixed gas diving shallower than 300 fsw; or
3. Diving outside the no-decompression limits shallower than 300 fsw.

A decompression chamber capable of recompressing the diver at the surface to the maximum depth of the dive must be available at the dive location for dives deeper than 300 fsw.
The decompression chamber must be:
1. Dual-lock;
2. Multiplace; and
3. Located within 5 minutes of the dive location.

The decompression chamber must be equipped with:
1. A pressure gauge for each pressurized compartment designed for human occupancy;
2. A built-in-breathing-system with a minimum of one mask per occupant;
3. A two-way voice communication system between occupants and a dive team member at the dive location;
4. A viewport; and
5. Illumination capability to light the interior.

Treatment tables, treatment gas appropriate to the diving mode, and sufficient gas to conduct treatment must be available at the dive location.
A dive team member must be available at the dive location during and for at least one hour after the dive to operate the decompression chamber (when required or provided).

RECORD OF DIVE

The following information must be recorded and maintained for each diving operation:
1. Names of dive team members including designated person-in-charge;
2. Date, time, and location;
3. Diving modes used;
4. General nature of work performed;
5. Approximate underwater and surface conditions (visibility, water temperature and current); and
6. Maximum depth and bottom time for each diver.

For each dive outside the no-decompression limits, deeper than 100 fsw or using mixed gas, the following additional information must be recorded and maintained:
1. Depth-time and breathing gas profiles;
2. Decompression table designation (including modification); and
3. Elapsed time since last pressure exposure if less than 24 hours or repetitive dive designation for each diver.

For each dive in which decompression sickness is suspected or symptoms are evident, the following additional information must be recorded and maintained:
1. Description of decompression sickness symptoms (including depth and time of onset); and
2. Description and results of treatment.

DECOMPRESSION PROCEDURE ASSESSMENT

The employer must:
1. Investigate and evaluate each incident of decompression sickness based on the recorded information, consideration of the past performance of decompression table used, and individual susceptibility;
2. Take appropriate corrective action to reduce the probability of recurrence of decompression sickness; and
3. Prepare a written evaluation of the decompression procedure assessment, including any corrective action taken, within 45 days of the incident of decompression sickness.

SPECIFIC OPERATIONS PROCEDURES

SCUBA DIVING

Employers engaged in SCUBA diving must comply with the following requirements, unless otherwise specified.

LIMITS

SCUBA diving must not be conducted:
1. At depths deeper than 130 fsw;
2. At depths deeper than 100 fsw or outside the no-decompression limits unless a decompression chamber is ready for use;
3. Against currents exceeding one (1) knot unless line-tended; or
4. In enclosed or physically confining spaces unless line-tended.

PROCEDURES
• A STANDBY DIVER MUST BE AVAILABLE WHILE A DIVER IS IN THE WATER.
• A diver must be line-tended from the surface, or accompanied by another diver in the water in continuous visual contact during the diving operations.
• A diver must be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.
• A diver-carried reserve breathing gas supply must be provided for each diver consisting of: 1. A manual reserve (J valve); or
2. An independent reserve cylinder with a separate regulator or connected to the underwater breathing apparatus.
The valve of the reserve breathing gas supply must be in the closed position prior to the dive.

SURFACE-SUPPLIED AIR DIVING
Employers engaged in surface-supplied air diving must comply with the following requirements, unless otherwise specified.

LIMITS
• Surface-supplied air diving must not be conducted at depths deeper than 190 fsw, except that dives with bottom times of 30 minutes or less may be con-ducted to depths of 220 fsw.
• A decompression chamber must be ready for use at the dive location for any dive outside the no-decompression limits or deeper than 100 fsw.
• A bell must be used for dives with an inwater decompression time greater than 120 minutes, except when heavy gear is worn or diving is conducted in physically confining spaces.

PROCEDURES
• Each diver must be continuously tended while in the water.
• A diver must be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.
• Each diving operation must have a primary breathing gas supply sufficient to support divers for the duration of the planned dive including decompression.

For dives deeper than 100 fsw or outside the no-decompression limits:
1. A separate dive team member must tend each diver in the water;
2. A standby diver must be available while a diver is in the water;
3. A diver-carried reserve breathing gas supply must be provided for each diver except when heavy gear is worn; and
4. A dive-location reserve breathing gas supply must be provided

For heavy-gear diving deeper than 100 fsw or outside the no-decompression limits:
1. An extra breathing gas hose capable of supplying breathing gas to the diver in the water must be available to the standby diver.
2. An in-water stage must be provided to divers in the water.

Except when heavy gear is worn or where physical space does not permit, a diver-carried reserve breathing gas supply must be provided whenever the diver is prevented by the configuration of the dive area from ascending directly to the surface.

MIXED-GAS DIVING
Employers engaged in mixed-gas diving must comply with the following requirements, unless otherwise specified.

LIMITS
Mixed-gas diving must be conducted only when:
1. A decompression chamber is ready for use at the dive location; and
2. A bell is used at depths greater than 220 fsw or when the dive involves inwater decompression time of greater than 120 minutes, except when heavy gear is worn or when diving in physically confining spaces; or
3. A closed bell is used at depths greater than 300 fsw, except when diving is conducted in physically confining spaces.

PROCEDURES
• A separate dive team member must tend each diver in the water.
• A standby diver must be available while a diver is in the water.
• A diver must be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.
• Each diving operation must have a primary breathing gas supply sufficient to support divers for the duration of the planned dive including decompression.
• Each diving operation must have a dive-location reserve breathing gas supply.

WHEN HEAVY GEAR IS WORN:
1. An extra breathing gas hose capable of supplying breathing gas to the diver in the water must be available to the standby diver; and
2. An inwater stage must be provided to divers in the water.
• An inwater stage must be provided for divers without access to a bell for dives deeper than 100 fsw or outside the no-decompression limits.
• When a closed bell is used, one dive team member in the bell must be available and tend the diver in the water.

Except when heavy gear is worn or where physical space does not permit, a diver-carried reserve breathing gas supply must be provided for each diver:
1. Diving deeper than 100 fsw or outside the no-decompression limits; or
2. Prevented by the configuration of the dive area from directly ascending to the surface.

LIVEBOATING
Employers engaged in diving operations involving liveboating must comply with the following requirements.

LIMITS
Diving operations involving liveboating must not be conducted:
1. With an inwater decompression time of greater than 120 minutes;
2. Using surface-supplied air at depths deeper than 190 fsw, except that dives with bottom times of 30 minutes or less may be conducted to depths of 220 fsw;
3. Using mixed gas at depths greater than 220 fsw;
4. In rough seas which significantly impede diver mobility or work function; or
5. In other than daylight hours.

PROCEDURES

• The propeller of the vessel must be stopped before the diver enters or exits the water.
• A device must be used which minimizes the possibility of entanglement of the diver's hose in the propeller of the vessel.
• Two-way voice communication between the designated person-in-charge and the person controlling the vessel must be available while the diver is in the water.
• A standby diver must be available while a diver is in the water.
• A diver-carried reserve breathing gas supply must be carried by each diver engaged in liveboating operations.

EQUIPMENT PROCEDURES AND REQUIREMENTS
EQUIPMENT

• All employers must comply with the following requirements, unless otherwise specified.
• Each equipment modification, repair, test, calibration or maintenance service must be recorded by means of a tagging or logging system, and include the date and nature of work performed, and the name or initials of the person performing the work.

AIR SUPPLY SYSTEMS (COMPRESSED GASES AND AIR)

For purposes of this standard, air supply systems must include:
1. Air supplied directly to a diver;
2. Compressed systems used to fill air cylinders (tanks);
3. Compressed air cylinders (tanks); and
4. Compressed oxygen cylinder.
5. For additional requirements for compressed gas cylinders: 1910.101, Compressed Gases; 1910.134(d), Respiratory Protection; and 30 CFR 11, Respiratory Protective Devices.

AIR COMPRESSOR SYSTEM

• Compressors used to supply air to the diver must be equipped with a volume tank with a check valve on the inlet side, a pressure gauge, a relief valve, and a drain valve.
• Air compressor intakes must be located away from areas containing exhaust or other contaminants.

Respirable air supplied to a diver must not contain:
1. A level of carbon monoxide (CO) greater than 20 p/m;
2. A level of carbon dioxide (CO2) greater than 1,000 p/m;
3. A level of oil mist greater than 5 milligrams per cubic meter; or
4. A noxious or pronounced odor.
• The output of air compressor systems must be tested for air purity every 6 months by means of samples taken at the connection to the distribution system, except that non-oil lubricated compressors need not be tested for oil mist.

Tests for carbon monoxide must be conducted on the air in air supply systems as follows:
1. At least daily for air supplied directly to the diver; and
2. At least once for each group or batch of cylinders filled or purchased.

BREATHING GAS SUPPLY HOSES

Breathing gas supply hoses must:
1. Have a working pressure at least equal to the working pressure of the total breathing gas system;
2. Have a rated bursting pressure at least equal to 4 times the working pressure;
3. Be tested at least annually to 1.5 times their working pressure; and
4. Have their open ends taped, capped or plugged when not in use.

Breathing gas supply hose connectors must:
1. Be made of corrosion-resistant materials;
2. Have a working pressure at least equal to the working pressure of the hose to which they are attached; and
3. Be resistant to accidental disengagement.

Umbilicals must:
1. Be marked in 10-foot increments to 100 feet beginning at the diver's end, and in 50 foot increments thereafter;
2. Be made of kink-resistant materials; and
3. Have a working pressure greater than the pressure equivalent to the maximum depth of the dive (relative to the supply source) plus 100 psi.

The employer must insure that the following requirements are met, regardless of where compressed gas cylinder (tanks) are purchased or filled.

BUOYANCY CONTROL

• Helmets or masks connected directly to the dry suit or other buoyancy-changing equipment must be equipped with an exhaust valve.
• A dry suit or other buoyancy-changing equipment not directly connected to the helmet or mask must be equipped with an exhaust valve.
• When used for SCUBA diving, a buoyancy compensator must have an inflation source separate from the breathing gas supply.
• An inflatable flotation device capable of maintaining the diver at the surface in a face-up position, having a manually activated inflation source independent of the breathing supply, an oral inflation device, and an exhaust valve must be used for SCUBA diving.

COMPRESSED GAS CYLINDERS

Compressed gas cylinders must:
1. Be designed, constructed and maintained in accordance with the applicable provisions of 29 CFR 1910.101 and 1910.169 through 1910.171.
2. Be stored in a ventilated area and protected from excessive heat;
3. Be secured from falling; and
4. Have shut-off valves recessed into the cylinder or protected by a cap, except when in use or manifolded, or when used for SCUBA diving.

DECOMPRESSION CHAMBERS

• Each decompression chamber manufactured after the effective date of this standard, must be built and maintained in accordance with the ASME Code or equivalent.
• Each decompression chamber manufactured prior to the effective date of this standard must be maintained in conformity with the code requirements to which it was built, or equivalent.

Each decompression chamber must be equipped with:
1. Means to maintain the atmosphere below a level of 25 percent oxygen by volume;
2. Mufflers on intake and exhaust lines, which must be regularly inspected and maintained;
3. Suction guards on exhaust line openings; and
4. A means for extinguishing fire, and must be maintained to minimize sources of ignition and combustible material.

GAUGES AND TIMEKEEPING DEVICES

• Gauges indicating diver depth which can be read at the dive location must be used for all dives except SCUBA.
• Each depth gauge must be deadweight tested or calibrated against a master reference gauge every 6 months, and when there is a discrepancy greater than two percent (2 percent) of full scale between any two equivalent gauges.
• A cylinder pressure gauge capable of being monitored by the diver during the dive must be worn by each SCUBA diver.
• A timekeeping device must be available at each dive location.

MASKS AND HELMETS

Surface-supplied air and mixed-gas masks and helmets must have:
1. A non-return valve at the attachment point between helmet or mask and hose which must close readily and positively; and
2. An exhaust valve.

