**VENTURA COUNTY SHERIFF'S OFFICE**

**UNDERWATER SEARCH AND RESCUE (VCSAR4) TEAM**

# Search, Rescue, and Recovery

# Training Manual for Public Safety Divers

Revised: February 1, 2022

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# CHAPTER 1 INTRODUCTION

Underwater search and recovery operations occur in an environment that is basically hostile to people. These operations are finite, limited by the diver's access to air. Nevertheless, it is necessary in public service to conduct underwater operations in order to recover lost or disposed of property, or to recover drowning victims to either be revived, or to give their families necessary closure. Unfortunately, not all underwater search operations are successful. The success or failure of any search conducted underwater can be affected by a multitude of factors. Those of particular concern are: surface conditions, underwater visibility, depth, bottom topography, bottom composition, vegetation, accessibility, surge, tides, currents, accuracy of bearings, water temperature, pollution, obstacles or hazards, etc.

None of these listed factors can be controlled by the searcher. There is, in fact, only one aspect of an underwater search that can be controlled organization. The other factors must be taken into consideration when a search is planned. Each must be considered as the search is organized and methods altered to ensure that the most effective and efficient means are implemented. However, it is most often organization of the Dive Team (or lack thereof) that most significantly impacts the outcome of an underwater search. An organized team effort is the difference between a coordinated, systematic, methodical approach to the search and a lot of divers doing their own thing in the water.

There is a common misperception that a diver need only get to the bottom to efficiently search for sunken objects. Often divers inexperienced in search and recovery are under the impression that they need only descend where a helpful witness indicates, and there the object will be. Unfortunately, this is the exception rather than the rule. More frequently, divers searching for an object have made a poor showing due to poor information, lack of organization, lack of planning, and lack of experience.

Divers participating in an organized underwater search receive a great deal of satisfaction when the object of the search is located and successfully recovered; as this is, in most cases, no small feat. However, an underwater search may involve many long hard hours (even days) of diving ending in disappointment should the object of the search not be found. Unlike pleasure diving, search and recovery diving must be done at the place where the object was lost and many times without delay that may necessitate diving under adverse conditions. The techniques involved in locating and recovering an object submersed underwater are based both in art and in science. The mechanics of the search are truly an art; while the principles applied to the operation are firmly grounded in science and mathematics.

This publication is not intended to be a manual on how to dive. In fact, we assume a degree of proficiency in the reader equal to that of an advanced level diver. This manual does not claim to be the final authority on search and recovery diving. The techniques described herein are limited to the use of open circuit SCUBA and designed to be applicable to the aquatic geography of Ventura County. In addition to those contained in this manual, there are other techniques that utilize equipment differing from that which we describe. The reader must realize that while the listed techniques and equipment will suffice to successfully accomplish the majority of underwater search and recovery operations, there often are occasions wherein further specialized techniques and equipment are required. Some examples of such are penetration searches conducted in underwater caves or wrecks, dives below ice, dives requiring decompression, or dives in polluted water.

The information and techniques presented in this manual have been developed and refined over the past fifty-five years by the Underwater Search and Rescue Unit of the Ventura County Sheriff's Office. However, we do not claim sole authorship . . . much of the information contained herein has been shared both with us, and by us. The benchmark of professionalism in a public safety agency lies in the sharing of knowledge and expertise with others. It is to this end that we dedicate this manual to the professionals involved in performing underwater search, rescue and recovery.

# CHAPTER 2 UNDERWATER SEARCH AND RESCUE ACADEMY / COURSE REQUIREMENTS

## PURPOSE

This course is designed to train certified SCUBA divers in the techniques of conducting underwater search and rescue/recovery missions in a variety of aquatic environments on behalf of the Ventura County Sheriff's Office.

## PROGRAM CONTENT

This program of instruction encompasses 90 hours of training inclusive of classroom, confined water, and open water instruction. Classes are conducted on Friday evenings and Sunday mornings (excepting holidays).

## PRE-REQUISITES

Candidates must be:

- Certified as an Open Water Diver from a nationally recognized certification agency.
- Qualified as an Advanced Open Water Diver and/or demonstrate skills equivalent to an advanced certification.
    - Good watermanship skills
    - Good physical condition
    - Knowledge of / comfort with gear
    - Water entry /exit skills
    - Understanding / application of proper buoyancy
    - Underwater navigation ability
    - Diving technique
- A resident of the County of Ventura or immediate vicinity.
- A minimum of 21 years of age.
- Possess a valid California Driver License.

- Successfully pass a law enforcement background investigation conducted by the Ventura County Sheriff's Human Resources Bureau.
- Possess First Aid / CPR Certification (may be obtained concurrently with Dive Academy).

## DOCUMENTATION REQUIRED

- ☐ Photocopy of Driver's License.
- ☐ Photocopy of First Aid / CPR cards.
- ☐ Photocopy of dive certification card(s).
- ☐ Signed "Liability Release and Express Assumption of Risk".
- ☐ Current "Medical Statement" – Must be reviewed and approved by the Dive team Physician.
- ☐ Submission of a completed Sheriff's Office "Personal History Statement" (to be utilized for the purpose of background investigation) to the SAR Coordinator by the specified date.

## EQUIPMENT / SUPPLIES REQUIRED

- ☐ Candidates must personally possess SCUBA diving equipment as specified in the text.
- ☐ Prior to conclusion of the course, candidates must acquire and maintain all individual equipment necessary for conducting underwater search and recovery operations.
- ☐ Successful candidates will be issued Sheriff's Office equipment (on loan, for the duration of team membership only) and will be required to maintain it in the same, good working, condition.

## PROGRAM LIMITS

- No dives will be conducted to depths greater than 60fsw during this course.
- Adequate instructional and safety personnel will be present at each water session (confined and open water).
- All dives will be performed within normal no-decompression limits.

- All dives will require appropriate safety stops.
- Any and all equipment to be utilized in an open water exercise must be first utilized in a confined water session.

## WATER SKILLS REQUIREMENTS

Candidates must demonstrate the ability to perform the following skills at required intervals during the course:

- Proper set-up and handling of SCUBA equipment.
- Surface Doff and Don of equipment.
- Swim in a simulated out of air (OOA) situation – without breathing and while slowly exhaling for a distance of 50 feet.
- Underwater Doff and Don.
- Neutral Buoyancy – ability to attain and maintain for a period of ten minutes.
- Swim on the surface in full SCUBA utilizing a snorkel for a distance of 500 yards while towing a float (Mini-Mother) and anchor.
- Swim on the surface in full SCUBA utilizing a snorkel with a deflated BCD while carrying a 10-pound weight for a distance of 250 yards.
- Surf entry and exit.
- Use of full-face mask, underwater communication system, and the pony bottle.
- Recovery from entanglement.
- Perform safety diver drill.
- Deployment of Mini-Mother and search line.
- Conduct search patterns.
- Circular search.
- Semi-circular search.
- Straight sweep.
- Jackstay.
- Use and deployment of body recovery system.
- Use of lift bags.
- Evidence recovery.

## POST-COURSE SKILLS DEVELOPMENT

Following completion of the course, qualified divers will be placed on a **one-year probationary period** during which the following skills may be attained / refreshed:

- Deep Diving – Dive(s) will be made to depths of 100—130 fsw.
- Overhead Environment – Dive(s) will be made into a cave utilizing a continuous guideline.
- Rappelling – Deployment into and recovery from an aquatic environment utilizing line and anchor systems.
- Helicopter Operations – Deployment into and recovery from an aquatic environment by helicopter.
- Vehicle Recovery – Use of Vehicle Recovery System to lift a submerged vehicle to the surface.
- Swift Water – Rescue operations in swift moving water (optional).
- Boat Operations -- Orientation to Radon, Whaler, and Chinook watercraft.
- Portable Sonar – familiarization with Kongsberg Mesotech Scanning Sonar and Klein Side-Scan Sonar.
- DPV Operation – Use of Torpedo underwater diver propulsion vehicle.
- ROV Operations -- Familiarization with Video Ray remotely operated vehicle.
- Emergency First Aid / CPR recertification.

Due to the nature of the probationary training, candidates must attend each monthly training session following the Academy until completion of the probationary period.

Throughout the Dive Academy and probationary period, divers will be evaluated on the following:

- Knowledge of basic dive procedures as well as information taught throughout the course.
- Basic watermanship skills (e.g., water entries and exits, buoyancy control, control of ascent rate, control of body movements, etc.).
- Basic underwater search skills (e.g., proper search technique, in-water attitude, finning technique and efficiency, etc.).
- Competency in function, care and utilization of dive equipment (e.g., equipment familiarization, organization and streamlining of equipment, etc.).

- Problem-solving skills (e.g., replacement and clearing of lost mask, regulator or other equipment; entanglement management, etc.)
- Underwater navigation skills.
- Ability to follow instructions.
- Judgment.
- Ability to function effectively in a team environment.

## PROBATIONARY DIVERS

Probationary divers with the Ventura County Sheriff's Search and Rescue Dive Team are responsible for the following:

- Submission of a certificate from a licensed physician stating that the individual is medically qualified for diving.
- Submission of a completed Sheriff's Office Personal History Statement (to be utilized for the purpose of background investigation) to the SAR Coordinator by the date specified.
- Completion of First Aid / Cardio-Pulmonary Resuscitation training from a recognized provider prior to, or within one year of completion of the SAR Dive Academy. Thereafter, First Aid / CPR certification must be kept current.
- Attendance at all Dive Academy training sessions (except where make-up arrangements can be made).
- Upon completion of the Dive Academy, attendance at all Dive Team training sessions (held once each month on the second Sunday thereof).
- At the end of the probationary period, divers will be evaluated with respect to their suitability and qualifications for permanent status as a Dive Team member.
- Throughout the Dive Academy and probationary period, divers will be evaluated on the following:
    - Knowledge of basic dive procedures as well as information taught throughout the course.
    - Basic watermanship skills (IE: water entries and exits, buoyancy control, control of ascent rate, control of body movements such as hand sculling, etc.)
    - Basic underwater search skills (IE: proper search technique, in water attitude, fining technique and efficiency, etc.).
    - Competency in function, care, and utilization of dive equipment (ie: equipment familiarization, organization and trim of equipment).

- Problem-solving skills (e.g., replacement of lost regulator, mask, or other equipment; entanglement management, etc.).
- Underwater navigation skills.
- Ability to follow instructions.
- Judgment.
- Ability to effectively function in a team environment

## TEAM MEMBERSHIP

Following successful completion of the probationary period, candidates are accepted as members of the Underwater Search and Rescue Team based upon a vote of the present members.