Surface-supplied air masks and helmets must have a minimum ventilation rate capability of 4.5 acfm at any depth at which they are operated or the capability of maintaining the diver's inspired carbon dioxide partial pressure below 0.02 ATA when the diver is producing carbon dioxide at the rate of 1.6 standard liters per minute.

OXYGEN SAFETY

• Equipment used with oxygen or mixtures containing over forty percent (40%) by volume oxygen must be designed for oxygen service.
• Components (except umbilical's) exposed to oxygen or mixtures containing over forty percent (40%) by volume oxygen must be cleaned of flammable materials before use.
• Oxygen systems over 125 psig and compressed air systems over 500 psig must have slow-opening shut-off valves.

WEIGHTS AND HARNESSES

• Except when heavy gear is worn, divers must be equipped with a weight belt or assembly capable of quick release.

Except when heavy gear is worn or in SCUBA diving, each diver must wear a safety harness with:
1. A positive buckling device;
2. An attachment point for the umbilical to prevent strain on the mask or helmet; and
3. A lifting point to distribute the pull force of the line over the diver's body.

CONDITIONS WHICH MAY RESTRICT OR LIMIT EXPOSURE TO HYPERBARIC CONDITIONS

The following disorders may restrict or limit occupational exposure to hyperbaric conditions depending on severity, presence of residual effects, response to therapy, number of occurrences, diving mode, or degree and duration of isolation.

• History of seizure disorder other than early febrile convulsions
• Malignancies (active) unless treated and without recurrence for 5 years
• Chronic inability to equalize sinus and/or middle ear pressure
• Cystic or cavitary disease of the lungs
• Impaired organ function caused by alcohol or drug use.
• Conditions requiring continuous medication for control (e.g., antihistamines, steroids, barbiturates, mood-altering drugs, or insulin)
• Meniere's disease
• Hemoglobinopathies
• Obstructive or restrictive lung disease
• Vestibular end organ destruction
• Pneumothorax
• Cardiac abnormalities (e.g., pathological heart block, valvular disease, intraventricular conduction defects other than isolated right bundle branch block, angina pectoris, arrhythmia, coronary artery disease)
• Juxta-articular osteonecrosis

EQUIPMENT REQUIREMENTS FOR REBREATHERS

- The employer must ensure that each employee operates the rebreather (i.e., semi-closed-circuit and closed-circuit self-contained underwater breathing apparatuses (hereafter, “SCUBAs”)) according to the rebreather manufacturer‘s instructions.
- The employer must ensure that each rebreather has a counterlung that supplies a sufficient volume of breathing gas to their divers to sustain the divers’ respiration rates, and contains a baffle system and/or other moisture separating system that keeps moisture from entering the scrubber.

The employer must place a moisture trap in the breathing loop of the rebreather, and ensure that:

1. The rebreather manufacturer approves both the moisture trap and its location in the breathing loop; and
2. Each employee uses the moisture trap according to the rebreather manufacturer‘s instructions.

The employer must ensure that each rebreather has a continuously functioning moisture sensor, and that:

1. The moisture sensor connects to a visual (e.g., digital, graphic, analog) or auditory (e.g., voice, pure tone) alarm that is readily detectable by the diver under the diving conditions in which the diver operates, and warns the diver of moisture in the breathing loop in sufficient time to terminate the dive and return safely to the surface; and
2. Each diver uses the moisture sensor according to the rebreather manufacturer‘s instructions.

The employer must ensure that each rebreather contains a continuously func-tioning CO2 sensor in the breathing loop, and that:

1. The rebreather manufacturer approves the location of the CO2 sensor in the breathing loop;
2. The CO2 sensor is integrated with an alarm that operates in a visual (e.g., digital, graphic, analog) or auditory (e.g., voice, pure tone) mode that is readily detectable by each diver under the diving conditions in which the diver operates; and
3. The CO2 alarm remains continuously activated when the inhaled CO2 level reaches and exceeds 0.005 atmospheres absolute (ATA).

Before each day‘s diving operations, and more often when necessary, the employer must calibrate the CO2 sensor according to the sensor manufacturer‘s instructions, and ensure that:

1. The equipment and procedures used to perform this calibration are accurate to within 10 percent of a CO2 concentration of 0.005 ATA or less;
2. The equipment and procedures maintain this accuracy as required by the sensor manufacturer‘s instructions; and
3. The calibration of the CO2 sensor is accurate to within 10 percent of a CO2 concentration of 0.005 ATA or less.

- The employer must replace the CO2 sensor when it fails to meet the accuracy requirements and ensure that the replacement CO2 sensor meets the accuracy requirements before placing the rebreather in operation.
- As an alternative to using a continuously functioning CO2 sensor, the employer may use a schedule for replacing CO2-sorbent material provided by the rebreather manufacturer. The employer may use such a schedule only when the rebreather manufacturer has developed it according to the canister-testing protocol specified below, and must use the canister within the temperature range for which the manufacturer conducted its scrubber canister tests following that protocol. Variations above or below the range are acceptable only after the manufacturer adds that lower or higher temperature to the protocol.

When using CO2-sorbent replacement schedules, the employer must ensure that each rebreather uses a manufactured (i.e., commercially pre-packed), disposable scrubber cartridge containing a CO2-sorbent material that:

1. Is approved by the rebreather manufacturer;
2. Removes CO2 from the diver‘s exhaled gas; and
3. Maintains the CO2 level in the breathable gas (i.e., the gas that a diver inhales directly from the regulator) below a partial pressure of 0.01 ATA.

As an alternative to manufactured, disposable scrubber cartridges, the employer may fill CO2 scrubber cartridges manually with CO2-sorbent material when:

1. The rebreather manufacturer permits manual filling of scrubber cartridges;
2. The employer fills the scrubber cartridges according to the rebreather manufacturer‘s instructions;
3. The employer replaces the CO2-sorbent material using a replacement schedule; and
4. The employer demonstrates that manual filling meets the requirements.

The employer must ensure that each rebreather has an information module that provides:

1. A visual (e.g., digital, graphic, analog) or auditory (e.g., voice, pure tone) display that effectively warns the diver of solenoid failure (when the rebreather uses solenoids) and other electrical weaknesses or failures (e.g., low battery voltage);
2. For a semi-closed circuit rebreather, a visual display for the partial pressure of CO2, or deviations above and below a preset CO2 partial pressure of 0.005 ATA; and
3. For a closed-circuit rebreather, a visual display for: partial pressures of O2 and CO2, or deviations above and below a preset CO2 partial pressure of 0.005 ATA and a preset O2 partial pressure of 1.40 ATA or lower; gas temperature in the breathing loop; and water temperature.

Before each day‘s diving operations, and more often when necessary, the employer must ensure that the electrical power supply and electrical and electronic circuits in each rebreather are operating as required by the rebreather manufacturer‘s instructions.

SPECIAL REQUIREMENTS FOR CLOSED-CIRCUIT REBREATHERS

The employer must ensure that each closed-circuit rebreather uses supply-pressure sensors for the O2 and diluents (i.e., air or nitrogen) gases and continuously functioning sensors for detecting temperature in the inhalation side of the gas-loop and the ambient water.

The employer must ensure that:

1. At least two O2 sensors are located in the inhalation side of the breathing loop; and
2. The O2 sensors are: functioning continuously; temperature compensated; and approved by the rebreather manufacturer.

Before each day‘s diving operations, and more often when necessary, the employer must calibrate O2 sensors as required by the sensor manufacturer‘s instructions. In doing so, the employer must:

1. Ensure that the equipment and procedures used to perform the calibration are accurate to within 1 percent of the O2 fraction by volume;
2. Maintain this accuracy as required by the manufacturer of the calibration equipment;
3. Ensure that the sensors are accurate to within 1 percent of the O2 fraction by volume;
4. Replace O2 sensors when they fail to meet the accuracy requirements; and
5. Ensure that the replacement O2 sensors meet the accuracy requirements before placing a rebreather in operation.

The employer must ensure that each closed-circuit rebreather has:
1. A gas-controller package with electrically operated solenoid O2-supply valves;
2. A pressure-activated regulator with a second-stage diluent-gas addition valve;
3. A manually operated gas-supply bypass valve to add O2 or diluent gas to the breathing loop; and
4. Separate O2 and diluent-gas cylinders to supply the breathing-gas mixture.

O2 CONCENTRATION IN THE BREATHING GAS

The employer must ensure that the fraction of O2 in the nitrox breathing-gas mixture:
1. Is greater than the fraction of O2 in compressed air (i.e., exceeds 22 percent by volume);
2. For open-circuit SCUBA, never exceeds a maximum fraction of breathable O2 of 40 percent by volume or a maximum O2 partial pressure of 1.40 ATA, whichever exposes divers to less O2; and
3. For a rebreather, never exceeds a maximum O2 partial pressure of 1.40 ATA.

SPECIAL REQUIREMENTS FOR CLOSED-CIRCUIT REBREATHERS

The employer must ensure that each closed-circuit rebreather uses supply-pressure sensors for the O2 and diluents (i.e., air or nitrogen) gases and continuously functioning sensors for detecting temperature in the inhalation side of the gas-loop and the ambient water.
The employer must ensure that:
1. At least two O2 sensors are located in the inhalation side of the breathing loop; and
2. The O2 sensors are: functioning continuously; temperature compensated; and approved by the rebreather manufacturer.

Before each day‘s diving operations, and more often when necessary, the employer must calibrate O2 sensors as required by the sensor manufacturer‘s instructions. In doing so, the employer must:
1. Ensure that the equipment and procedures used to perform the calibration are accurate to within 1 percent of the O2 fraction by volume;
2. Maintain this accuracy as required by the manufacturer of the calibration equipment;
3. Ensure that the sensors are accurate to within 1 percent of the O2 fraction by volume;
4. Replace O2 sensors when they fail to meet the accuracy requirements; and
5. Ensure that the replacement O2 sensors meet the accuracy requirements before placing a rebreather in operation.

The employer must ensure that each closed-circuit rebreather has:
1. A gas-controller package with electrically operated solenoid O2-supply valves;
2. A pressure-activated regulator with a second-stage diluent-gas addition valve;
3. A manually operated gas-supply bypass valve to add O2 or diluent gas to the breathing loop; and
4. Separate O2 and diluent-gas cylinders to supply the breathing-gas mixture.

O2 CONCENTRATION IN THE BREATHING GAS

The employer must ensure that the fraction of O2 in the nitrox breathing-gas mixture:

1. Is greater than the fraction of O2 in compressed air (i.e., exceeds 22 percent by volume);
2. For open-circuit SCUBA, never exceeds a maximum fraction of breathable O2 of 40 percent by volume or a maximum O2 partial pressure of 1.40 ATA, whichever exposes divers to less O2; and
3. For a rebreather, never exceeds a maximum O2 partial pressure of 1.40 ATA.

Before producing nitrox breathing-gas mixtures using a compressor in which the gas pressure in any system component exceeds 125 pounds per square inch (psi), the:

1. Compressor manufacturer must provide the employer with documentation that the compressor is suitable for mixing high-pressure air with the highest O2 fraction used in the nitrox breathing-gas mixture when operated according to the manufacturer‘s operating and maintenance specifications;
2. Employer must comply regulations above unless the compressor is rated for O2 service and is oil-less or oil-free; and
3. Employer must ensure that the compressor meets the requirements above whenever the highest O2 fraction used in the mixing process exceeds 40 percent.

Before producing nitrox breathing-gas mixtures using an oil-lubricated compress to mix high pressure air with O2, and regardless of the gas pressure in any system component, the:

1. Employer must use only uncontaminated air (i.e., air containing no hydrocarbon particulates) for the nitrox breathing-gas mixture;
2. Compressor manufacturer must provide the employer with documentation that the compressor is suitable for mixing the high-pressure air with the highest O2 fraction used in the nitrox breathing-gas mixture when operated according to the manufacturer‘s operating and maintenance specifications;
3. Employer must filter the high-pressure air to produce O2-compatible air;
4. The filter-system manufacturer must provide the employer with documentation that the filter system used for this purpose is suitable for producing O2compatible air when operated according to the manufacturer‘s operating and maintenance specifications; and
5. Employer must continuously monitor the air downstream from the filter for hydrocarbon contamination.

The employer must ensure that diving equipment using nitrox breathing-gas mixtures or pure O2 under high pressure (i.e., exceeding 125 psi) conforms to the O2-service requirements specified.

EMERGENCY EGRESS

Regardless of the type of diving equipment used by a diver (i.e., open-circuit SCUBA or rebreathers), the employer must ensure that the equipment contains (or incorporates) an open-circuit emergency-egress system (a “bail-out” system) in which the second stage of the regulator connects to a separate supply of emergency breathing gas, and the emergency breathing gas consists of air or the same nitrox breathing-gas mixture used during the dive.
As an alternative to the “bail-out” system specified above, the employer may use:

1. For open-circuit SCUBA, an emergency-egress system as specified, or
2. For a semi-closed-circuit and closed-circuit rebreather, a system configured so that the second stage of the regulator connects to a reserve supply of emergency breathing gas.

The employer must obtain from the rebreather manufacturer sufficient information to ensure that the bail-out system performs reliably and has sufficient capacity to enable the diver to terminate the dive and return safely to the surface.

TREATING DIVING-RELATED MEDICAL EMERGENCIES

Before each day‘s diving operations, the employer must:

1. Verify that a hospital, qualified health-care professionals, and the nearest Coast Guard Coordination Center (or an equivalent rescue service operated by a state, county, or municipal agency) are available to treat diving-related medical emergencies;
2. Ensure that each dive site has a means to alert these treatment resources in a timely manner when a diving-related medical emergency occurs; and
3. Ensure that transportation to a suitable decompression chamber is readily available when no decompression chamber is at the dive site, and that this transportation can deliver the injured diver to the decompression chamber within four (4) hours travel time from the dive site.

The employeer must ensure that protable O2 equipment is available at the dive site to treat injured divers. In doing so, the employer must ensure that:

1. The equipment delivers medical-grade O2 that meets the requirements for medical USP oxygen (Type I, Quality Verification Level A) of CGA G-4.3-2000 (—Commodity Specification for Oxygen“);
2. The equipment delivers this O2 to a transparent mask that covers the injured diver‘s nose and mouth; and
3. Sufficient O2 is available for administration to the injured diver from the time the employer recognizes the symptoms of a diving-related medical emergency until the injured diver reaches a decompression chamber for treatment.

Before each day‘s diving operations, the employer must:

1. Ensure that at least two attendants, either employees or non-employees, qualified in first-aid and administering O2 treatment, are available at the dive site to treat diving-related medical emergencies; and
2. Verify their qualifications for this task.

DIVING LOGS AND NO-DECOMPRESSION TABLES

Before starting each day‘s diving operations, the employer must:

1. Designate an employee or a non-employee to make entries in a diving log; and
2. Verify that this designee understands the diving and medical terminology, and proper procedures, for making correct entries in the diving log.

The employer must:

1. Ensure that the diving log conforms to the requirements of Record of dive; and
2. Maintain a record of the dive according to Recordkeeping requirements.

The employer must ensure that a hard-copy of the no-decompression tables used for the dive is readily available at the dive site, whether or not the divers use dive-decompression computers.

DIVER TRAINING

The employer must ensure that each diver receives training that enables the diver to perform work safely and effectively while using open-circuit SCUBAs or rebreathers supplied with nitrox breathing-gas mixtures.

Accordingly, each diver must be able to demonstrate the ability to perform critical tasks safely and effectively, including, but not limited to: recognizing the effects of breathing excessive CO2 and O2; taking appropriate action after detecting excessive levels of CO2 and O2; and properly evaluating, operating, and maintaining their diving equipment under the diving conditions they encounter.

TESTING PROTOCOL FOR DETERMINING THE CO2 LIMITS OF REBREATHER CANISTERS

The employer must ensure that the rebreather manufacturer has used the following procedures for determining that the CO2-sorbent material meets the specifications of the sorbent material's manufacturer:

1. The North Atlantic Treating Organization CO2 absorbent-activity test;
2. The RoTap shaker and nested-sieves test;
3. The Navy Experimental Diving Unit ("NEDU")-derived Schlegel test; and
4. The NEDU MeshFit software.

The employer must ensure that the rebreather manufacturer has applied the following canister-testing materials, methods, procedures, and statistical analyses:

1. Use of a nitrox breathing-gas mixture that has an O2 fraction maintained at 0.28 (equivalent to 1.4 ATA of O2 at 130 fsw, the maximum O2 concentration permitted at this depth);
2. While operating the rebreather at a maximum depth of 130 fsw, use of a breathing machine to continuously ventilate the rebreather with breathing gas that is at 100 percent humidity and warmed to a temperature of 98.6 degrees F (37 degrees C) in the heating-humidification chamber;
3. Measurement of the O2 concentration of the inhalation breathing gas delivered to the mouthpiece;
4. Testing of the canisters using the three ventilation rates listed in Table I below (with the required breathing-machine tidal volumes and frequencies, and CO2-injection rates, provided for each ventilation rate):
5. When using a work rate (i.e., breathing-machine tidal volume and frequency) other than the work rates listed in the table above, addition of the appropriate combinations of ventilation rates and CO2-injection rates;
6. Performance of the CO2 injection at a constant (steady) and continuous rate during each testing trial;
7. Determination of canister duration using a minimum of four (4) water temperatures, including 40, 50, 70, and 90 degrees F (4.4, 10.0, 21.1, and 32.2 degrees C, respectively);
8. Monitoring of the breathing-gas temperature at the rebreather mouth-piece (at the "chrome T" connector), and ensuring that this temperature con-forms to the temperature of a diver's exhaled breath at the water temperature and ventilation rate used during the testing trial;
9. Implementation of at least eight (8) testing trials for each combination of temperature and ventilation-CO2-injection rates (for example, eight testing trials at 40 degrees F using a ventilation rate of 22.5 Lpm at a CO2-injection rate of 0.90 Lpm);
10. Allowing the water temperature to vary no more than 2.0 degrees F (1.0 degree C) between each of the eight testing trials, and no more than 1.0 degree F (0.5 degree C) within each testing trial;
11. Use of the average temperature for each set of eight testing trials in the statistical analysis of the testing-trial results, with the testing-trial results being the time taken for the inhaled breathing gas to reach 0.005 ATA of CO2 (i.e., the canister-duration results);

12. Analysis of the canister-duration results using the repeated-measures statistics described in NEDU Report 2-99;
13. Specification of the replacement schedule for the CO2-sorbent materials in terms of the lower prediction line (or limit) of the 95 percent confidence interval; and
14. Derivation of replacement schedules only by interpolating among, but not by extrapolating beyond, the depth, water temperatures, and exercise levels used during canister testing.

NEDU can provide the manufacturer with information on the temperature of a diver‘s exhaled breath at various water temperatures and ventilation rates, as well as techniques and procedures used to maintain these temperatures during the testing trials.

RECORDKEEPING REQUIREMENTS

The employer must record the occurrence of any diving-related injury or illness which requires any dive team member to be hospitalized for 24 hours or more, specifying the circumstances of the incident and the extent of any injuries or illnesses.

AVAILABILITY OF RECORDS

- Upon the request of the Assistant Secretary of Labor for Occupational Safety and Health, or the Director, National Institute for Occupational Safety and Health, Department of Health and Human Services of their designees, the employer must make available for inspection and copying any record or document required by this standard.
- Records and documents required by this standard must be provided upon request to employees, designated representatives, and the Assistant Secretary.
- Safe practices manuals, depth-time profiles, recordings of dives, decompression procedure assessment evaluations, and records of hospitalizations must be provided in
- the same manner as employee exposure records or analyses using exposure or medical records.
- Equipment inspections and testing records which pertain to employees must also be provided upon request to employees and their designated representatives.

Records and documents required by this standard must be retained by the employer for the following period:
1. Dive team member medical records (physician's reports) - 5 years;
2. Safe practices manual - current document only;
3. Depth-time profile - until completion of the recording of dive, or until completion of decompression procedure assessment where there has been an incident of decompression sickness;
4. Recording of dive - 1 year, except 5 years where there has been an incident of decompression sickness;
5. Decompression procedure assessment evaluations - 5 years;
6. Equipment inspections and testing records - current entry or tag, or until equipment is withdrawn from service;
7. Records of hospitalizations - 5 years.

• After the expiration of the retention period of any record required to be kept for five (5) years, the employer must forward such records to the National Institute for Occupational Safety and Health, Department of Health and Human Services.

In the event the employer ceases to do business:
• The successor employer must receive and retain all dive and employee medical records required by this standard; or

If there is no successor employer, dive and employee medical records must be forwarded to the National Institute for Occupational Safety and Health, Department of Health and Human Services.

DEFINITIONS

As used in this standard, the listed terms are defined as follows:

Acfm: Actual cubic feet per minute.

ASME Code or equivalent: ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code, Section VIII, or an equivalent code which the employer can demonstrate to be equally effective.

ATA: Atmosphere absolute.

Bell: An enclosed compartment, pressurized (closed bell) or unpressurized (open bell), which allows the diver to be transported to and from the underwater work area and which may be used as a temporary refuge during diving operations.

Bottom time: The total elapsed time measured in minutes from the time when the diver leaves the surface in descent to the time that the diver begins ascent.

Bursting pressure: The pressure at which a pressure containment device would fail structurally

Cylinder: A pressure vessel for the storage of gases.

Decompression chamber: A pressure vessel for human occupancy such as a surface decompression chamber, closed bell, or deep diving system used to decompress divers and to treat decompression sickness.

Decompression sickness: A condition with a variety of symptoms which may result from gas or bubbles in the tissues of divers after pressure reduction.

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

Depth: The actual depth of the dive measured in feet below the water's surface. For purposes of determining pressure equivalents, these measurements are assumed to be salt water at 0.445 pounds per square inch per foot of depth (0.445 psi/ft depth). Fresh water equals 0.432 psi/ft depth.

Dive-guiding operations means leading groups of sports divers, who use an open-circuit, semi-closed-circuit, or closed-circuit self-contained underwater breathing apparatus, to local undersea diving locations for recreational purposes.

Dive location: A surface or vessel from which a diving operation is conducted.

Dive-location reserve breathing gas: A supply system of air or mixed-gas (as appropriate) at the dive location which is independent of the primary supply system and sufficient to support divers during the planned decompression.

Dive team: Divers and support employees involved in a diving operation, including the designated person-in-charge.

Diver: An employee working in water using under water apparatus which supplies compressed breathing gas at the ambient pressure.

Diver-carried reserve breathing gas: A diver-carried supply of air or mixed gas (as appropriate) sufficient under standard operating conditions to allow the diver to reach the surface, or another source of breathing gas, or to be reached by a standby diver.

Diving mode: A type of diving requiring specific equipment, procedures and techniques (SCUBA, surface-supplied air, or mixed gas).

Fsw: Feet of seawater (or equivalent static pressure head).