Post probationary training is conducted once each month. Attendance and participation are required as per Dive Team Bi-Laws.

Membership on the Dive Team is a commitment to public service. If you are unable to make the commitment required, please do not waste your time, energy and effort – nor ours.

# CHAPTER 3 REQUIRED EQUIPMENT

A vital element of search and recovery diving is proper equipment. Inadequate or faulty equipment can cause a search to be haphazard and a fruitless waste of time and effort. Types of equipment include:

- Personal Dive Equipment Required on Any Search and Recovery Dive
- Ancillary Equipment to Support the SAR Diver
- Specialized Search Equipment
- Underwater Communications System
- Submersible Marker Buoy (SMB / DSMB)
- Uniform Equipment
- Team Equipment

Except where specifically indicated herein, all dive equipment inclusive of personal dive equipment, ancillary equipment, search equipment, and uniform equipment are to be purchased, maintained, and replaced as required by the individual diver.

## COMMON EQUIPMENT ISSUES

It is important not only to possess the proper equipment on a search and recovery dive, but to also configure that equipment so as to render the diver capable of performing as efficiently as possible. Among equipment issues to be considered are:

1. Proper Weighting -- Excessive weight worn by a diver has been responsible for many diving "accidents". Weight should ideally amount to only enough to render a diver neutrally buoyant at safety stop depth (15-20fsw) with a deflated BCD and 500 PSI in the cylinder. Under certain operational conditions (IE: heavy current or surge), it may be desirable to increase ballast slightly.
2. Drag Reduction – Improper equipment placement can cause increased drag through the water, which works against the efficient performance of a diver. In addition to ballast weight being of the proper amount, it should be properly worn (trimmed) in order to enable the diver to operate as efficiently as possible.
3. Entanglement Potential – Failure to streamline equipment can subject a diver to entanglement hazards.

4. Accessibility of Equipment – knives and emergency cutters must be placed on the diver's torso so as to be accessible with either hand. The placement of a cutting implement on the lower leg (as is traditional amongst sport divers) is ill advised due to both the propensity of items so located to cause entanglement as well as the difficulty reaching a cutting implement so situated in tight quarters.

## PERSONAL DIVE EQUIPMENT (PRIMARY)

- **Mask** – Low volume recommended for ease of clearing, drag reduction, increased field of vision, and use as back-up to FFM. Mask straps are to be inverted or taped to avoid line entrapment, or alternatively, a neoprene/Velcro strap can be utilized.
- **Snorkel** – Affixed to mask, but capable of being removed, stored, and replaced.
- **Bifins** – Long enough and stiff enough for adequate torque and propulsion, but not so much so as to cause excessive leg fatigue and/or cramps.
- **Gear Bag** – Large enough to hold all personal gear except cylinder(s) and weights. A soft bag (non-rolling) is required for helicopter deployment.
- **Exposure Suit** – Wet or dry including hood, gloves, and booties.
- **Regulator** – Good quality. Capable of delivering sufficient breathing gas at depth and/or under heavy workload.
- **Gauges** – Must be secured so as not to drag the bottom when swimming in an inverted position. Gauges may be integrated to perform multi functions. Gauges may be consolidated into a console:
    - **Submersible Pressure Gauge** (May be integrated into dive computer).
    - **Underwater Compass** (may be integrated into dive computer / timing device).
    - **Dive Computer** (May be integrated into pressure gauge, compass, depth gauge, and/or timing device).
    - **Depth Gauge** (May be integrated into dive computer / timing device).
    - **Timing Device** – watch or bottom timer (May be integrated into dive computer, compass, depth gauge, and/or compass).
- **SCUBA Cylinder** (2 total in quantity): minimum 63 cu. ft. capacity each. The cylinder size selected must be proportional to the diver's physical size and breathing gas requirement.

- **Buoyancy Control Device (BCD)** – Must be stable and fit securely and comfortably without excess sway. The BCD must incorporate two 'D-rings" or other adequate attachment points, or alternatively, a harness incorporating D-rings can be worn in conjunction with the BCD.
- **Power Inflator** – Must be secured so as to not drag the bottom when swimming in an inverted position, nor float above the diver's head when vertical. Can be combined with an alternate air source (IE: Air II, etc.).
- **Alternate Air Source** – Octopus regulator, Air II, etc. Must be secured in a manner similar to that required of the power inflator.
- **Weight Belt** – Two: saltwater and fresh water; or integrated weight system with quick releases. (NOTE: metal weight belt buckles are recommended in as much as plastic buckles are prone to cracking, breaking, and slippage).
- **Knife** – Minimum of two cutting implements are required, in any combination of knives, shears, line cutters, etc. Must be sharp and free of rust. Cutting implements should be worn in the area of the chest or waist where retrievable with either hand. Knives worn on the calves of the leg present a line entanglement issue as well as a retrieval issue in cramped quarters.
- **Signaling Device(s)** – One visual / one audible surface signal (IE: whistle, flares, flasher, submersible marker buoy, Dive Alert", etc.).
- **Pony Bottle** – 13-30 cu. ft. capacity with redundant regulator. (Can be substituted for alternate air source).
- **Full Face Mask & Underwater Communications System** – Issued by team.
- **Submersible Maker Buoy (SMB) with reel/spool and line** - Issued by team.

## PERSONAL DIVE EQUIPMENT (ANCILLARY)

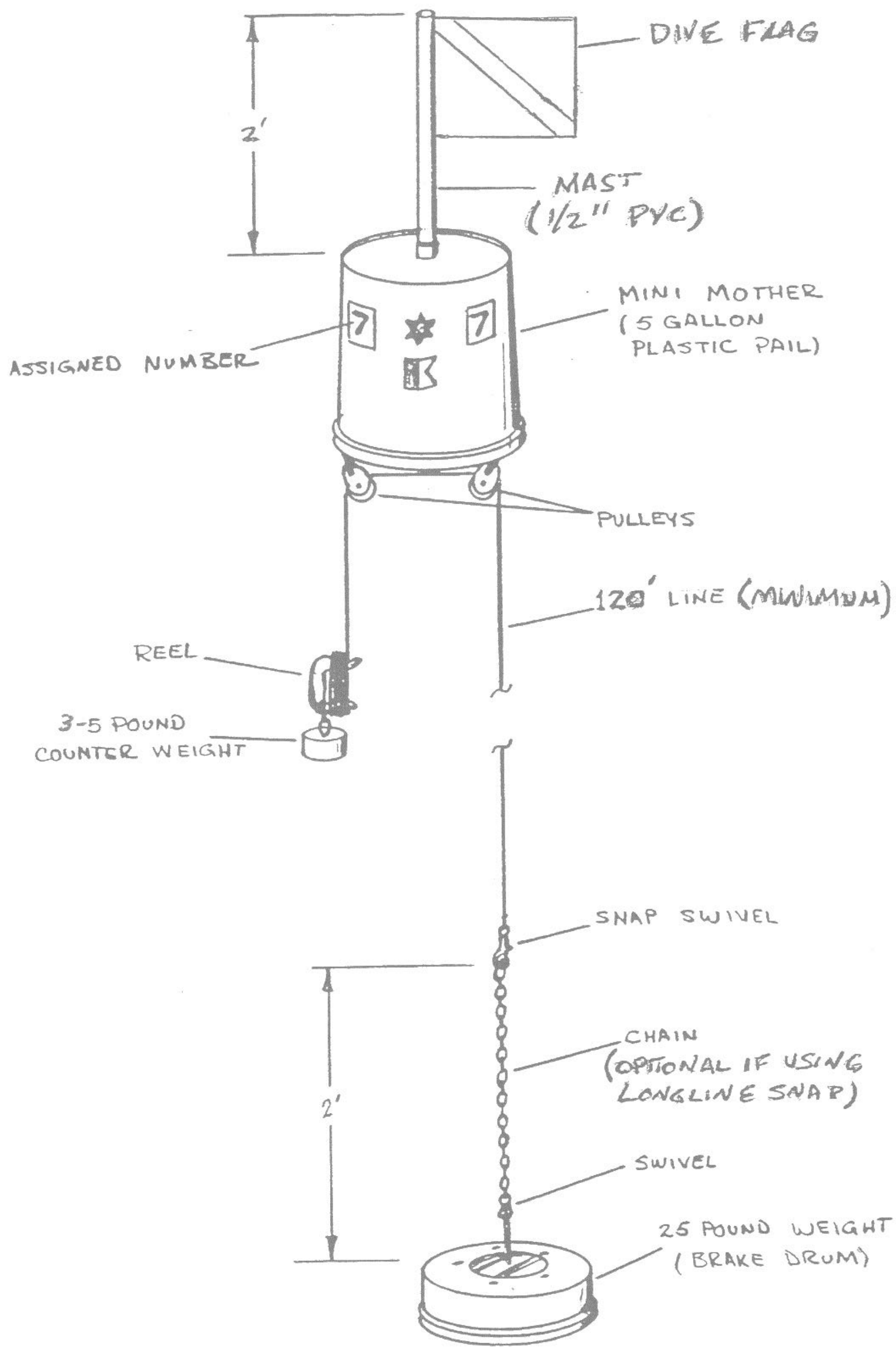
- **Underwater Light** – Two required (primary and back-up) / 3 are recommended (primary and 2 back-ups) for diving in overhead environments.
- **Side Cutters** – (Dykes or Electrician's Pliers) Used for cutting wire and light cable (knives / line cutters / shears are ineffective).
- **Marker Buoy** – Pelican float, etc. for marking position, found objects, etc.
- **First Aid Kit with CPR Mask**
- **Lift Bag(s)**
- **Small Mesh ("goodie" type) Bag**
- **Decompression Tables and Worksheets (waterproof)**
- **Spare Parts / Repair Kit**

- **Slate and Pencil**
- **Cellular Telephone** – Team members are required to possess and carry with them a cell phone for the purpose of receiving Dive Team call-out information.

## SPECIALIZED SEARCH EQUIPMENT

- **"Mini-Mother"** – Bucket (7.5 gal) & mast (2 ft.) with 25-30 lb. base weight (anchor) with 2-foot of galvanized chain with swivels at each end. Swivels must be large enough to resist binding caused by sand or debris. Cavity of Mini-Mother must be approximately 85% filled with medium density two-part foam (issued).