Heavy gear: Diver-worn deep-sea dress including helmet, breastplate, dry suit, and weighted shoes.
Hyperbaric conditions: Pressure conditions in excess of surface pressure.
Inwater stage: A suspended underwater platform which supports a diver in the water.
Liveboating: The practice of supporting a surfaced-supplied air or mixed gas diver from a vessel which is underway.
Mixed-gas diving: A diving mode in which the diver is supplied in the water with a breathing gas other than air.
No-decompression limits: The depth-time limits of the no-decompression limits and repetitive dive group designation table for no-decompression air dives, U.S. Navy Diving Manual or equivalent limits which the employer can demonstrate to be equally effective.
Psi (g): Pounds per square inch (gauge).
Recreational diving instruction means training diving students in the use of recreational diving procedures and the safe operation of diving equipment, including an open-circuit, semi-closed-circuit, or closed-circuit self-contained underwater breathing apparatus, during dives.
Scientific diving means diving performed solely as a necessary part of a scientific, research, or educational activity by employees whose sole purpose for diving is to perform scientific research tasks. Scientific diving does not include performing any tasks usually associated with commercial diving such as: Placing or removing heavy objects underwater; inspection of pipelines and similar objects; construction; demolition; cutting or welding; or the use of explosives.
SCUBA diving: A diving mode independent of surface supply in which the diver uses open circuit self-contained underwater breathing apparatus.
Standby diver: A diver at the dive location available to assist a diver in the water.
Surface-supplied air diving: A diving mode in which the diver in the water is supplied from the dive location with compressed air for breathing.
Treatment table: A depth-time and breathing gas profile designed to treat decompression sickness.
Umbilical: The composite hose bundle between a dive location and a diver or bell, or between a diver and a bell, which supplies the diver or bell with breathing gas, communications, power, or heat as appropriate to the diving mode or conditions, and includes a safety line between the diver and the dive location.
Volume tank: A pressure vessel connected to the outlet of a compressor and used as an air reservoir.
Working pressure: The maximum pressure to which a pressure containment device may be exposed under standard operating conditions.

DIVING SAFETY AND PLANNING CHECKLIST
STEPS IN PLANNING OF DIVING OPERATIONS
Detailed, advanced planning is the foundation of diving safety.
ANALYZE THE MISSION FOR SAFETY
__ Ensure mission objective is defined.
__ Determine that non-diving means of mission accomplishment have been considered and eliminated as inappropriate.
__ Coordinate emergency assistance.
__ Review relevant instructions.
IDENTIFY AND ANALYZE POTENTIAL HAZARDS
NATURAL HAZARDS:
ATMOSPHERIC:
__ Exposure of personnel to extreme conditions
__ Adverse exposure of equipment and supplies to elements
__ Delays or disruption caused by weather
SURFACE:
__ Sea sickness
__ Water entry and exit
__ Handling of heavy equipment in rough seas
__ Maintaining location in tides and currents
__ Ice, flotsam, kelp, and petroleum in the water
__ Delays or disruption caused by sea state
UNDERWATER AND BOTTOM:
__ Depth which exceeds diving limits or limits of available equipment
__ Exposure to cold temperatures
__ Dangerous marine life
__ Tides and currents
__ Limited visibility
__ Bottom obstructions
__ Ice (underwater pressure ridges, loss of entry hole, loss of orientation, etc.)
__ Dangerous bottom conditions (mud, drop-offs, etc.)
ON-SITE HAZARDS:
__ Local marine traffic or other conflicting operations
__ Other conflicting commercial operations
__ High-powered, active sonar
__ Radiation contamination and other pollution (chemical, sewer outfalls, etc.)

MISSION HAZARDS:
__ Decompression sickness
__ Communications problems
__ Drowning
__ Other trauma (injuries)
__ Hostile action

OBJECT HAZARDS:
__ Entrapment and entanglement
__ Shifting or working of object
__ Explosives or other ordnance

SELECT EQUIPMENT, PERSONNEL, AND EMERGENCY PROCEDURES

DIVING PERSONNEL:
__ Assign a complete and properly qualified Diving Team.
__ Assign the right man to the right task.
__ Verify that each member of the Diving Team is properly trained and qualified for the equipment and depths involved.

DETERMINE THAT EACH MAN IS PHYSICALLY FIT TO DIVE, PAYING ATTENTION TO:
__general condition and any evidence of fatigue
__record of last medical exam
__ears and sinuses
__severe cold or flu
__use of stimulants or intoxicants

OBSERVE DIVERS FOR EMOTIONAL READINESS TO DIVE:
__motivation and professional attitude
__stability (no noticeably unusual or erratic behavior)

DIVING EQUIPMENT:
__ Verify that diving gear chosen and diving techniques are adequate and authorize for mission and particular task.
__ Verify that equipment and diving technique are proper for depth involved.
__ Verify that life support equipment has been tested and approved for use.
__ Determine that all necessary support equipment and tools are readily available and are best for accomplishing job efficiently and safely.
__ Determine that all related support equipment such as winches, boats, cranes, floats, etc. are operable, safe and under control of trained personnel.
__ Check that all diving equipment has been properly maintained (with appropriate records) and is in full operating condition.

PROVIDE FOR EMERGENCY EQUIPMENT

__ Obtain suitable communications equipment with sufficient capability to reach outside help; check all communications for proper operation.

__ Verify that recompression chambers is ready for use, or notify the nearest command with one that its use may be required within a given timeframe.

__ Verify that a completely stocked first aid kit is at hand.

__ If oxygen will be used as standby first aid, verify that the tank is full and properly pressurized, and that masks, valves, and other accessories are fully operable.

__ If a resuscitator will be used, check apparatus for function.

__ Check that fire-fighting equipment is readily available and in full operating condition.

__ Verify that emergency transportation is either standing by or on immediate call.

ESTABLISH EMERGENCY PROCEDURES:

__ Know how to obtain medical assistance immediately.
__ For each potential emergency situation, assign specific tasks to the diving team and support personnel.
__ Complete and post Emergency Assistance Checklist; ensure that all personnel are familiar with it.
__ Verify that an up-to-date copy of Decompression Tables is available.
__ Ensure that all divers, boat crews and other support personnel understand all diver hand signals.
__ Predetermine distress signals and call-signs.
__ Ensure that all divers have removed anything from their mouths on which they might choke during a dive (gum, dentures, tobacco).
Thoroughly drill all personnel in Emergency Procedures, with particular attention to cross-training; drills should include:

ESTABLISH SAFE DIVING OPERATIONAL PROCEDURES
COMPLETE PLANNING, ORGANIZATION, AND COORDINATION ACTIVITIES:

__ Ensure that other means of accomplishing mission have been considered before deciding to use divers.
__ Ensure that contingency planning has been conducted.
__ Carefully state goals and tasks of each mission and develop a flexible plan of operations (Dive Plan).
__ Completely brief the diving team and support personnel.
__ Designate a Master Diver or properly qualified Diving Supervisor to be in charge of the mission.
__ Designate a recorder/timekeeper and verify that he understands his duties and responsibilities.
__ Determine the exact depth at the job-site through the use of a lead line, pneumofathometer, or commercial depth sounder.
__ Verify existence of an adequate supply of compressed air available for all planned diving operations plus an adequate reserve for emergencies.
__ Ensure that no operations or actions on part of diving team, support personnel, technicians, boat crew, winch operators, etc., take place without the knowledge of and by the direct command of the Diving Supervisor.
__ All efforts must be made through planning, briefing, training, organization, and other preparations to minimize bottom time. Water depth and the condition of the diver (especially fatigue), rather than the amount of work to be done, shall govern diver's bottom time.
__ Current decompression tables shall be on hand and shall be used in all planning and scheduling of diving operations.
__ Instruct all divers and support personnel not to cut any lines until approved by the Diving Supervisor.
__ Ensure that ship, boat, or diving craft is securely moored and in position to permit safest and most efficient operations (exceptions are emergency and critical ship repairs).
__ Verify that, when using surface-supplied techniques, the ship, boat, or diving craft has at least a two-point moor.
__ Ensure that, when conducting SCUBA operations in hazardous conditions, a boat can be quickly cast off and moved to a diver in distress.

PERFORM DIVING SAFETY PROCEDURES, ESTABLISH SAFETY MEASURES:

__ Ensure that each diver checks his own equipment in addition to checks made by tenders, technicians or other support personnel.
__ Designate a standby diver for all diving operations; standby diver shall be dressed to the necessary level and ready to enter the water if needed.
__ Assign buddy divers, when required, for all scuba operations.
__ Take precautions to prevent divers from being fouled on bottom. If work is conducted inside a wreck or other structure, assign a team of divers to accomplish task. One diver enters wreck, the other tends his lines from point of entry.

__ When using explosives, take measures to ensure that no charge shall be fired while divers are in water.
__ Use safety procedures as outlined in relevant Naval publications for all U/W cutting and welding operations.
__ Brief all divers and deck personnel on the planned decompression schedules for each particular dive. Check provisions for decompressing the diver.
__ Verify that ship, boat, or diving craft is displaying proper signals, flags, day shapes, or lights to indicate diving operations are in progress. (Consult publications governing International or Inland Rules, International/Inland local signals, and Navy communications instructions.)
__ Ensure that protection against harmful marine life has been provided.
__ Check that the quality of diver's air supply is periodically and thoroughly tested to ensure purity.
__ Thoroughly brief boat crew.
__ Verify that proper safety and operational equipment is aboard small diving boats or craft.

NOTIFY PROPER PARTIES THAT DIVE OPERATIONS ARE READY TO COMMENCE:

__ Diving Officer
__ Captain of ship

ENSURE THAT SHIP'S PERSONNEL SHALL NOT:

__ turn the propeller or thrusters
__ get underway
__ activate active sonar or other electronics
__ drop heavy items overboard
__ shift the moor

__Other Interested Parties and Commands:
__ Harbor Master
__ U.S. Coast Guard (if broadcast warning to civilians is required)
__ Other: _____
__Notify facilities having recompression chambers and sources of emergency transportation that diving operations are underway and their assistance may be needed.

SURFACE-SUPPLIED DIVING OPERATIONS PRE-DIVE CHECKLIST

BASIC PREPARATION:

__ Verify that a recompression chamber, Diving Officer, and Diving Medical Officer shall be present on the diving station for dives of more than 190 fsw.

__ Verify that proper signals indicating underwater operations being conducted are displayed correctly.

__ Ensure that all personnel concerned, or in the vicinity, are informed of diving operations.

__ Determine that all valves, switches, controls, and equipment components affecting diving operation are tagged-out to prevent accidental shut-down or activation.

__ Verify that diving system and recompression chamber are currently certified or granted a waiver to operate.

EQUIPMENT PROTECTION:

__ Assemble all members of the diving team and support personnel (winch operators, boat crew, watchstanders, etc.) for a predive briefing.

__ Assemble and lay out all dive equipment, both primary equipment and standby spares for diver (or standby diver), including all accessory equipment and tools.

__ Check all equipment for superficial wear, tears, dents, distortion, or other discrepancies.

__ Check all masks, helmets, view ports, faceplates, seals, and visors for damage.

__ Check all harnesses, laces, strain reliefs, and lanyards for wear; renew as needed.

MK 21 MOD1:

__ Ensure that all Operating Procedures (OPs) have been completed.

MK 20 MOD 0:

__ Ensure that all Operating Procedures (OPs) have been completed.

General Equipment:

__ Check that all accessory equipment – tools, lights, special systems, spares, etc., – are on site and in working order. In testing lights, tests should be conducted with lights submerged in water and extinguished before removal, to prevent overheating and failure.

__ Erect diving stage or attach diving ladder. In the case of the stage, ensure that the screw pin shackle connecting the stage line is securely fastened with the shackle pin seized with wire or a safety shackle is used to help prevent opening.

PREPARING THE DIVING SYSTEM:

__ Check that a primary and suitable back-up air supply is available with a capacity in terms of purity, volume, and supply pressure to completely service all divers including decompression, recompressions and accessory equipment throughout all phases of the planned operation.

__ Verify that all diving system operating procedures have been conducted to properly align the dive system.

__ Ensure that qualified personnel are available to operate and stand watch on the dive system.

COMPRESSORS:

__ Determine that sufficient fuel, coolant, lubricants, and antifreeze are available to service all components throughout the operation. All compressors should be fully fueled, lubricated, and serviced (with all spillage cleaned up completely).