## Mini Mother Search System

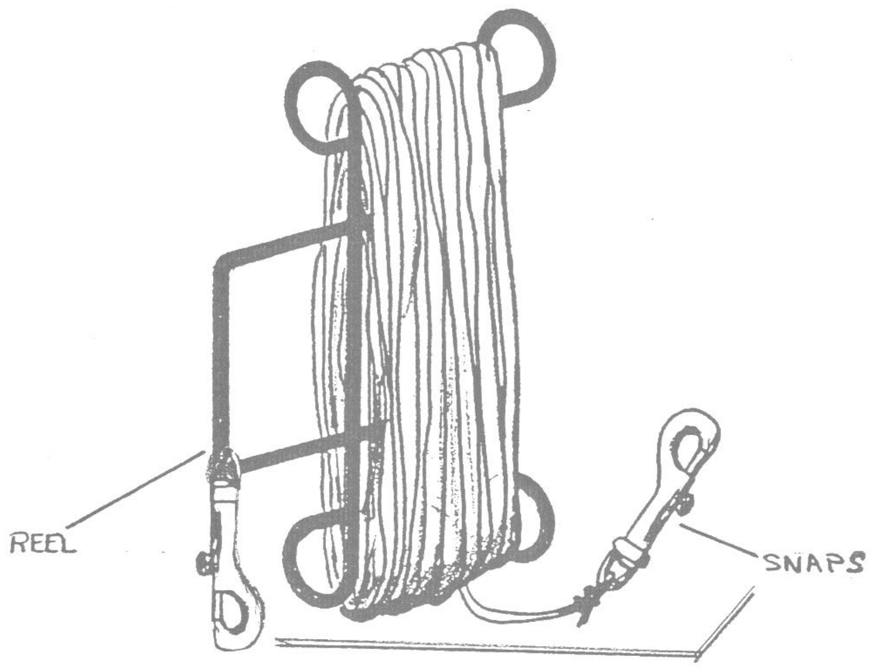



MINI MOTHER SEARCH SYSTEM

- **Ascending / Descending Reel (issued)** -- A 120-foot (minimum.) heavy-duty ascending/descending line and 3-5 lb. counter weight (see Mini Mother Diagram).

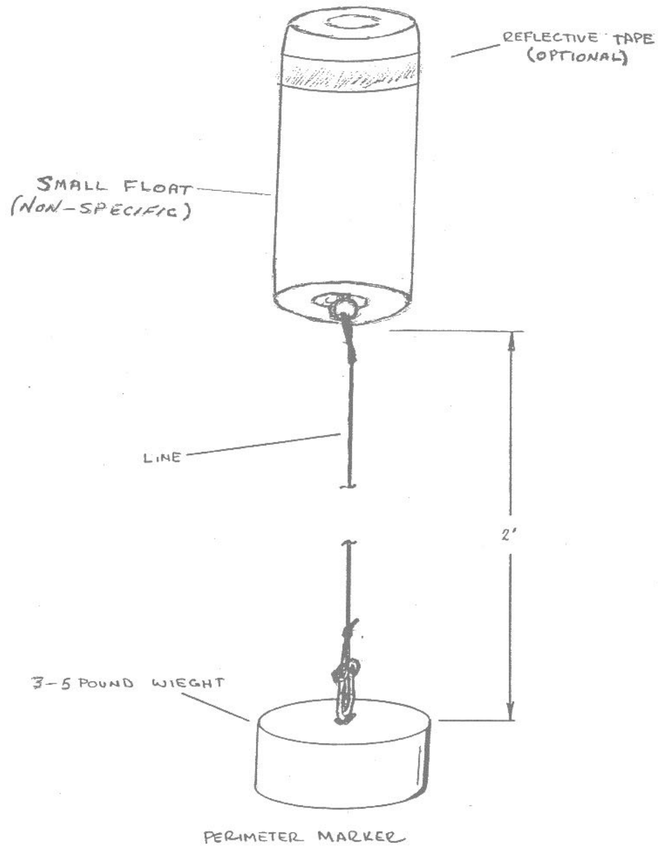
-  **100’ Search Line & Search Reel** – one with 100-foot (min.) search line. Aluminum line holder is recommended. Floating line is recommended. Round reels (cave reels) are not recommended, as they tend to tangle during the line recovery phase

**100' Search Line**



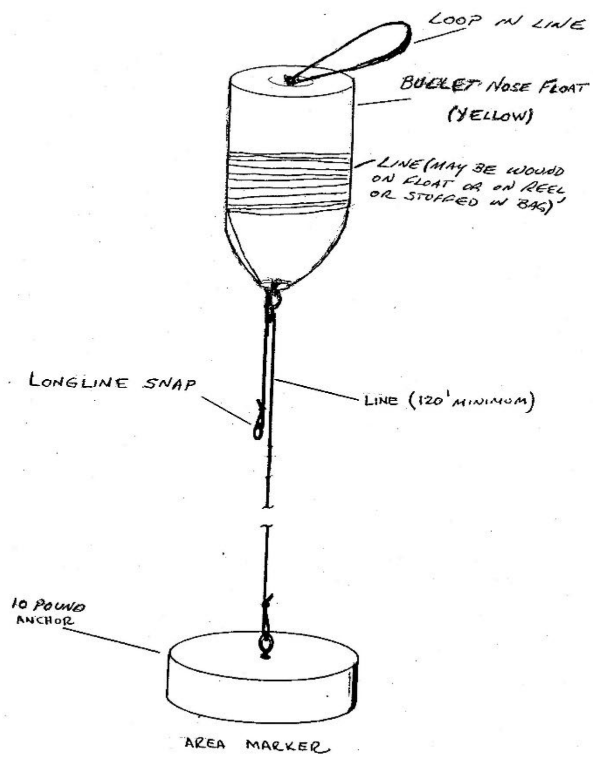

100' SEARCH LINE

- **Perimeter Marker** – Small float or empty, sealed, water bottle and 3-5-pound weight.

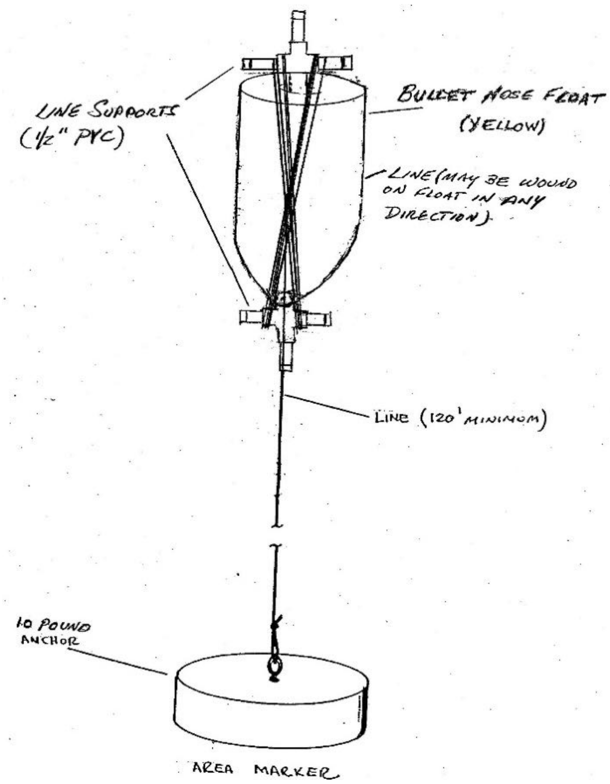


- **Area Marker** -- “Lobster Pot” float, yellow (1 each): 11.5 inches in length, 5 inches in diameter with 7 pounds of positive buoyancy; 10 lb. weight plus sufficient line.

**Area Marker 1**

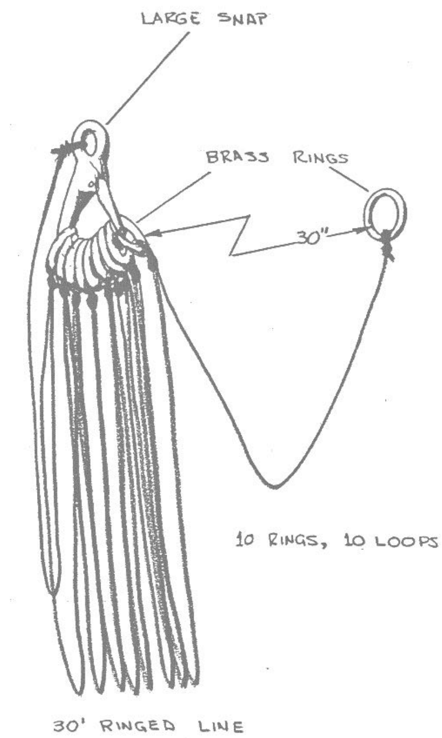



**Area Marker 2**



- **Low Visibility Search Line (aka: Ring Line)** – Two each: snap w/ swivel with 10 rings (brass or nylon) spaced 30” apart.

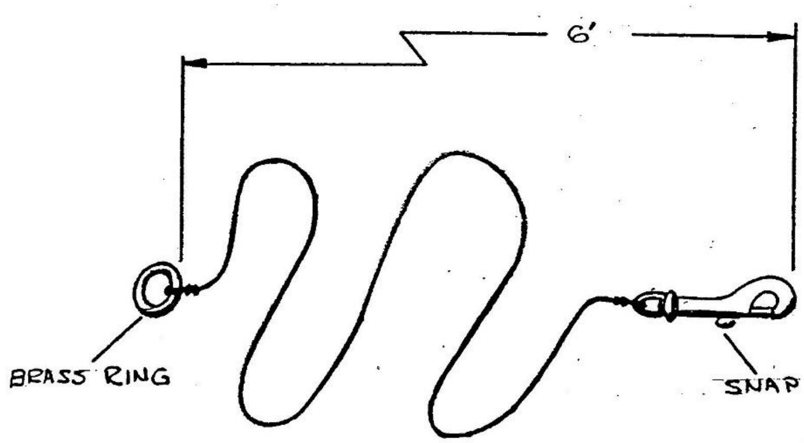
## 30' Ringed Line



- **Wrist Bungee w/ snap** – For attaching diver to a Ring Line or for attachment to a line used to perform a straight sweep (see page # 3.7).

WRIST BUNGEE

- **Buddy Line** – Six-foot line with either a snap w/ swivel on one end and ring on the other, or alternatively, a snap w/ swivel at each end.

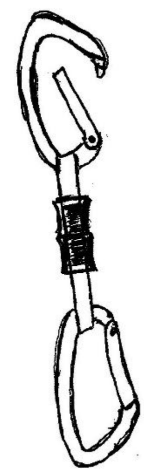



6' BUDDY LINE

- **Double Ended Snap** – Has numerous uses.

DOUBLE SNAP

- **Safety Clip** – Two carabineers joined together by a length of webbing material approximately 8-12 inches in length and incorporating a quick release.



SAFETY CLIP

- **SMB / Finger Spool** – To serve as an emergency signal from a submerged diver in the event of an entanglement, etc. accompanied by a failure in electronic communications (issued).

All lines and equipment are to be secured by means of clips, snaps, or carabineers. Tensioned knots when utilized underwater can be virtually impossible to untie.

The search reel is required to have two clips affixed thereto: one for clipping onto the chain between the base anchor and ascending/descending line; and one for clipping the reel to the diver. Clipping the search reel to the diver's chest (BCD or harness D-ring) is important for the following reasons:

1. It results in the most accurate search pattern (circular) being accomplished due to the fact that the "tether point" is consistently located at the same point on the diver's body. Handholding the search reel will eventually result in arm fatigue and an alteration of arm positioning thereby altering the search pattern, which will result in "holes" (un-searched areas) in the search pattern and the possibility of the object of the search being missed.
2. It is much easier to keep the search line taught when it is affixed to the diver, as opposed to the search reel being hand-held. Thus, there is less chance of the diver bypassing their perimeter marker and performing needless sweeps.
3. It ensures that the diver will always be tethered to the search line and thus safety diver(s) will have direct access and positive location to a searching diver should that diver become entangled or suffer some medical emergency.
4. It leaves the searching diver with two free hands (e.g., one hand to search, one to hold a light; both hands for searching; one hand to hold a light, the other for adjusting buoyancy; etc.).
5. It leaves both hands free for handling the object of the search or other items (e.g., "bagging" items of evidence, deploying a lift bag, dealing with a drowning victim, etc.).

The specialized search equipment system herein described and illustrated has proven itself to be functional and reliable through many years, on many searchers, through many conditions. Periodically, someone will endeavor to invent a "better mousetrap", and actually be successful. Ingenuity in this regard is not discouraged, however any proposed modification to the existing search system must be submitted to the team training committee and thoroughly tested prior to implementation as either a part of, or an entirety of a search equipment system.

## SAR UNDERWATER COMMUNICATIONS SYSTEM EQUIPMENT

The Ventura County Sheriff's Office Search and Rescue / Aviation Unit furnishes each SAR diver a full-face mask (FFM) and communications system consisting of the following:

- OTS Guardian full-face mask
- OTS second stage regulator with LP hose
- OTS Buddy Phone for FFM
- Equalizing Kit
- OTS FFM bag

In addition, the team is assigned an Ocean Technology Systems Portable Surface Transceiver.

This equipment is owned solely by the County of Ventura, Sheriff's Office and under the control of the Search and Rescue / Aviation Unit. Equipment must be returned to the SAR Unit in good condition upon a diver's departure from the dive team. Servicing and repair of this equipment is the financial responsibility of the Sheriff's Office. Individual divers will be responsible for seeing that this equipment is properly maintained, regularly serviced, and kept in operative condition.

Dive team personnel are responsible for reading the manuals accompanying this equipment supplied by the manufacturers.

There are several important considerations with respect to this equipment, which divers must be familiar with and follow:

- **OTS / Guardian Full-Face Mask**
    - The FFM consists of a silicone skirt and spider strap, polycarbonate lens, and adapters for regulator(s) and communication device.
    - The lens of the mask must not be scrubbed with toothpaste, or any other abrasive cleaner. Do not use a mask clearing agent on the lens of the OTS FFM.
    - The FFM is equipped with an ambient breathing valve (ABV) which allows for the breathing of ambient air while donning the FFM. Whenever the FFM is not underwater, the ABV should be in the "open" position.
    - Prior to commencing a dive, the ABV must be closed and the cylinder valve activated.
    - In donning the mask, the spider strap must be completely loosened at each attachment point. The FFM is first fitted to the chin and then sealed to the face. Move the buddy Phone to the rear of the mask as far as possible to prevent it from binding against the buckles on the spider. The mask is held in place on the face while the straps at

the jawline, then the straps at the temples, then, and finally the strap at the top of the head are adjusted. The top strap should be tightened very little.

  - The mask should be removed by placing the thumbs under the tabs that tension the lower spider straps, loosening them, and lifting the FFM over the face. Alternatively, the thumbs can be placed under the mask skirt at the chin and lifted up, sliding the mask over the back of the head.
  - Clearing a flooded FFM is accomplished by looking upward at a 45-degree angle and purging the regulator for three seconds, then exhaling into the mask in a tucked chin-down position.
  - Dropping the FFM into a body of water in excess of eight feet deep will likely damage the microphone due to the rapid pressure change.
  - As with all SCUBA equipment, after use the FFM is to be rinsed in fresh water and allowed to dry prior to storage. The regulator can be soaked and/or thoroughly rinsed after which all residual water should be shaken out. The OTS FFM can be soaked for approximately 2-3 minutes then rinsed. Soaking for longer than 5 minutes will likely result in the microphone within the mask becoming waterlogged and ruined. The FFM should then be shaken to remove residual water and wiped completely dry with a soft cloth. The FFM should be hung upside down in order to drain all water from the oral/nasal cavity.
  - Refer to "Guardian Full Face Mask Owner's Manual" for additional information.

- **OTS Second Stage Regulator**
  - The second stage regulator attaches to the mouth cavity of the FFM by means of clamping system. Force the regulator into the mask mouthpiece area and make sure that it snaps solidly into place. Wiggle the regulator to confirm a solid attachment. A red colored quick release button is located in the oral/nasal cavity inside of the FFM to dislodge the regulator.
  - The OTS second stage regulator has no resistance adjustment. If excessive breathing resistance is encountered, switch to a higher quality first stage or perhaps have the first stage serviced.
  - After use, the second stage must be thoroughly rinsed with fresh water and allowed to dry prior to storage.

- Refer to the OTS Guardian Full Face Mask Owner's Manual" for further information.

- **OTS Communication System - Buddy Phone (2-Channel)**
  - The OTS Buddy Phone is activated by contact with an aquatic environment.
  - The OTS Buddy Phone earpiece is manufactured of ceramic material – **Do NOT drop it** as it is likely to shatter.
  - The OTS Buddy Phone has a volume adjustment feature.
  - The OTS communicator operates on a push-to-talk (PTT) system. A "continuous transmit" mode is available when / if needed.
  - The comprehension of your transmissions will be enhanced by the following:
    - Speak clearly. Enunciate your speech but do not distort it.
    - Do not yell! The clearest transmission will result from a normal, relaxed, quiet voice.
    - Speak in short, concise phrases.
    - When speaking, keep exhalation to a minimum.
  - The Buddy Phone requires one of several variations of 9v transistor battery. There are advantages / disadvantages of each.
  - Remove the battery cover with a screwdriver shaft or the flat of the OTS auxiliary wrench supplied with the FFM. Do NOT use the blade of a screwdriver or other sharp object to remove the battery cover.
  - The O-ring on the battery cover must be lubricated with silicone grease.
  - Refer to the "OTS Buddy Phone User's Guide" for further information.
- **OTS Surface Communications Unit (Aquacom STX-101)**
  - The OTS Aquacom unit is a four-channel transceiver that consists of the following:
    1. Hand-held microphone
    2. Antenna transducer
    3. External speaker
  - Care must be taken to keep the Aquacom surface unit and microphone dry as well as all connectors and plugs attaching thereto.
    - Silicone grease should be applied to all plugs to prevent corrosion.
  - The Aquacom unit must not be dropped, thrown or otherwise jarred.

        - The antenna is sensitive to sudden mechanical shock.
    - The cable must not be stretched or cut, as there is a danger of corrosion of the antenna wire.
    - The Aquacom unit can be cleaned with a mild detergent solution and damp cloth.
    - The Aquacom unit must be stored in a dry environment in order to prevent corrosion of the audio and battery terminals.
    - Refer to "Aquacom Transceiver Manual" and "RCS-13 Smart Battery Operation Instructions."
- **Redundant Air Supply**
    - When utilizing the FFM, divers are required to employ an emergency back-up air supply in the form of a pony bottle and first/second stage regulator.
    - The pony bottle will hold a capacity of a minimum of 13 cu. ft. of air.
    - The pony bottle will be firmly affixed (quick release system is encouraged) to the diver's primary air supply.
    - Divers must carry a spare SCUBA mask to be worn (backward around the neck is recommended) or carried (in a pouch) during the SAR dive. If carried in a pouch, care must be taken to ensure that the mask is not permanently stored in the pouch, as doing so over a long period of time will cause the mask skirt to be misshapen and render it useless if and when needed.
    - There are many reasons for requiring the use of a pony cylinder with a Full-Face Mask. Any of the following can cause problems for a diver with respect to a continual air supply:
        - The diver utilizing the FFM will consume air at a much faster rate than with a regular dive mask causing the cylinder air to be consumed more quickly than may be anticipated.
        - A working diver may neglect to appropriately monitor the SPG and breathe the main cylinder empty.
        - A stuck needle within the SPG will indicate incorrect cylinder pressure.
        - Failure to fully open the cylinder valve will eventually result in air deprivation.
        - Either knowingly or unknowingly initiating a dive with a partially filled cylinder can cause apparent depletion of the air supply sooner than anticipated

- Misalignment or wear of the cylinder O-ring can empty the cylinder of air.
- The burst disc on the cylinder valve can fail due to age or corrosion rapidly emptying the cylinder.
- The regulator first stage filter can become clogged due to sediment or oxidation within the cylinder.
- Cold water, nitrogen narcosis, fighting current, working hard will all cause a diver to consume more air.
- A diver having a problem underwater (e.g., becoming entangled or entrapped) will consume excessive air.
- Regulator malfunction due to corrosion or lack of maintenance can cause either free-flow or failure to deliver air on the part of the regulator.
- Regulator malfunction due to damage (e.g., impact from falling, heavy object placed on regulator, etc.) can cause either free flow or failure of regulator to deliver air.
- O-ring failure at a first stage port will cause loss of air.
- O-ring failure on the primary second stage will cause loss of air.
- O-ring failure in the power inflator will result in free flow.
- O-ring failure on the SPG will deplete cylinder air.
- A leak developing at a hose fitting will cause loss of air from the cylinder.
- A hose rupture will cause a rapid loss of air from the cylinder.
- A hose damaged due to cutting by a sharp object will cause a free flow.
- Foreign particles or sand in the second stage may cause a regulator to free-flow.
- The diaphragm of the second stage can develop a tear or slip out of place causing free flow.
- Regulator free-flow can occur in the process of filling an open circuit lift bag via a second stage as a result of the purge valve becoming stuck.
- Free-flow can occur in the process of utilizing a power inflator hose to fill a closed-circuit lift bag by virtue of the Schrader valve becoming stuck.
- A regulator freeze-up in extremely cold water will cut off the diver’s air supply.