__ Verify that all diving system operating procedures have been conducted properly to align the dive system.
__ Check maintenance and repair logs to ensure the suitability of the compressor (both primary and back-up) to support the operation.
__ Verify that all compressor controls are properly marked and any remote valving is tagged with “Divers Air Supply - Do Not Touch” signs.
__ Ensure that compressor is secure in diving craft and shall not be subject to operating angles, caused by roll or pitch, that will exceed 15 degrees from the horizontal.
__ Verify that oil in the compressor is an approved type. Check that the compressor oil does not overflow Fill mark; contamination of air supply could result from fumes or oil mist.
__ Check that compressor exhaust is vented away from work areas and, specifically, does not foul the compressor intake.
__ Check that compressor intake is obtaining a free and pure suction without contamination. Use pipe to lead intake to a clear suction if necessary.
__ Check all filters, cleaners and oil separators for cleanliness IAW PMS.
__ Bleed off all condensed moisture from filters and from the bottom of volume tanks. Check all manifold drain plugs, and that all petcocks are closed.
__ Check that all belt-guards are properly in place on drive units.
__ Check all pressure-release valves, check valves and automatic unloaders.
__ Verify that all supply hoses running to and from compressor have proper leads, do not pass near high-heat areas such as steam lines, are free of kinks and bends, and are not exposed on deck in such a way that they could be rolled over, damaged, or severed by machinery or other means.
__ Verify that all pressure supply hoses have safety lines and strain reliefs properly attached.

ACTIVATE THE AIR SUPPLY IN ACCORDANCE WITH APPROVED OPS

COMPRESSORS:

__ Ensure that all warm-up procedures are completely followed.
__ Check all petcocks, filler valves, filler caps, overflow points, bleed valves, and drain plugs for leakage or malfunction of any kind.
__ Verify that there is a properly functioning pressure gauge on the air receiver and that the compressor is meeting its delivery requirements.

CYLINDERS:

__ Gauge all cylinders for proper pressure.
__ Verify availability and suitability of reserve cylinders.
__ Check all manifolds and valves for operation.
__ Activate and check delivery.
__ For all supply systems, double check “Do Not Touch” tags (tags outs).

DIVING HOSES:

__ Ensure all hoses have a clear lead and are protected from excessive heating and damage.

__ Check hose in accordance with PMS.
__ Ensure that the hose (or any length) has not been used in a burst test program. No hose length involved in such a program shall be part of an operational diving hose.
__ Check that hoses are free of moisture, packing material, or chalk.
__ Soap test hose connections after connection to air supply and pressurization.
__ Ensure umbilical boots are in good condition.

TEST EQUIPMENT WITH ACTIVATED AIR SUPPLY IN ACCORDANCE WITH APPROVED OPS.

__ Hook up all air hoses to helmets, masks and chamber; make connections between back-up supply and primary supply manifold.
__ Verify flow to helmets and masks.
__ Check all exhaust and non-return valves.
__ Hook up and test all communications.
__ Check air flow from both primary and back-up supplies to chamber.

RECOMPRESSION CHAMBER CHECKOUT (PREDIVE ONLY):

__ Check that chamber is completely free and clear of all combustible materials.
__ Check primary and back-up air supply to chamber and all pressure gauges.
__ Check that chamber is free of all odors or other “contaminants.”
__ Hook up and test all communications.
__ Check air flow from both primary and back-up supplies to chamber.

FINAL PREPARATIONS:

__ Verify that all necessary records, logs, and timesheets are on the diving station.
__ Check that appropriate decompression tables are readily at hand.
__ Place the dressing bench in position, reasonably close to the diving ladder or stage, to minimize diver travel.

EQUIPMENT ACCIDENT/INCIDENT INFORMATION SHEET

GENERAL

Unit point of contact _____ Position _____
Command _____Date_____ Time of occurrence _____
EQUIPMENT (indicate type of all equipment worn/used) Contributing factor _____
UBA: SCUBA _____ MK21 _____ MK20 _____
MK 16 _____ LAR V _____
Other (specify) _____
Suit type: Dry _____ Wet _____ Hot water _____
Other dress:
Gloves _____ Booties _____ Fins _____
Mask _____ Snorkel _____ Knife _____
Weight belt (indicate weight) _____
Depth gauge _____ Last calibration date _____
Buoyancy compensator/life preserver: _____
Inflated at scene: _____ partially _____ Operational _____
Inflation mode: Oral _____ CO2 _____ Independent supply _____
Cylinders:
Number worn _____ Size (cu ft) _____ Valve type _____
Gas mix _____ Aluminum _____ Steel _____
Surface pressure: Before _____ After_____
Regulator: _____ Last PMS date _____ Functional at scene? _____
Submersible pressure gauge: _____ Functional at scene? _____
CONDITIONS Location _____
Depth_____ fsw Visibility_____ ft. Current _____ Knots sea state____ (0-9)
Air temp _____°F Water temp: at surface _____ °F at depth_____ °F
Bottom type (mud, sand, coral, etc.)_____
DIVE TIME
Bottom_____ Decompression _____ Total dive time _____
Was equipment operating and maintenance procedure a contributing factor?
(Explain):_____
Is there contributory error in O&M Manual or 3M System?
(Explain):_____
OTHER CONTRIBUTING FACTORS_____

DIVING LOG

Date			Geographic Location			Air Temp (°F)		
Equipment Used			Dress			Wave Height (ft)		
Breathing Medium			Platform			Water Temp (°F)		
Breathing Medium Source					Current (kts.)			
Depth of Dive (fsw)			Bottom Type			Bottom Vis (ft)		
Diver	LS	RB	LB	RS	TBT	TDT	TTD	Schedule Used

Purpose of Dive, Tools Used, etc.

Repet Group

Surface Interval
New Repet Group
RNT

Dive Comments

Signature (Diving Supervisor)
Signature (Diving Officer/Master Diver)

Emergency Assistance Log
Recompression Chamber

_____ _____
Name Phone Number

_____ _____
Location Response Time

Air Transportation

_____ _____
Name Phone Number

_____ _____
Location Response Time

Sea Transportation

_____ _____
Name Phone Number

_____ _____
Location Response Time

Hospital

_____ _____
Name Phone Number

_____ _____
Location Response Time

Gas Supplies

_____ _____
Name Phone Number

_____ _____
Location Response Time

Communications

_____ _____
Name Phone Number

_____ _____
Location Response Time

Other Diving Contractor

_____ _____
Name Phone Number

_____ _____
Location Response Time

Project Manager

_____ _____
Name Phone Number

_____ _____
Location Response Time

Diving Medical Doctor

_____ _____
Name Phone Number

_____ _____
Location Response Time

Emergency Consultation Duty Phone Numbers 24 Hours a Day
U.S. Navy Experimental Dive Unit (NEDU) Commercial (850) 234-4351
U.S. Navy Diving Salvage and Training Center (NDSTC) Commercial (850) 234-4651

DANGEROUS MARINE LIFE

It is beyond the scope of this addendum to catalog all types of marine encounters and potential injury. Divers and affiliated marine employees should consult their local Coast Guard for more definite information. Medical personnel are also a good source of information and should be consulted prior to operating in unfamiliar waters. A good working knowledge of the marine environment should preclude lost time and severe injury.

PREDATORY MARINE ANIMALS

SHARKS

Shark attacks on humans are infrequent. These attacks are unpredictable and injuries may result not only from bites, but also by coming in contact with the shark's skin. Shark skin is covered with very sharp dentine appendages, called denticles, which are reinforced with tooth-like centers. Contact with shark skin can lead to wide abrasions and heavy bleeding.

SHARK PRE-ATTACK BEHAVIOR

Pre-attack behavior by most sharks is somewhat predictable. A shark preparing to attack swims with an exaggerated motion, its pectoral fins pointing down in contrast to the usual flared out position, and it swims in circles of decreasing radius around the prey. An attack may be heralded by unexpected acceleration or other marked change in behavior, posture, or swim patterns. Should surrounding schools of fish become unexplainably agitated, sharks may be in the area. Sharks are much faster and more powerful than any swimmer. All sharks must be treated with extreme respect and caution.

FIRST AID AND TREATMENT

Bites may result in a large amount of bleeding and tissue loss. Take immediate action to control bleeding using large gauze pressure bandages. Cover wounds with layers of compressive dressings preferably made with gauze, but easily made from shirts or towels, and held in place by wrapping the wound tightly with gauze, torn clothing, towels, or sheets. Direct pressure with elevation or extreme compression on pressure points will control all but the most serious bleeding.

The major pressure points are: the radial artery pulse point for the hand; above the elbow under the biceps muscle for the forearm (brachial artery); and the groin area with deep finger-tip or heel-of-the-hand pressure for bleeding from the leg (femoral artery). When bleeding cannot be controlled by direct pressure and elevation or pressure points, a tourniquet or ligature may be needed to save the victim's life even though there is the possibility of loss of the limb. Tourniquets are applied only as a last resort and with only enough pressure to control bleeding. Do not remove the tourniquet. The tourniquet should be removed only by a physician in a hospital setting. Loosening of a tourniquet may cause further shock by releasing toxins into the circulatory system from the injured limb as well as continued blood loss.

Treat for shock by laying the patient down and elevating his feet. If medical personnel are available, begin intravenous (IV) Ringer's lactate or normal saline with a large-bore cannula (16 or 18 ga). If blood loss has been extensive, several liters should be infused rapidly. The patient's color, pulse, and blood pressure should be used as a guide to the volume of fluid required. Maintain an airway and administer oxygen. Do not give fluids by mouth. If the patient's

cardiovascular state is stable, narcotics may be administered in small doses for pain relief. Observe closely for evidence of depressed respirations due to the use of narcotics.

Initial stabilization procedures should include attention to the airway, breathing, and circulation, followed by a complete evaluation for multiple traumas. Transport the victim to a medical facility as soon as possible. Reassure the patient. Should a severed limb be retrieved, wrap it in bandages; moisten with saline, place in a plastic bag and chill, but not in direct contact with ice. Transport the severed limb with the patient.

Clean and debride wounds as soon as possible in a hospital or controlled environment. Since shark teeth are cartilage, not bone, and may not appear on an X-ray, operative exploration should be performed to remove dislodged teeth. Consider X-ray evaluation for potential bone damage due to crush injury. Severe crush injury may result in acute renal failure due to myoglobin released from injured muscle, causing the urine to be a smoky brown color. Monitor closely for kidney function and adjust IV fluid therapy appropriately. Administer tetanus prophylaxis: Tetanus toxoid, 0.5 ml intramuscular (IM) and tetanus immune globulin, 250 to 400 units IM.

Culture infected wounds for both aerobes and anaerobes before instituting broad spectrum antibiotic coverage; secondary infections with Clostridium and Vibrio species have been reported frequently. Acute surgical repair, reconstructive surgery, and hyperbaric oxygen (HBO) adjuvant therapy improving tissue oxygenation may all be needed. In cases of unexplained decrease in mental status or other neurological signs and symptoms following shark attack while diving, consider arterial gas embolism or decompression sickness as a possible cause.

KILLER WHALES

Killer whales live in all oceans, both tropical and polar. This whale is a large mammal with a blunt, rounded snout and high black dorsal fin. The jet black head and back contrast sharply with the snowy-white underbelly. Usually, a white patch can be seen behind and above the eye. The killer whale is usually observed in packs of 3 to 40 whales. It has powerful jaws, great weight, speed, and interlocking teeth. Because of its speed and carnivorous habits, this animal should be treated with great respect. There have been no recorded attacks on humans.

PREVENTION

When killer whales are spotted, all personnel should immediately leave the water. Extreme care should be taken on shore areas, piers, barges, ice floes, etc., when killer whales are in the area.

FIRST AID AND TREATMENT

First aid and treatment would follow the same general principles as those used for a shark bite.