        - Separation of the mouthpiece from the second stage or separation of the second stage from the FFM will deprive the diver of air.
- **CO2 Buildup**
    - Carbon dioxide (CO2) buildup is a potential hazard with a FFM due to excessive dead air space within the interior of the mask., although CO2 buildup is minimized with the Guardian FFM by virtue of the vents below the visor which flush the mask with cool, dry air with each breath.
    - It is critical that CO2 buildup be minimized in order to avoid panic, unconsciousness and possible death.
    - CO2 buildup can exacerbate the effects of nitrogen narcosis and increase the effects of oxygen toxicity.
    - CO2 buildup can result in hypercapnia, the symptoms of which are headache, dizziness, labored breathing, or a suffocating feeling.
    - CO2 buildup increases heat loss in a diver, alters the heart rhythm, and may increase the chances of decompression sickness.
    - Divers must not attempt useless and dangerous techniques of air conservation such as skip breathing. Such techniques actually increase air demand through an increase in CO2 in the bloodstream.
    - When using a FFM (or any time for that matter) divers should breathe via long, full deep inhalations followed by a pause, then long, full exhalations, pause, etc.
- **Full Face Mask Communications System**
    - The full facemask with communicator (FFM/Comm.) can present a significant safety feature for SAR divers: they keep the face warm, allow for diver-to-diver, diver-to-surface, and surface-to-diver communications, and can protect against hazardous waterborne materials; however, they are not without their limitations and detractors.
    - As with all other underwater SAR equipment, all straps, hoses, etc. attendant to the FFM/Comm. system must be streamlined so as not to present an entanglement hazard for the diver.
    - Divers will find (at least initially) that their air consumption is increased by approximately 20-30% by use of a FFM.
    - Underwater communicators can be affected and limited by a number of factors:

    - Heavy boating traffic in an area.
    - Thermoclines.
    - Underwater obstructions such as: large rocks, kelp, submerged vessels, canyons, etc.
    - Underwater sonar
    - Dolphins, etc.
    - Work output of the diver.
    - Density of the breathing gas.
    - Regulator noise.
    - Exhaust bubble noise.
    - Restrictions created by hood, mask, spider straps or speaking cavity.
  - Prior to the employment of the FFM/Comm. on any SAR operation, divers must be thoroughly familiar with the features of the FFM/Comm. System, their redundant air system, and competent in their utilization and appropriate emergency procedures.
- **FFM Deployment**
  - Due to the increased air space within the FFM, divers must compensate for approximately 3-4 pounds of increased buoyancy when the FFM is utilized without a redundant breathing system. (Note: this weight differential will be partially / entirely offset by the weight of the pony bottle and redundant regulator).
  - When a redundant breathing system is utilized, weight requirements should be adjusted (reduced) accordingly.
  - The use of FFM is contrary to surface swims and surf entries in as much as a diver must breathe from their cylinder during such activities resulting in severely limited bottom times for any subsequent underwater search. Additionally, surf entries indicate a preference for a streamlined profile, which is defeated by the FFM and pony bottle.
  - There will undoubtedly be occasions wherein the use of FFM/Communications is not conducive to conducting a safe and efficient search. In such instances, the use of FFM/Communications by SAR divers can be suspended by the dive master in favor of utilization of traditional SCUBA mask and snorkel upon agreement by the ranking on-scene Sheriff's Office SAR official.

- **Training/Certification**
    - Personnel shall be certified/re-certified on the FFM once each year.
    - Personnel must demonstrate satisfactory knowledge of the emergency procedures attendant to the use of a FFM in order to maintain certification.

## SUBMERSIBLE MARKER BUOY (SMB) / DELAYED SUBMERSIBLE MARKER BUOY (DSMB)

The Submersible Marker Buoy (SMB), sometimes referred to as a "Safety Sausage" is a significant piece of diving safety equipment. An SMB consists of an inflatable length of tubular material designed to be used as a surface signal (warning) for watercraft in the area of a diver(s). In theory, SMB's minimize the amount of time that divers must wait on the surface for boat recognition and pick-up, maximizing their visibility and thus, their safety.

One SCUBA certification agency (PADI) made instruction in the deployment of a SMB an integral part of their Open Water Certification Course in 2014. Sometimes deployed from depth, prior to a safety stop or decompression stop, **the SMB, when attached to a descending line, becomes known as a DSMB (Delayed Submersible Marker Buoy, or alternatively, Deco Submersible Marker Buoy).** Deployment of a DSMB requires greater knowledge, practice, and skill.

SMBs are not only useful, but become almost necessary in the following circumstances:

- When drifting on the surface and there is a need to signal your boat of your location and/or to warn other boaters of your presence in the water.
- When drifting in a current at depth, on a safety stop, etc. in order for your boat to track your location.

Ideally, a SMB should be constructed of heavy-duty nylon or some other material that can withstand the elements to which it is exposed in the course of SCUBA diving. (Note: These devices are available made of plastic, and although they are inexpensive, they cannot be expected to survive more than one deployment). The SMB should be of closed-circuit design with an oral/power inflator nozzle and an overpressure valve (OPV). Without an OPV, as gas expands within the DSMB it will stress the stitching/glue that holds the device together, causing it to rupture and releasing all of the air therein, thus rendering it useless. The SMB should be approximately three to six foot in length, with the larger SMB preferable in open water situations involving large surface swells or rough seas. For ocean diving, it is also desirable that a SMB have radar reflective tape affixed. In the case of a lost diver(s) on the surface, this tape will reflect radar signals sent out by rescue craft.

The most common problems experienced by divers deploying a DSMB involve:

- Poor buoyancy during deployment.
- Tangled line spooling from the reel.
- Runaway inflated (unattached) DSMBs.
- Allowing line to spool off too rapidly.
- Dropping a reel.
- Diver attachment to an inflated, rising DSMB.

All of these situations lead to an unnecessarily complicated dive and can result in exposure to injury (such as decompression sickness, DCS).

SMBs are manufactured in bright colors: red, orange, yellow, day-glow green, etc. for the obvious reason. Divers in Europe and tech divers in this country have adopted the yellow-colored SMB as a signal of diver distress and a call for help.

In deploying a SMB from the surface, one only needs to fill the chamber with air by means of any of the below described methods and hold the SMB vertical in order to enhance the ability of boat skippers to see the device. In order to enhance observation by far away watercraft, the SMB can be waived in the air. When deploying a DSMB, some form of line and reel or tape must be used.

## INFLATION METHODS

There are several methods by which air can be added to a SMB, either on the surface, or at depth:

1. **Oral Inflation:** Probably the simplest method, providing that the SMB has an oral inflation nozzle. Oral inflation works best on the surface, or at shallow depths. If orally inflating a DSMB, initially a normal breath of air should only be halfway exhaled into the device in order to get it slightly inflated and out of the way and to avoid buoyancy changes. Thereafter, once the reel or spool is prepped and ready, small amounts of air added into the DSMB will eventually send it toward the surface. (Note: oral inflation of an SMB is not possible while wearing a Full-Face Mask).

2. **Separate Low-Pressure Inflator Attachment:** Probably the most effective method as it allows the addition of plenty of air to the DSMB without creating a buoyancy shift. This method also allows the DSMB and reel to be held out away from the diver's face and body. This is the recommended method of DSMB inflation. If the DSMB has an open dam, a nozzle on this LP attachment will effectively supply air. Care must be taken in the selection of an inflator hose/fitting to ensure that the Shrader valve will not lock on to the nozzle of the DSMB.
3. **BCD Power Inflator:** This method likewise allows for filling the DSMB with plenty of air without creating a buoyancy shift. It does require that the diver either place the BCD inflator mouthpiece at the bottom of an open dam DSMB and simultaneously depress both the Inflator and exhaust buttons in order to release air into the tube of the device. However, this method requires that the DSMB and reel be held very close to the diver in order for the power inflator hose to reach the device which enhances the possibility of entanglement. Then too, if the diver does not sufficiently depress the exhaust button as they presses the inflator button, they will add gas to the BCD causing positive buoyancy.
4. **BCD Power Inflator Hose:** Working similarly to the "Separate Low-Pressure Inflator Attachment" described above, this method also allows the addition of plenty of air to the DSMB without creating a buoyancy shift. However due to the length of the inflator hose (or rather lack of) the possibility of entanglement with the DSMB / reel exists. Then to, there is the issue of a disconnected hose causing a later problem with its reconnection.
5. **Regulator Second Stage:** If the DSMB is not of closed-circuit design, that is, has an open dam at the bottom, the regulator second stage or octopus regulator can be used. However, it is never a great idea to intentionally cause free-flow of a regulator, especially in cold water as it could potentially result in a significant loss of air, or even depletion of an entire cylinder.
6. **Primary Regulator Exhaust:** This method also requires that the DSMB have an open dam. The open dam of the DSMB must be held in such a manner as to cause exhaled air to enter the DSMB. It is difficult to tell if exhaled gas is making it into the shaft of the DSMB and at shallow depths, difficult to get sufficient air into the device without causing significant buoyancy shift. This method also requires that the DSMB and reel be held close to the diver's body thus enhancing the possibility of entanglement.

## STOWING AN SMB

The SMB should be attached to its deployment reel or spool with a double ended snap and is best kept in a pocket of the BCD, dry suit pocket, utility pocket, or a specifically designed SMB pouch. The SMB can be pre-affixed to the reel if desired. Carrying the SMB and reel in the open (e.g., clipped to a D-ring, etc.) subjects both the SMB and reel and its line to exposure and inadvertent damage (e.g., sun damage, bumps to the reel, line entanglement, etc.). There is also the consideration that a double-ended gate snap clipped to a D-ring yields two failure points for the reel/SMB to be lost. If one determines to carry the SMB and reel clipped to a D-ring, it is strongly suggested that a line lock be placed on the gate of the snap attached to the spool in that by doing so, one failure point will be eliminated.