BARRACUDA

The barracuda is a long, thin fish with prominent jaws and teeth, silver to blue in color, with a large head and a V-shaped tail. It may grow up to 10 feet long and is a fast swimmer, capable of striking rapidly and fiercely. It will follow swimmers but seldom attacks an under-water swimmer. It is known to attack surface swimmers and limbs dangling in the water. Barracuda wounds can be distinguished from those of a shark by the tooth pattern. A barracuda leaves straight or V-shaped wounds while those of a shark are curved like the shape of its jaws. Life threatening attacks by barracuda are rare.

PREVENTION

Barracuda are attracted by any bright object. Avoid wearing shiny equipment or jewelry in waters when barracudas are likely to be present. Avoid carrying speared fish, as barracuda will strike them. Avoid splashing or dangling limbs in barracuda-infested waters.

FIRST AID AND TREATMENT

First aid and treatment follow the same general principles as those used for shark bites. Injuries are likely to be less severe than shark bite injuries.

MORAY EELS

While some temperate zone species of the moray eel are known, it primarily inhabits tropical and subtropical waters. It is a bottom dweller and is commonly found in holes and crevices or under rocks and coral. It is snake-like in both appearance and movement and has tough, leathery skin. It can grow to a length of 10 feet and has prominent teeth. A moray eel is extremely territorial and attacks frequently result from reaching into a crevice or hole occupied by the eel. It is a powerful and vicious biter and may be difficult to dislodge after a bite is initiated. Bites from moray eels may vary from multiple small puncture wounds to the tearing, jagged type with profuse bleeding if there has been a struggle. Injuries are usually inflicted on hands or forearms.

PREVENTION

Extreme care should be used when reaching into holes or crevices. Avoid provoking or attempting to dislodge an eel from its hole.

FIRST AID AND TREATMENT

Primary first aid must stop the bleeding. Direct pressure and raising the injured extremity almost always controls bleeding. Arrange for medical follow-up. Severe hand injuries should be evaluated immediately by a physician. Mild envenomation may occur from a toxin that is released from the palatine mucosa in the mouth of certain moray eels. The nature of this toxin is not known. Treatment is supportive. Follow principles of wound management and tetanus prophylaxis as in caring for shark bites. Antibiotic therapy should be instituted early. Immediate specialized care by a hand surgeon may be necessary for tendon and nerve repair of the hand to prevent permanent damage and loss of function of the hand.

SEA LIONS

The sea lion inhabits the Pacific Ocean and is numerous on the West Coast of the United States. It resembles a large seal. Sea lions are normally harm-less; however, during the breeding season (October through December) large bull sea lions can become irritated and will nip at divers. Attempts by divers to handle these animals may result in bites. These bites appear similar to dog bites and are rarely severe.

PREVENTION

Divers should avoid these mammals when in the water.

FIRST AID AND TREATMENT

Control local bleeding. Clean and debride wound. Administer tetanus prophylaxis as appropriate. Wound infections are common and prophylactic antibiotic therapy is advised.

VENOMOUS MARINE ANIMALS

VENOMOUS FISH (EXCLUDING STONEFISH, ZEBRAFISH, SCORPIONFISH)

Identification of a fish following a sting is not always possible; however, symptoms and effects of venom do not vary greatly. Venomous fish are rarely aggressive and usually contact is made by accidentally stepping on or handling the fish. Dead fish spines remain toxic. Venom is generally heat-labile and may be decomposed by hot water. Local symptoms following a sting may first include severe pain later combined with numbness or even hypersensitivity around the wound. The wound site may become cyanotic with surrounding tissue becoming pale and swollen. General symptoms may include nausea, vomiting, sweating, mild fever, respiratory distress and collapse. The pain induced may seem disproportionately high to apparent severity of the injury. Medical personnel should be prepared for serious anaphylactic reactions from apparently minor stings or envenomation.

PREVENTION

Avoid handling suspected venomous fish. Venomous fish are often found in holes or crevices or lying well camouflaged on rocky bottoms. Divers should be alert for their presence and should take care to avoid them.

FIRST AID AND TREATMENT

Get victim out of water; watch for fainting. Lay patient down and reassure. Observe for signs of shock. Wash wound with cold, salt water or sterile saline solution. Surgery may be required to open up the puncture wound. Suction is not effective to remove this toxin. Soak wound in hot water for 30 to 90 minutes. Heat may break down the venom. The water should be as hot as the victim can tolerate but not hotter than 122ºF (50ºC). Immersion in water above 122ºF (50ºC) for longer than a brief period may lead to scalding. Immersion in water up to 122ºF (50ºC) should therefore be brief and repeated as necessary. Use hot compresses if the wound is on the face. Adding magnesium sulfate (epsom salts) to the water offers no benefit.

Calcium gluconate injections, diazepam, or methocarbamol may help to reduce muscle spasms. Infiltration of the wound with 0.5 percent to 2.0 per-cent xylocaine with no epinephrine is helpful

in reducing pain. If xylocaine with epinephrine is mistakenly used, local necrosis may result from both the toxin and epinephrine present in the wound. Narcotics may also be needed to manage severe pain. Clean and debride wound. Spines and sheath frequently remain. Be sure to remove the entire sheath as it may continue to release venom. Tourniquets or ligatures are no longer advised. Use an antiseptic or antibiotic ointment and sterile dressing. Restrict movement of the extremity with immobilizing splints and cravats. Administer tetanus prophylaxis as appropriate. Treat prophylactically with topical antibiotic ointment. If delay in treatment has occurred, it is recommended that the wound be cultured prior to administering systemic antibiotics.

HIGHLY TOXIC FISH (STONEFISH, ZEBRAFISH, AND SCORPIONFISH)

Stings by stonefish, zebrafish, and scorpionfish have been known to cause fatalities. While many similarities exist between these fish and the venomous fish of the previous section, a separate section has been included because of the greater toxicity of their venom and the availability of an antivenin. The antivenin is specific for the stonefish but may have some beneficial effects against the scorpionfish and zebrafish. Local symptoms are similar to other fish envenomation except that pain is more severe and may persist for many days. Generalized symptoms are often present and may include respiratory failure and cardiovascular collapse. These fish are widely distributed in temperate and tropical seas and in some arctic waters. They are shallow-water bottom dwellers. Stonefish and scorpionfish are flattened vertically, dark and mottled. Zebrafish are ornate and feathery in appearance with alternating patches of dark and light color.

PREVENTION

Prevention is the same as for venomous fish.

FIRST AID AND TREATMENT

Give the same first aid as that given for venomous fish. Observe the patient carefully for the possible development of life-threatening complications. The venom is an unstable protein which acts as a myotoxin on skeletal, involuntary, and cardiac muscle. This may result in muscular paralysis, respiratory depression, peripheral vasodilation, shock, cardiac dysrhythmias, or cardiac arrest.

Clean and debride wound. Antivenin is available from Commonwealth Serum Lab, Melbourne, Australia. If antivenin is used, the directions regarding dosage and sensitivity testing on the accompanying package insert should be followed and the physician must be ready to treat for anaphylactic shock (severe allergic reaction). In brief, one or two punctures require 2,000 units (one ampule); three to four punctures, 4,000 units (two ampules); and five to six punctures, 6,000 units (three ampules). Antivenin must be delivered by slow IV injection and the victim closely monitored for anaphylactic shock. Institute tetanus prophylaxis, analgesic therapy and antibiotics as described for other fish stings.

STINGRAYS

The stingray is common in all tropical, subtropical, warm, and temperate regions. It usually favors sheltered water and will burrow into sand with only eyes and tail exposed. It has a bat-like shape and a long tail. Approximately 1,800 stingray attacks are reported annually in the U.S. Most attacks occur when waders inadvertently step on a ray, causing it to lash out defensively with its tail. The spine is located near the base of the tail. Wounds are either of the laceration or puncture type and are extremely painful. The wound appears swollen and pale with a blue rim. Secondary wound infections are common. Systemic symptoms may be present and can include fainting, nausea, vomiting, sweating, respiratory difficulty, and cardiovascular collapse.

PREVENTION

In shallow waters which favor stingray habitation, shuffle feet on the bottom and probe with a stick to alert the rays and chase them away.

FIRST AID AND TREATMENT

Give the same first aid as that given for venomous fish. No antivenom is available. Make sure to institute hot water therapy as described under fish envenomation instructions. Clean and debride wound. Removal of the spine may additionally lacerate tissues due to retro-pointed barbs. Be sure to remove integumental sheath as it will continue to release toxin. Observe patient carefully for the possible development of life-threatening complications.

Symptoms can include cardiac dysrhythmias, hypotension, vomiting, diarrhea, sweating, muscle paralysis, respiratory depression, and cardiac arrest. Fatalities have been reported occasionally. Institute tetanus prophylaxis, analgesic therapy, and broad-spectrum antibiotics as described for fish envenomation.

COELENTERATES (JELLYFISH, ANEMONE, ETC.)

HAZARDOUS TYPES OF COELENTERATES INCLUDE

Portuguese man-of-war, sea wasp or box jellyfish, sea nettle, sea blubber, sea anemone, and rosy anemone. Jellyfish vary widely in color (blue, green, pink, red, brown) or may be transparent. They appear to be balloon-like floats with tentacles dangling down into the water. The most common stinging injury is the jellyfish sting. Jelly-fish can come into direct contact with a diver in virtually any oceanic region, worldwide. When this happens, the diver is exposed to literally thousands of minute stinging organs in the tentacles called nematocysts. Most jellyfish stings result only in painful local skin irritation.

The sea wasp or box jellyfish and Portuguese man-of-war are the most dangerous types. The sea wasp or box jellyfish (found in the Indo-Pacific) can induce death within 10 minutes by cardiovascular collapse, respiratory failure, and muscular paralysis. Deaths from Portuguese man-of-war stings have also been reported. Even though intoxication from ingesting poisonous sea anemones is rare, sea anemones must not be eaten.

PREVENTION

Do not handle jellyfish, beached or apparently dead. Hazardous specimens may still be able to sting. Coelenterates include the Portuguese man-of-war and the sea wasp. Even towels or clothing contaminated with the stinging nematocysts may cause stinging months later.

AVOIDANCE OF TENTACLES

In some species of jellyfish, tentacles may trail for great distances horizontally or vertically in the water and are not easily seen by the diver. Swimmers and divers should avoid close proximity to jellyfish to avoid contacting their tentacles, especially when near the surface.

PROTECTION AGAINST JELLYFISH

Wet suits, body shells, or protective clothing should be worn when diving in waters where jellyfish are abundant. Petroleum jelly applied to exposed skin (e.g., around the mouth) helps to prevent stinging, but caution should be used since petroleum jelly can deteriorate rubber products.

FIRST AID AND TREATMENT

Without rubbing, gently remove any remaining tentacles using a towel or clothing. For preventing any further discharge of the stinging nematocysts, use vinegar (dilute acetic acid) or a 3- to 10-percent solution of acetic acid. An aqueous solution of 20 percent aluminum sulfate and 11 percent surfactant (detergent) is moderately effective but vinegar works better. Do not use alcohol or preparations containing alcohol. Methylated spirits or methanol, 100 percent alcohol and alcohol plus seawater mixtures have all been demonstrated to cause a massive discharge of the nematocysts. In addition, these compounds may also worsen the skin

inflammatory reaction. Picric acid, human urine, and fresh water also have been found to either be ineffective or even to discharge nematocysts and should not be used. Rubbing sand or applying papain-containing meat tenderizer is ineffective and may lead to further nematocysts discharge and should not be used. It has been suggested that isopropyl (rubbing) alcohol may be effective. It should only be tried if vinegar or dilute acetic acid is not available.

SYMPTOMATIC TREATMENT

Symptomatic treatment can include topical steroid therapy, anesthetic ointment (xylocaine, 2 percent) antihistamine lotion, systemic antihistamines or analgesics. Benzocaine topical anesthetic preparations should not be used as they may cause sensitization and later skin reactions.

ANAPHYLAXIS

Anaphylaxis (severe allergic reaction) may result from jellyfish stings.