## THE REEL AND LINE

There are three types of line control systems that can be utilized to deploy a DSMB:

1. **Standard Dive Reel:** These come in a variety of sizes (Primary Cave Reel, Back-Up Reel, Gap Reel, etc.) with varying lengths and thicknesses of line attached. The most common line utilized is probably #24 line which is considered the standard line of cave divers. Many wreck divers prefer #36 line as it is stouter and will hold up to more abuse than will #24. The use of a reel with a DSMB is not advised as reels tend to be not only expensive, but heavy and bulky and if inadvertently dropped during the DSMB deployment, results in a whole lot of line to be recovered in order to retrieve the reel. Additionally, reels are more subject to entanglements and jamming than are either of the other two listed methods.
2. **Finger Spool:** Far and away the best line system for use with a DSMB. These are small and lightweight. It is worth noting that most manufacturers/sellers of finger spools tend to machine wind too much line onto the spool. This is done so that the buyer will feel that they is getting their money's worth of product. Although at time of purchase, the spool line is neatly and snugly wound onto the spool, once the line is wet it will swell and, it will never fit onto the spool the same way again. For this reason, the finger spool should probably contain no more than 75-80% of its rated line length. Line should be wound loosely onto the spool, but not so loosely that it slops over the side(s) of the spool. Tightly winding line onto the spool can result in loops and snags forming "birds' nests" as the line spools off during

deployment. Finger spools can be found manufactured of plastic, Delrin, aluminum, and stainless steel. Delrin is the preferred material for a finger spool as it is lightweight, sturdy, and slightly negatively buoyant. A Delrin spool will sit mid-water while being deployed which is advantageous if it happens to slip from the diver's grip for some reason. Plastic is cheap and tends to break easily especially in cold conditions. A plastic spool will float upward should a diver lose their grip. Aluminum spools are also lightweight and only slightly more negative than Delrin, but are subject to oxidation. Stainless steel spools are sturdy, but also heavy and are subject to corrosion. Stainless steel finger spools will sink if dropped while being deployed. Plastic and Delrin are black in color, while stainless steel spools are white metal and aluminum spools can be manufactured in a variety of colors.

3. **Surface Marker Webbing Deployment System:** This is a length of flat webbing material, usually no more than 15-20 feet in length that is used only when deploying the DSMB at safety stop depth. This webbing material is folded and held together by a bungee as opposed to being wound on a reel.

## SMB LINE LENGTH/COLOR

It is recommended that there be 50% more line on a reel or finger spool than the planned depth of DSMB deployment. This should be a consideration in determining the size of spool to purchase. While the most commonly utilized line is white in color, white line can be very difficult to see in the water. Line is also available in high visibility colors: yellow, orange, green, and pink.

## PREPARING THE LINE FOR ATTACHMENT TO THE SMB

1. Tie a large loop (approx. three foot in overall length) at the end of the line to be attached to the SMB. Double knot this loop with two simple overhand knots. This loop will attach the line to the SMB.
2. Halfway between the end of the large loop and the knot that forms the loop, tie a smaller loop (approx. one inch long) using again, an overhand knot. This loop will assist in locating the end of the line when the line is wound on the finger spool.
3. At the end of the large loop, tie another small (approx. one-inch-long) loop, again using an overhand knot. This is sometimes referred to as a

"Jasper Loop". This loop will be used to secure the end of the line to the finger spool with the double ended snap.

4. Secure the line to the spool with one end of the double ended snap. In order to avoid the snap inadvertently releasing line, the snap must be positioned so that the gate of the snap faces outward from the spool. The free end of the snap can be used to secure the system to other gear.
5. It is helpful to tie in a small swivel between the running line and the leader loop in order to minimize line twisting.
6. If desired, it is acceptable to pre-stage the spool and SMB by attaching the end of the spool line to the SMB prior to stowage. Care must be taken to ensure that the line will not spool free.

## DEPLOYING A DSMB

1. Deploying a DSMB takes heightened situational awareness on the part of the diver. The following are recommended steps for deploying a DSMB at depth:
2. Establish / maintain neutral buoyancy.
3. Face down current. In this manner, as the DSMB is unfurled it will drift with the current away from the diver as opposed to drifting back toward the diver and possibly cause an entanglement.
4. Look around to ensure that other divers or objects are not in close proximity.
5. Retrieve the DSMB, finger spool, and double ended snap from their stowage compartment(s).
6. Pass the loop in the end of the line through the D-ring, eye of the bolt snap, or webbing at the bottom of the DSMB, then around the entirety of the DSMB; or alternatively, pass the spool through the loop to secure the line thereto. (Note: This step can be eliminated if the DSMB and spool are pre-staged.)
7. Hold the DSMB and spool in one hand.
8. Be sure that the line is spooling off the finger spool from the underside; that is from down and under; as opposed to up and over. This will tend to prevent snags and loops in the line as well as gear entanglements. It will additionally simplify line recovery.
9. Slightly inflate the DSMB.
10. Visually and tactilely check to make sure there are no entanglement issues.

11. Look above and to each side to ensure that there are no overhead obstructions (boat, other divers, kelp, etc.)
12. Be sure to loosen the spool lock on the Defender Pro spool in order that the spool will turn freely on the spindle.
13. Continue to inflate the DSMB (small bursts of air). (Note: It does not require much aid to inflate a small SMB).
14. Release the DSMB and push it upward.
15. Carefully control the line unspooling with the tips of the thumb and index finger of the spool hand. Use the opposite hand as a brake or drag on the spool.
16. Upon DSMB reaching the surface (confirm either visually or by slack in the line), tension the line, tighten the spool lock, and secure the line to the spool with the double ender.
17. Ascend while winding line back onto the finger spool – maintain some tension on the line in order to keep the DSMB standing vertical in the water – but not so much tension as to submerge the DSMB.

## DON'TS OF DSMB DEPLOYMENT

- Don't place a finger (or thumb) into the center hole of the finger spool. A snag can potentially drag you to the surface rapidly or break a finger.
- Don't allow the line to spool off so rapidly that it creates loops or a "bird's nest." Keep the finger spool and line in front of you in order to manage it easily. Control the release of line by applying drag (finger pressure) to the spool.
- Don't hang on to a jammed reel/spool. The rising DSMB will drag you to the surface at a much greater rate of ascent than what is safe. ***Let it go and retrieve it later.***
- Don't attempt to recover the spool line in the water should you drop a spool and it descends – this will result in a lot of loose line in the water around you and is a real entanglement hazard. Recover the line and reel from the surface – aboard the boat.
- Don't be lackadaisical about DSMB deployment and/or recovery – you are deploying line into the water that has the potential of becoming an entanglement.
- Don't wind line in overhand fashion onto the spool. This will put a twist in the line resulting in a possible "bird's nest" or loops or a snag in the line should the DSMB be deployed again.

## RECOVERING DEPLOYED DSMB LINE

There are three methods of line recovery utilizing the Halcyon Defender Pro Spool:

1. Loosen the spool lock and use the winding knob if wearing gloves.
2. If bare-handed, loosen the spool lock and use the index finger in a spool hole.
3. "Roll' the line onto the spool. This method requires that the spool be locked and held in one hand. The "free" hand is placed on the line at a comfortable distance (approx. 2 ft.) from the spool. Extend the "free" hand on the line while rolling the spool toward the "free" hand and thus the line onto the spool; and repeat the process.

## UNIFORM EQUIPMENT (CLOTHING)

The Dive Team "uniform" is designed to be functional within the purpose of the team. Dive Team uniform articles consist of the following:

- **Red Nylon Jacket** – With Sheriff's Department designated patches (cloth badge, shoulder patches, Search and Rescue rockers, and Search and Rescue back placard) -- required.
- **Baseball Cap / Watch Cap** -- With team logo – optional.
- **Dive Team Shirt** – T-shirt, polo shirt, sweatshirt with team logo
- **Sheriff's Office SAR Gortex Raingear** – With designated badge and placard – Issued.

All uniform equipment is to be clean and presentable when worn. Torn, faded, or excessively soiled uniform equipment is to be replaced within a reasonable period.

Obviously, the list of required equipment is extensive: SCUBA diving is an equipment intensive activity, and search and recovery diving is even more so. It is virtually impossible, as well as impractical, to carry all of the listed equipment on any one operational dive. The diver must evaluate the nature and objective of each operational or training dive and determine the type and amount of equipment that can be reasonably be anticipated to be needed on the dive. The "law of diminishing returns" is applicable to SCUBA equipment and tools carried: too much gear interferes with a diver's movement, increases hydrodynamic drag, interferes with proper trim, creates buoyancy issues, and requires an expenditure of more energy. Those items of equipment that are not anticipated to be needed should be left topside.

All diving equipment is to be maintained in good working order. It is extremely important that all equipment be properly maintained (inclusive of proper washing after a dive, proper storage between dives, periodic inspection, and necessary servicing). Damaged equipment must be repaired / replaced as soon as possible. It is an unfortunate fact that poor equipment maintenance has been a factor in many diving "accidents". Diving equipment is, in fact, life support equipment and must be handled and maintained as such. It would serve you well to remember that the gear that you fail to take care of after your last dive – may not take care of you on your next dive.

## TEAM EQUIPMENT

The dive team has access to specialized equipment to assist in the accomplishment of various operational missions. Specialized equipment will be utilized only with the knowledge and consent of SAR Administration by those personnel who are trained and certified to operate same. Among this equipment are the following items:

- Dive Boat: Radon, 26 ft. will support 8 divers with gear.
- Dive Platform (Freshwater), Chinook 30ft. pontoon boat will support fifteen divers with gear.
- Dive Boat: Whaler 14 ft. will support 6 divers with gear.
- Underwater Metal Detector -- 1
- Lift Bags:
  - Open Circuit
    - 1000 lbs. – 1
    - 200 lbs. --2
    - 100 lbs. -- 2
  - Closed Circuit
    - 500 lbs. – 1
    - 85 lbs. – 2
  - Vehicle Recovery System
    - 4000 lbs. - 1
- Video Ray Remote Operated Vehicle (ROV) – 1
- Tow Camera – 1
- Kongsberg Scanning Sonar – 1

- Klein Side Scan Sonar -- 1
- Manta Hand Held Sonar --1
- Safety Cylinder – Two 30 cu. ft. cylinders with stage bottle strap and regulator attached.
- Oxygen Bottle and Mask – 1
- Medical Kit -- 1
- Torpedo Diver Propulsion Vehicles (DPV) – 2
- Evidence Collection Canisters
  - Large – 1
  - Small – 5
- Data Scope and Range Finder – 1
- Compass Tac Boards – 4
- Full Body Rappel Harness – 8
- Protective Helmets – 4
- Seat Harness -- 1
- Rescue Tube – 1
- Body Recovery Strap System – 1 (2 straps)
- SCUBA Cylinder (72 cu. ft.) – 2
- Rappelling System Pack – 1
- Chain / Strap Retrieval Rod – 2
- Area Marker w/ 10# Weight – 6
- Pelican Float – 10
- Tool Box with Misc. Tools – 1
- Planning Board - 2
- Camera – GoPro Digital Camera – 2
- x7ix Body Recovery System
- Bashield Murky Water Trainer mask for OTS Guardian FFM – 5
- Shock Alert Electrical Current Indicator – 1
- Lockout / Tagout Kit --1
- Carbon Fiber Rescue Pole -- 1

The above listed equipment is the property of the County of Ventura, Sheriff's Office. Dive team members are collectively responsible for the care and maintenance of this equipment.

## SCUBA EQUIPMENT MAINTENANCE

Needless to say, SCUBA diving is an equipment intensive activity. SCUBA equipment, although intended for recreational use, cannot be treated as one might treat a set of golf clubs – left in the trunk of the car to await the next outing – days or possibly even weeks away; it cannot be treated as one might treat softball equipment (bat, ball, glove, etc.) – set aside in a corner of the garage until next week's game. The maintenance of SCUBA equipment is a topic that is, or should be covered in Basic SCUBA Instruction, however many divers either fail to learn, soon forget, or choose to disregard the basic tenants of SCUBA gear maintenance. SCUBA equipment, utilized holistically, constitutes a life support system. The environment in which SCUBA gear is utilized is a harsh one. If SCUBA equipment is to maintain reliability for use after use, it must be properly cared for.

SCUBA gear has some staunch enemies in salt (dried from seawater), sand, excessive sunlight (ultraviolet rays), ozone, and chlorine. The failure to protect gear from these attackers can cause an uncomfortable or excessively challenging dive experience; a dive or even an entire diving trip to be aborted; or even worse – a tragedy resulting in injury or even death.

The sport diver has a greater degree of latitude in their decision to make a dive or abort dive plans than does the SAR diver. A sport diver can choose whether to make a dive with a rip in their wetsuit, or not. The SAR diver may not have this leeway. For this reason, it is critical that excessively worn or damaged SCUBA equipment be quickly repaired or replaced as appropriate. In order to ensure its serviceability when needed, SCUBA equipment must be properly cared for and maintained.

Competent care and maintenance of all SCUBA equipment items cannot be over emphasized, for it is a fact that the gear that a diver fails to take proper care of today, may not take proper care of the diver tomorrow. Many sport divers are lazy in this regard and will do only the minimum amount of maintenance that they personally feel to be necessary. Some even neglect to maintain their equipment,

or portions thereof, altogether. The SAR diver cannot afford to tumble down into this trap. The harsh reality is that a problem caused due to a lack of proper care and maintenance may not manifest itself until the diver is at depth with the equipment. The bottom line is of course, that it is your life or safety that is at stake. Just how lucky do you really feel? If you are one of those people who feel that you are immune to misfortune, or that a guardian angel is waiting to rescue you, then read no further.

For the rest of you, the following are suggested as recommended procedures for the cleaning, storage, and maintenance of SCUBA diving equipment. While it is true that SCUBA gear is by-and-large well designed and hardy, and likewise true that some care is better than no care at all, in order to have confidence that this equipment will perform to its maximum potential, it is important that it receive proper pre-dive inspection, proper post dive cleaning, proper storage, and proper maintenance.

## PRE-DIVE INSPECTION

Prior to any dive the following should be checked:

- **Cylinder** – The cylinder (including the pony bottle) valve should be visually checked to ensure that the O-ring is in place in the valve to regulator interface. Cylinder pressure can be checked by attaching the regulator, activating the valve, and examining the submersible pressure gauge; or conversely by attaching a "tank checker" to the cylinder in place of the regulator. Either will give an accurate reading of the amount of breathing gas available in the cylinder prior to the dive. It is possible for cylinders to lose their air supply through a ruptured burst disc, or a leaking valve. Additionally, since dive shop employees are human, they can make mistakes. It is possible for a cylinder to receive no air fill at all, or only a partial fill and be "taped" or "capped" indicating that the cylinder is full.
- **Regulator** – The mouthpiece of the second stage should be checked to ensure that it is not ripped nor the biteplates chewed through. A couple of breaths should be drawn through the second stage to ensure that the regulator is both functional and efficient in its air delivery. Any knobs on the second stage should be checked to insure smooth functioning. Regulator hoses and connections should be checked for damage.
- **Gauges** – Once the air is activated through the regulator system, the tank valve should be turned to the "off" position and the submersible pressure gauge checked by watching the needle of the SPG while drawing air through the regulator. If the needle does not fall with each breath, the

gauge is faulty and must be repaired / replaced prior to use. The computer should be checked to ensure that it is operational and the compass checked to ensure that it is serviceable.

- **Buoyancy Control Device** – Prior to charging the regulator system, the power inflator hose should be attached to the inflator device. Once charged, the BCD inflator button should be depressed a couple of times to ensure that it is operational. The air cell should be visually inspected to ensure that it is not ripped or torn. The corrugated deflator hose should be checked for damage. The BCD should be inflated orally and left standing for approximately twenty minutes to ensure that the bladder will hold air. The air cell should then be fully deflated prior to water entry.
- **Mask** – The dive mask should be checked for cracks in the skirt, tears in the head strap, broken strap buckles, and cracks in the lens retaining ring or the lens. Water spots caused by mineral deposits on the lens can be removed through the careful application of a small amount of white vinegar. Prior to the dive, the inside lens of the mask should be treated with a commercial mask clearing agent, or sprayed with a 50/50 solution of baby shampoo and water, then rinsed.
- **Snorkel** – The snorkel should be checked to ensure that both the mouthpiece and barrel of the snorkel are firmly attached to the body. Any purge valve should be checked to affirm its presence and to ensure that it has not warped (potato chipped) or split. The snorkel keeper should be checked to ensure that it is not torn.
- **Bifins** – Fin straps should be checked for tearing or rotting, especially in the areas where the strap is fed through the buckles. Fin strap buckles should be checked to ensure that they are operational. Fin blades and foot pockets should be inspected for splitting.
- **Thermal Protection** – The wetsuit, hood, booties, and gloves should be inspected for rips or tears and unraveling of stitching. Any observed damage should be repaired prior to the dive. Check zippers on wetsuits and booties to ensure that they work freely, if not, lubricate them with "zip-wax". Drysuit seals should be inspected to ensure their integrity. Drysuit zippers should be lubricated according to the manufacturer's recommendations.
- **Safety Tools** – Knives, shears, line cutters, etc. should be checked for sharpness and corrosion. Dull tools should be sharpened and any rust removed prior to the dive. Safety tools are seldom required to be used

and are, for the most part, "out of sight / out of mind." Should they be needed in an emergency, they must be sharp and corrosion free.

- **Lights** – Dive lights should be checked to ensure that the bulb and batteries are operable and of sufficient power to provide adequate illumination. O-rings should be lubricated with silicone grease. Do not use silicone spray on o-rings.
- **Weight Belt and/or Integrated Weight System** – The weight belt buckle should be examined to ensure that it is functional. Likewise, quick release buckles on integrated weight systems should be checked for functionality. Stitching on weight pockets should be checked for unraveling.
- **Snaps and Clips** – Any attachment clips or snaps used to fasten equipment items to D-rings on the dive harness should be checked to ensure that their moving parts such as "gates" move freely. If "sticky" they can be lubricated with silicone spray and, if necessary, cleaned with white vinegar.
- **Velcro** – Any Velcro utilized on the BCD (IE: hose retainers, cummerbunds, etc.) should be checked for the presence of dried salt, sand, threads, lint, or other debris, and if present, the foreign material should be brushed out of the Velcro.

## POST-DIVE CLEANING

The single most important ingredient for the cleaning of SCUBA equipment following a dive is copious amounts of clean, fresh water. Warm water (not hot) is preferable, but cold water will do. The aquatic environment, both fresh and seawater, will cause adverse maintenance issues for SCUBA equipment if not properly rinsed following exposure. Fresh water from swimming pools contains chlorine, which will attack rubber products and bleach nylon if not rinsed out. Fresh water in lakes, ponds, streams, etc. will likely contain chemicals from algaecides, petroleum products, fertilizers, etc. Seawater of course, contains salt and sand. If allowed to dry within regulators and/or rubber products, seawater will evaporate leaving salt crystals, which can cut rubber products, perforate silicone seats in regulators, and expedite corrosion.

- **Cylinders** – SCUBA tanks should be rinsed in freshwater and the boot removed and allowed to dry thoroughly prior to being re-installed on the tank.
- **Regulator** – The SCUBA regulator is the most critical piece of equipment to consider in so far as post-dive cleaning is concerned. If following a dive, a

diver does not have time to clean their equipment; the regulator must be cleaned anyway. Hose protectors should be slid down the hose to expose the fittings. The regulator should be soaked in fresh water for a period of approximately twenty minutes. The best way to do this in order to ensure that no water enters the internal workings of the first stage as well as to examine the regulator for leaks from the regulator components or hose fittings is to attach the regulator to a cylinder, then pressurize and submerge the entire regulator. The purge button on the second stage should be depressed to dislodge any salt or debris that might be clinging thereto. If there is no facility to accomplish this, the regulator can be submerged by itself, however care must be taken to ensure that the dust cap cover on the first stage is secured and that the purge valve on the second stage is not depressed in this soaking process. Following the soaking of the regulator, in order to remove lingering salt deposits and debris, it should be rinsed in running water while taking care to hold the first stage higher than the second. A low-pressure stream of water should be directed into the ports of the first stage and into the mouthpiece and exhaust T of the second stage. Again, if the regulator is not pressurized, be careful that the purge valve is not depressed in the process, which would allow water to travel through the hose from the second stage to the first stage. Once thoroughly rinsed, the regulator should be placed in a cool shaded place to dry with the first stage positioned higher than the second stage. Once dry, the regulator hoses should be treated with a rubber preservative (e.g., "Armor All", "303 Protectant", etc.).

- **Buoyancy Control Device** – The BCD should be soaked for approximately 20-30 minutes in clean fresh water. Any alternate air source / power inflator (e.g., "Air II", etc.) should be rinsed similarly to that recommended for the second stage of the primary regulator. The inflation and exhaust buttons should be depressed several times while under water in order to free up any salt, sand, or other debris trapped in the button mechanism. Prior to removal from the water, the power inflator should be disconnected from the air supply in order to flush the internal mechanism. The air cell of the BCD should then be filled via the mouthpiece of the oral inflator approximately 1/3 – ½ full of fresh water, and the remainder of the bladder filled with air. The water should be "sloshed" about the inside of the bladder several times and then drained via the mouthpiece, power inflator connection, and any manual purging vents. This internal rinsing should be done a minimum of three times, or until the water drained from the air bladder following a rinse does not taste of salt. A commercial BCD cleaner can be utilized if desired, but make sure to follow the instructions for use. Following the rinsing of the BCD, it should be fully inflated and hung to dry in a cool, shaded area.