ANTIVENIN

Antivenin is available to neutralize the effects of the sea wasp or box jellyfish (Chironex fleckeri). The antivenin should be administered slowly through an IV, with an infusion technique if possible. IM injection should be administered only if the IV method is not feasible.

One container (vial) of sea wasp antivenin should be used by the IV route and three containers if injected by the IM route. Each container of sea wasp antivenin is 20,000 units and is to be kept refrigerated, not frozen, at 36-50ºF (2-10ºC). Sensitivity reaction to the antivenin should be treated with a subcutaneous injection of epinephrine (0.3cc of 1:1,000 dilution), corticosteroids, and antihistamines. Treat any hypotension (severely low blood pressure) with IV volume expanders and pressor medication as necessary. The antivenin may be obtained from the Commonwealth Serum Laboratories, Melbourne, Australia.

CORAL

Coral, a porous, rock-like formation, is found in tropical and subtropical waters. Coral is extremely sharp and the most delicate coral is often the most dangerous because of their razor-sharp edges. Coral cuts, while usually fairly superficial, take a long time to heal and can cause temporary disability. The smallest cut, if left untreated, can develop into a skin ulcer. Secondary infections often occur and may be recognized by the presence of a red and tender area surrounding the wound. All coral cuts should receive medical attention. Some varieties of coral can actually sting a diver since coral is a coelenterate like jelly-fish. Some of the soft coral of the genus Palythoa have been found recently to contain the deadliest poison known to man. This poison is found within the body of the organism and not in the stinging nematocysts. The slime of this coral may cause a serious skin reaction (dermatitis) or even be fatal if exposed to an open wound. No antidote is known.

PREVENTION

Extreme care should be used when working near coral. Often coral is located in a reef formation subjected to heavy surface water action, surface current, and bottom current. Surge also develops in reef areas. For this reason, it is easy for the unknowing diver to be swept or tumbled across coral with serious consequences. Be prepared.

PROTECTION AGAINST CORAL

Coral should not be handled with bare hands. Feet should be protected with booties, coral shoes or tennis shoes. Wet suits and protective clothing, especially gloves (neoprene or heavy work gloves), should be worn when near coral.

FIRST AID AND TREATMENT

Control local bleeding. Promptly clean with hydrogen peroxide or 10-percent povidone-iodine solution and debride the wound, removing all foreign particles. Cover with a clean dressing. Administer tetanus prophylaxis as appropriate. Topical antibiotic ointment has been proven very effective in preventing secondary infection. Stinging coral wounds may require symptomatic management such as topical steroid therapy, systemic antihistamines, and analgesics. In severe cases, restrict the patient to bed rest with elevation of the extremity, wet-to-dry dressings, and systemic antibiotics. Systemic steroids may be needed to manage the inflammatory reaction resulting from a combination of trauma and dermatitis.

OCTOPUSES

The octopus inhabits tropical and temperate oceans. Species vary depending on region. It has a large sac surrounded by 8 to 10 tentacles. The head sac is large with well-developed eyes and horny jaws on the mouth. Movement is made by jet action produced by expelling water from the mantle cavity through the siphon. The octopus will hide in caves, crevices and shells. It possesses a well-developed venom apparatus in its salivary glands and stings by biting. Most species of octopus found in the U.S. are harmless. The blue-ringed octopus common in Australian and Indo-Pacific waters may inflict fatal bites. The venom of the blue-ringed octopus is a neuromuscular blocker called tetrodotoxin and is also found in Puffer (Fugu) fish. Envenomation from the bite of a blue-ringed octopus may lead to muscular paralysis, vomiting, respiratory difficulty, visual disturbances, and cardiovascular collapse.

Octopus bites consist of two small punctures. A burning or tingling sensation results and may soon spread. Swelling, redness, and inflammation are common. Bleeding may be severe and the clotting ability of the blood is often retarded by the action of an anticoagulant in the venom.

PREVENTION

Extreme care should be used when reaching into caves and crevices. Regardless of size, an octopus should be handled carefully with gloves. One should not spear an octopus, especially the large ones found off the coast of the Northwestern United States, because of the risk of being entangled by its tentacles. If killing an octopus becomes necessary, stabbing it between the eyes is recommended.

FIRST AID AND TREATMENT

Control local bleeding. Clean and debride the wound and cover with a clean dressing. For suspected blue-ringed octopus bites, do not apply a loose constrictive band. Apply direct pressure with a pressure bandage and immobilize the extremity in a position that is lower than the heart using splints and elastic bandages. Be prepared to administer mouth-to-mouth resuscitation and cardiopulmonary resuscitation if necessary.

Blue-ringed octopus venom is heat stable and acts as a neurotoxin and neuromuscular blocking agent. Venom is not affected by hot water therapy. No antivenin is available. Medical therapy for blue-ringed octopus bites is directed toward management of paralytic, cardiovascular, and respiratory complications. Respiratory arrest is common and intubation with mechanical ventilation may be required. Duration of paralysis is between 4 and 12 hours. Reassure the patient. Administer tetanus prophylaxis as appropriate.

SEGMENTED WORMS (ANNELIDA) (E.G. BLOODWORM, BRISTLEWORM)

This invertebrate type varies according to region and is found in warm, tropical or temperate zones. It is usually found under rocks or coral and is especially common in the tropical Pacific, Bahamas, Florida Keys, and Gulf of Mexico. Annelida have long, segmented bodies with stinging bristle-like structures on each segment. Some species have jaws and will also inflict a very painful bite. Venom causes swelling and pain.

PREVENTION

Wear lightweight, cotton gloves to protect against bloodworms, but wear rubber or heavy leather gloves for protection against bristleworms.

FIRST AID AND TREATMENT

Remove bristles with a very sticky tape such as adhesive tape or duct tape. Topical application of vinegar will lessen pain. Treatment is directed toward relief of symptoms and may include topical steroid therapy, systemic antihistamines, and analgesics. Wound infection can occur but can be easily prevented by cleaning the skin using an antiseptic solution of 10 percent povidone-iodine and topical antibiotic ointment. Systemic antibiotics may be needed for established secondary infections that first need culturing, aerobically and anaerobically.

SEA URCHINS

There are various species of sea urchins with widespread distribution. Each species has a radial shape and long spines. Penetration of the sea urchin spine can cause intense local pain due to venom in the spine or from another type of stinging organ called the globiferous pedicellariae. Numbness, generalized weakness, paresthesias, nausea, vomiting, and cardiac dysrhythmias have been reported.

PREVENTION

Avoid contact with sea urchins. Even the short-spined sea urchin can inflict its venom via the pedicellariae stinging organs. Protective footwear and gloves are recommended. Spines can penetrate wet suits, booties, and tennis shoes.

FIRST AID AND TREATMENT

Remove large spine fragments gently, being very careful not to break them into small fragments that remain in the wound. Bathe the wound in vinegar or isopropyl alcohol. Soaking the injured extremity in hot water up to 122ºF (50ºC) may help. Caution should be used to prevent scalding the skin which can easily occur after a brief period in water above 122ºF (50ºC). Clean and debride the wound. Topical antibiotic ointment should be used to prevent infection. Culture both aerobically and anaerobically before administering systemic antibiotics for established secondary infections. Remove as much of the spine as possible. Some small fragments may be absorbed by the body. Surgical removal, preferably with a dissecting micro-scope, may be required when spines are near nerves and joints. X-rays may be required to locate these spines. Spines can form granulomas months later and may even migrate to other sites. Allergic reaction and bronchospasm can be controlled with subcutaneous epinephrine (0.3 cc of 1:1,000 dilution) and by using systemic antihistamines. There are no specific antivenins available. Administer tetanus prophylaxis as appropriate. Get medical attention for deep wounds.

CONE SHELLS

The cone shell is widely distributed in all regions and is usually found under rocks and coral or crawling along sand. The shell is most often symmetrical in a spiral coil, colorful, with a distinct head, one to two pairs of tentacles, two eyes, and a large flattened foot on the body. A cone shell sting should be considered as severe as a poisonous snake bite. It has a highly developed venom apparatus: venom is contained in darts inside the proboscis which extrudes from the narrow end but is able to reach most of the shell. Cone shell stings are followed by a stinging or burning sensation at the site of the wound. Numbness and tingling begin at the site of the wound and may spread to the rest of the body; involvement of the mouth and lips is severe. Other symptoms may include muscular paralysis, difficulty with swallowing and speech, visual disturbances, and respiratory distress.

PREVENTION

Avoid handling cone shells. Venom can be injected through clothing and gloves.

FIRST AID AND TREATMENT

Lay the patient down. Do not apply a loose constricting band or ligature. Direct pressure with a pressure bandage and immobilization in a position lower than the level of the heart using splints

and elastic bandages is recommended. Some authorities recommend incision of the wound and removal of the venom by suction, although this is controversial. However, general agreement is that if an incision is to be made, the cuts should be small (one centimeter), linear and penetrate no deeper than the subcutaneous tissue. The incision and suction should only be performed if it is possible to do so within two minutes of the sting. Otherwise, the procedure may be ineffective. Incision and suction by inexperienced personnel has resulted in inadvertent disruption of nerves, ten-dons, and blood vessels.

Transport the patient to a medical facility while ensuring that the patient is breathing adequately. Be prepared to administer mouth-to-mouth resuscitation if necessary. Cone shell venom results in paralysis or paresis of skeletal muscle, with or without myalgia. Symptoms develop within minutes of the sting and effects can last up to 24 hours. No antivenin is available.

Respiratory distress may occur due to neuromuscular block. Patient should be admitted to a medical facility and monitored closely for respiratory or cardio-vascular complications. Treat as symptoms develop. Local anesthetic with no epinephrine may be injected into the site of the wound if pain is severe. Analgesics which produce respiratory depression should be used with caution. Management of severe stings is supportive. Respiration may need to be sup-ported with intubation and mechanical ventilation. Administer tetanus prophylaxis as appropriate.

SEA SNAKES

The sea snake is an air-breathing reptile which has adapted to its aquatic environment by developing a paddle tail. Sea snakes inhabit the Indo-Pacific area and the Red Sea and have been seen 150 miles from land. The most dangerous areas in which to swim are river mouths, where sea snakes are more numerous and the water more turbid. The sea snake is a true snake, usually 3 to 4 feet in length, but it may reach 9 feet. It is generally banded. The sea snake is curious and is often attracted by divers and usually is not aggressive except during its mating season.

SEA SNAKE BITE EFFECTS

The sea snake injects a poison that has 2 to 10 times the toxicity of cobra venom. The bites usually appear as four puncture marks but may range from one to 20 punctures. Teeth may remain in the wound. The neurotoxin poison is a heat-stable non-enzymatic protein; hence, sea snake bites should not be immersed in hot water as with venomous fish stings. Due to its small jaws, bites often do not result in envenomation. Sea snake bites characteristically produce little pain and there is usually a latent period of 10 minutes to as long as several hours before the development of generalized symptoms: muscle aching and stiffness, thick tongue sensation, progressive paralysis, nausea, vomiting, difficulty with speech and swallowing, respiratory distress and failure, plus smoky-colored urine from myoglobinuria, which may go on to kidney failure.

PREVENTION

Wet suits or protective clothing, especially gloves, may provide substantial protection against bites and should be worn when diving in waters where sea snakes are abundant. Also, shoes should be worn when walking where sea snakes are known to exist, including in the vicinity of

fishing operations. Do not handle sea snakes. Bites often occur on the hands of fishermen attempting to remove snakes from nets.

FIRST AID AND TREATMENT

Keep victim still. Do not apply a loose constricting band or tourniquet. Apply direct pressure using a compression bandage and immobilize the extremity in the dependent position with splints and elastic bandages. This prevents spreading of the neurotoxin through the lymphatic circulation. Incise and apply suction. Transport all sea snake-bite victims to a medical facility as soon as possible, regardless of their current symptoms. Watch to ensure that the patient is breathing adequately. Be prepared to administer mouth-to-mouth resuscitation or cardiopulmonary resuscitation if required.

The venom is a heat-stable protein which blocks neuromuscular transmission. Myonecrosis with resultant myoglobinuria and renal damage are often seen. Hypotension may develop.

Respiratory arrest may result from generalized muscular paralysis; intubation and mechanical ventilation may be required. Renal function should be closely monitored and peritoneal or hemodialysis may be needed. Alkalinization of urine with sufficient IV fluids will promote myoglobin excretion. Monitor renal function and fluid balance anticipating acute renal failure. Vital signs should be monitored closely. Cardiovascular support plus oxygen and IV fluids may be required. Because of the possibility of delayed symptoms, all sea snake-bite victims should be observed for at least 12 hours.

If symptoms of envenomation occur within one hour, antivenin should be administered as soon as possible. In a seriously envenomated patient, antivenin therapy may be helpful even after a significant delay. Antivenin is available from the Commonwealth Serum Lab in Melbourne, Australia. If specific anti-venin is not available, polyvalent land snake antivenin (with a tiger snake or krait Elapidae component) may be substituted. If antivenin is used, the directions regarding dosage and sensitivity testing on the accompanying package insert should be followed and the physician must be ready to treat for anaphylaxis (severe allergic reaction). Infusion by the IV method or closely monitored drip over a period of one hour is recommended. Administer tetanus prophylaxis as appropriate.

SPONGES

Sponges are composed of minute multi-cellular animals with spicules of silica or calcium carbonate embedded in a fibrous skeleton. Exposure of skin to the chemical irritants on the surface of certain sponges or exposure to the minute sharp spicules can cause a painful skin condition called dermatitis.

PREVENTION

Avoid contact with sponges and wear gloves when handling live sponges.

FIRST AID AND TREATMENT

Adhesive or duct tape can effectively remove the sponge spicules. Vinegar or 3- to 10-percent acetic acid should be applied with saturated compresses as sponges may be secondarily inhabited by stinging coelenterates. Antihistamine lotion (diphenhydramine) and later a topical steroid (hydrocortisone) may be applied to reduce the early inflammatory reaction. Antibiotic ointment is effective in reducing the chance of a secondary infection.

POISONOUS MARINE ANIMALS

CIGUATERA FISH POISONING

Ciguatera poisoning is fish poisoning caused by eating the flesh of a fish that has eaten a toxin-producing microorganism, the dinoflagellate, Gambierdiscus toxicus. The poisoning is common in reef fish between latitudes 35ºN and 35ºS around tropical islands or tropical and semitropical shore-lines in Southern Florida, the Caribbean, the West Indies, and the Pacific and Indian Oceans. Fish and marine animals affected include barracuda, red snapper, grouper, sea bass, amberjack, parrot fish, and the moray eel. Incidence is unpredictable and dependent on environmental changes that affect the level of dinoflagellates. The toxin is heat-stable, tasteless, and odorless, and is not destroyed by cooking or gastric acid.

Symptoms may begin immediately or within several hours of ingestion and may include nausea, vomiting, diarrhea, itching and muscle weakness, aches and spasms. Neurological symptoms

may include pain, ataxia (stumbling gait), paresthesias (tingling), and circumoral parasthesias (numbness around the mouth). Sensory reversal of hot and cold sensation when touching or eating objects of extreme temperatures may occur. In severe cases, respiratory failure and cardiovascular collapse may occur. Pruritus (itching) is characteristically made worse by alcohol ingestion. Gastrointestinal symptoms usually disappear within 24 to 72 hours. Although complete recovery will occur in the majority of cases, neurological symptoms may persist for months or years. Signs and symptoms of ciguatera fish poisoning may be misdiagnosed as decompression sickness or contact dermatitis from unseen fire coral or jellyfish. Because of rapid modern travel and refrigeration, ciguatera poisoning may occur far from endemic areas with international travelers or unsuspecting restaurant patrons.

PREVENTION

Never eat the liver, viscera, or roe (eggs) of tropical fish. Unusually large fish of a species should be suspected. When traveling, consult natives concerning fish poisoning from local fish, although such information may not always be reliable. A radioimmunoassay has been developed to test fish flesh for the presence of the toxin and soon may be generally available.

FIRST AID AND TREATMENT

Treatment is largely supportive and symptomatic. If the time since suspected ingestion of the fish is brief and the victim is fully conscious, induce vomiting (syrup of Ipecac) and administer purgatives (cathartics, laxatives) to speed the elimination of undigested fish. In addition to the symptoms described above, other complications which may require treatment include hypotension and cardiac dysrhythmias.

Antiemetics and antidiarrheal agents may be required if gastrointestinal symptoms are severe. Atropine may be needed to control bradycardia. IV fluids may be needed to control hypotension. Calcium gluconate, diazepam, and methocarbamol can be given for muscle spasm.

Amytriptyline has been used successfully to resolve neurological symptoms such as depression. Cool showers may induce pruritus (itching).

SCOMBROID FISH POISONING

Unlike ciguatera fish poisoning, where actual toxin is already concentrated in the flesh of the fish, scombroid fish poisoning occurs from different types of fish that have not been promptly cooled or prepared for immediate consumption. Typical fish causing scombroid poisoning include tuna, skipjack, mackerel, bonito, dolphin fish, mahi mahi (Pacific dolphin), and bluefish. Fish that cause scombroid poisoning are found in both tropical and temperate waters.

A rapid bacterial production of histamine and saurine (a histamine-like compound) produce the symptoms of a histamine reaction: nausea, abdominal pain, vomiting, facial flushing, urticaria (hives), headache, pruritus (itching), bronchospasm, and a burning or itching sensation in the mouth. Symptoms may begin one hour after ingestion and last 8 to 12 hours. Death is rare.

PREVENTION

Immediately clean the fish and preserve by rapid chilling. Do not eat any fish that has been left in the sun or in the heat longer than two hours.

FIRST AID AND TREATMENT

Oral antihistamine, (e.g., diphenhydramine, cimetidine), epinephrine (given subcutaneously), and steroids are to be given as needed.

PUFFER (FUGU) FISH POISONING

An extremely potent neurotoxin called tetrodotoxin is found in the viscera, gonads, liver, and skin of a variety of fish, including the puffer fish, porcupine fish, and ocean sunfish. Puffer fish, also called blow fish, toad fish, and balloon fish, and called Fugu in Japanese, are found primarily in the tropics but also in temperate waters of the coastal U.S., Africa, South America, Asia, and the Mediterranean. Puffer fish is considered a delicacy in Japan, where it is thinly sliced and eaten as sashimi. Licensed chefs are trained to select those puffer fish least likely to be poisonous and also to avoid contact with the visceral organs known to concentrate the poison. The first sign of poisoning is usually tingling around the mouth, which spreads to the extremities and may lead to a body wide numbness. Neurological findings may progress to stumbling gait (ataxia), generalized weakness, and paralysis. The victim, though paralyzed, remains conscious until death occurs by respiratory arrest.

PREVENTION

Avoid eating puffer fish. Cooking the poisonous flesh will not destroy the toxin.

FIRST AID AND TREATMENT

Provide supportive care with airway management and monitor breathing and circulation. Monitor anal function. Monitor and treat cardiac dysrhythmias.

PARALYTIC SHELLFISH POISONING (PSP) (RED TIDE)

Paralytic shellfish poisoning (PSP) is due to mollusks (bivalves) such as clams, oysters, and mussels ingesting dinoflagellates that produce a neurotoxin which then affects man. Proliferation of these dinoflagellates during the warmest months of the year produces a characteristic red tide. However, some dinoflagellate blooms are colorless, so that poisonous mollusks may be unknowingly consumed. Local public health authorities must monitor both seawater and shellfish samples to detect the toxin. Poisonous shellfish cannot be detected by appearance, smell, or discoloration of either a silver object or garlic placed in the cooking water. Also, poisonous shell-fish can be found in either low or high tidal zones. The toxic varieties of dinoflagellates are common in the following areas: Northwestern U.S. and Canada, Alaska, part of western South America, Northeastern U.S., the North Sea European countries, and in the Gulf Coast area of the U.S. One other type of dinoflagellate, though not toxic if ingested, may lead to eye and respiratory tract irritation from shoreline exposure to a dinoflagellate bloom that becomes aerosolized by wave action and wind.

SYMPTOMS

Symptoms of body wide PSP include circumoral paresthesias (tingling around the mouth) which spread to the extremities and may progress to muscle weakness, ataxia, salivation, intense thirst, and difficulty in swallowing. Gastrointestinal symptoms are not common. Death, although uncommon, can result from respiratory arrest. Symptoms begin 30 minutes after ingestion and may last for many weeks. Gastrointestinal illness occurring several hours after ingestion is most likely due to a bacterial contamination of the shellfish (see paragraph 5C-4.5). Allergic reactions such as urticaria (hives), pruritus (itching), dryness or scratching sensation in the throat, swollen tongue and bronchospasm may also be an individual hypersensitivity to a specific shellfish and not PSP.

PREVENTION

Since this dinoflagellate is heat stable, cooking does not prevent poisoning. The broth or bouillon in which the shellfish is boiled is especially dangerous since the poison is water-soluble and will be found concentrated in the broth.

FIRST AID AND TREATMENT

No antidote is known. If the victim is fully conscious, induce vomiting with 30cc (two tablespoons) of syrup of Ipecac. Lavaging the stomach with alkaline fluids (solution of baking soda) may be helpful since the poison is acid-stable. Provide supportive treatment with close observation and advanced life support if needed until the illness resolves. The poisoning is also related to the quantity of poisonous shellfish consumed and the concentration of the dinoflagellate contamination.

BACTERIAL AND VIRAL DISEASES FROM SHELLFISH

Large outbreaks of typhoid fever and other diarrheal diseases caused by the genus Vibrio have been traced to consuming contaminated raw oysters and inadequately cooked crabs and shrimp. Diarrheal stool samples from patients suspected of having bacterial and viral diseases from shellfish should be placed on a special growth medium (thiosulfate-citrate-bile salts-

sucrose agar) to specifically grow Vibrio species, with isolates being sent to reference laboratories for confirmation.

PREVENTION

To avoid bacterial or viral disease (e.g., Hepatitus A or Norwalk viral gastroenteritis) associated with oysters, clams, and other shellfish, an individual should eat only thoroughly cooked shellfish. It has been proven that eating raw shellfish (mollusks) presents a definite risk of contracting disease.

FIRST AID AND TREATMENT

Provide supportive care with attention to maintaining fluid intake by mouth or IV if necessary. Consult medical personnel for treatment of the various Vibrio species that may be suspected.

SEA CUCUMBERS

The sea cucumber is frequently eaten in some parts of the world where it is sold as Trepang or Bechedemer. It is boiled and then dried in the sun or smoked. Contact with the liquid ejected from the visceral cavity of some sea cucumber species may result in a severe skin reaction (dermatitis) or even blindness. Intoxication from sea cucumber ingestion is rare.

PREVENTION

Local inhabitants can advise about the edibility of sea cucumbers in that region. However, this information may not be reliable. Avoid contact with visceral juices.

FIRST AID AND TREATMENT

Because no antidote is known, treatment is only symptomatic. Skin irritation may be treated like jellyfish stings.

PARASITIC INFESTATION

Parasitic infestations can be of two types: superficial and flesh. Superficial parasites burrow in the flesh of the fish and are easily seen and removed. These may include fish lice, anchor worms, and leeches. Flesh parasites can be either encysted or free in the muscle, entrails, and gills of the fish. These parasites may include roundworms, tapeworms, and flukes. If the fish is inadequately cooked, these parasites can be passed on to humans.

PREVENTION

Avoid eating raw fish. Prepare all fish by thorough cooking or hot-smoking. When cleaning fish, look for mealy or encysted areas in the flesh; cut out and discard any cyst or suspicious areas. Remove all superficial parasites. Never eat the entrails or viscera of any fish.