- **Mask, Snorkel, and Fins** – Silicone and rubber products should be soaked in fresh water in order to leach any chlorine, salt, chemicals, etc. from them. Following the soaking, they should likewise be placed in a cool shaded area to dry. Once dry, the fins (except for fin straps) and the snorkel (except for the mouthpiece) should be treated with a rubber preservative. Nothing but fresh water should be used on silicone mask skirts and straps.
- **Thermal Protection** – The wetsuit, hood, booties, and gloves being comprised of neoprene, soak up water like a sponge during a dive and are thus permeated with whatever is dissolved in the water (IE: salt, sand, chlorine, chemicals, etc.). These items should be soaked and agitated in warm fresh water for 20-30 minutes. If desired, a commercial wetsuit cleaning preparation can be utilized. Generally, after three such soakings in clean fresh water, these items will be relatively clean, however if following the third fresh water treatment there is still sand and debris at the bottom of the washtub, more soakings are indicated. Occasionally a commercial wetsuit cleaner / treatment or a solution of baking soda and water can be utilized in order to eliminate odors and provide protection for the suit and neoprene accessories. These items, like the others, should be hung in a cool shaded place to dry. Wetsuits should be hung on wide plastic hangers specifically made for this purpose. Drysuits should be cleaned according to the manufacturer's recommendations / instructions.
- **Tools** -- Metal tools (knives, line cutters, shears, wire cutters, etc.) should be thoroughly rinsed, then dried with a soft cloth or paper towel in order to eliminate as much moisture from the metallic surface of the tool as possible, then set aside to dry. Once thoroughly dry, metal surfaces as well as nooks and crannies should be sprayed with a light coat of silicone spray, which will help to prevent corrosion. Tools should be returned to their sheaths only after the latter have thoroughly dried.
- **Lights** – Dive lights should be submerged in clear water and the switch activated several times in order to flush any salt or debris from the switch mechanism. They can be either hung or set aside to dry. Once dry, the light should be dismantled, at least one battery removed, and the O-ring

checked for nicks and cuts. If the O-ring is serviceable, it should be lubricated with a small amount of silicone grease (not silicone spray). The O-ring channel should be cleaned with a Q-tip, the other end of the Q-tip sprayed with silicone spray and run through the O-ring channel. The O-ring should then be replaced. Do not turn the crown of the light all the way down on the O-ring until ready to put the light into service.

- **SMB and Finger Spool** – All water within the SMB must be expelled. If utilized in salt water the inside of the SMB should have fresh water introduced through the OPV and sloshed about to remove salt deposits. The SMB and finger spool should be soaked in fresh water and placed in a cool shaded place to dry. The SMB should be inflated to dry: the line on the spool should be played out to dry. Time should be taken to loosely but neatly re-wind line on the finger spool in order to eliminate loops and snags in the line the next time the SMB is deployed. As line is rewound it should be inspected for rips and tears and replaced if warranted.
- **Weight Belt and/or Integrated Weight System** -- Weights do not require much in the way of maintenance, however they too must be attended to. Salt deposits must be rinsed from metal buckles in order to avoid corrosion. (Plastic buckles do not have this problem, however are more prone to damage from the normal handling that weight belts encounter.) Weight belts should be rinsed and allowed to dry prior to storage. The weights that compose an integrated weight system should be removed from the pockets and both components rinsed and allowed to dry prior to replacement.

## STORAGE

All SCUBA equipment is subject to rotting at the hands of the elements. Gear should not be dried or stored in direct sunlight. It should not be stored in close proximity to the electric motors of water heaters or large electrical appliances or in the trunks of cars due to deterioration that can be caused by excessive heat or exposure to ozone. SCUBA gear should not be stored in areas where it is exposed to any chemical fumes. SCUBA equipment should be stored only when completely dry, in a cool dry place.

- **Cylinders** -- SCUBA tanks should be stored in an upright position and secured so as not to fall when inadvertently bumped or in the event of an earthquake, etc. They should be stored in a cool, dry environment away from sources of heat. Cylinders should not be totally drained of gas.

Should a tank be completely drained, the valve must be closed to prevent the entry of contaminants.

- **Regulator** – Upon removing the regulator from the air source, the dust cap cover must be immediately dried and secured in place over the first stage air pressure inlet. The regulator should be stored either lying flat with the hoses coiled, or mounted on a cylinder. If mounted on a cylinder, the yoke screw (or DIN wheel) should not be tightened on the valve in order to avoid compression of the O-ring.  The console, second stage, etc. should not be allowed to hang freely in as much as this places a strain on the hose fittings and can cause damage to the hose. Likewise, sharply bending or kinking a hose will damage it.
- **Buoyancy Control Device** – The BCD can either be hung from a hanger designed for this purpose, or mounted upon a cylinder. Either way, the BCD should be stored approximately ½ full of air in order to facilitate thorough drying and prevent any internal “sticking” of the air bladder.
- **Mask** – The mask should be stored in its protective case in order to prevent inadvertent damage. Mask and case can be stored in the dive bag.
- **Snorkel and Fins** – Can be stored in the dive bag. Tension should be released from fin straps in order to prevent cracking. Fins should be placed in the bottom of the dive bag, since they are invariably the last items to be donned and their weight and stiffness at the bottom of the bag will serve to support other items of equipment in transit.
- **Thermal Protection** – The wetsuit should be either laid flat, or hung on a wide plastic hanger specifically made for this purpose. The hood, gloves and booties can be stored in the dive bag; however, care should be taken not to place items such as fins, knives, etc. atop them due to the fact that compression of the neoprene in these items causes them to lose their value as thermal protection. Drysuits should be stored according to the manufacturer’s recommendations.
- **Tools** – Knives, etc. should be stored in their sheaths, either in the dive bag, or affixed to the BCD harness or waist belt. Care should be taken to ensure that the sheath is dry prior to placing the knife or tool therein.
- **Dive Lights** – Can be stored in the dive bag, however they should not rest upon any neoprene products. The batteries (at least one battery) should be removed from dive lights in order to prevent drainage of battery voltage and/or leakage of battery fluid during storage.

- **Weight Belt and/or Integrated Weight System** -- Weights should not be stored in the dive bag. Heavy weights are responsible for the premature demise of many a dive bag. Nor should integrated weight pockets be stored in the BCD loaded with weight.

## MAINTENANCE

In order to ensure serviceability and reliability of the SCUBA life support system, ongoing maintenance is necessary.

- **Cylinders** – SCUBA tanks are required to be **visually inspected once each year** by a certified inspector and to undergo **hydrostatic testing every five years**. Cylinder valves should be serviced if they leak or knobs become difficult to turn.
- **Regulators** -- In order to maintain warranties and ensure reliability, all SCUBA regulators should be professionally serviced on at least a bi-annual basis. This process cleans the internal parts of the regulator, replaces internal O-rings, and minor parts, and identifies worn springs and other parts which may need replacement, replaces old parts with updated parts according to the manufacturer's specifications, and adjusts the breathing resistance of the regulator to comply with the manufacturer's specifications.
- **Computers** – The battery and O-ring in the computer should be changed out once each year. This is best accomplished at the time that the regulator is routinely serviced.
- **Mask** – The mask lens should be treated approximately every six months with an abrasive toothpaste, household cleanser, white vinegar, or a commercial preparation to remove the silicone-releasing agent used in the manufacture of the mask, which will leach from the silicone skirt onto the mask lens. Abrasive cleaners should not be utilized on anti-fog lenses. The mask strap should be checked periodically for damage and replaced as appropriate.
- **Snorkel and Fins** – Fin straps and the snorkel keeper should be checked periodically for damage and replaced as necessary. No other maintenance is required.
- **Thermal Protection** – Other than a thorough rinsing following use, and an occasional treatment of "wetsuit shampoo", etc., no other maintenance of neoprene items is necessary.

- **Tools** -- Knives, shears, etc., should be checked periodically for corrosion and to insure sharpness. Knives or shears that are rusted, pitted, or otherwise corroded cannot and will not perform as designed or expected to.
- **Dive Lights** – Lights are relatively maintenance free with the exception of insuring that the sealing O-ring(s) is not damaged, batteries are good and have not leaked into the light, and the bulb is good.
- **Mini-Mother** – The Mini-Mother should be rinsed and flushed with fresh water following use. It should be checked for cracks as dropping or rough handling can cause damage.
- **Reels, Spools, and Floats** – Search reels, ascending/descending line, area marker reels, and floats, etc. should be thoroughly soaked in fresh water and the line played from the reel and allowed to thoroughly dry. Upon re-winding the line back onto the reel, it should be inspected for cuts or tears and repairs made. The double ended snap should be checked for functionality and cleaned / lubricated as necessary. The shaft of the spool and knurled locking nut should be periodically sprayed with silicone spray to inhibit corrosion.
- **Miscellaneous Items** – Items of search gear such as the wrist bungee, safety clip, perimeter marker, buddy line, etc. should be soaked in fresh water following a dive and thoroughly dried prior to storage.
- **Clips and Snaps** – Hardware is subject to corrosion and it is important to ensure that gates on snaps move freely and that swivels turn freely. Following rinsing, moving parts on hardware can be lubricated with silicone spray. It may be necessary from time to time to clean moving hardware parts with white vinegar.
- **FFM / Diver Communications System** – This equipment is to be cared for pursuant to the procedures set forth in this manual.
- **Team Equipment** – All team equipment inclusive of that listed in this manual under Team Equipment is to be maintained and stored with the same care that personal equipment should be given.

The aforementioned procedures, if followed, will go a long way toward guaranteeing that SCUBA equipment is safe and serviceable when needed as well as insuring that the individual diver's as well as the Sheriff's Department's financial investment in equipment is protected.

| | |
|---|---|
| | EQUIPMENT INSPECTION SHEET<br>**VENTURA COUNTY SHERIFF'S**<br>**UNDERWATER SEARCH AND RESCUE TEAM**<br><br>**Diver:**<br>**Date:** |

**PERSONAL OPEN WATER EQUIPMENT (FOG):**

| No. | Item Name | Serviceable | Non-Serviceable | Not Inspected |
|---|---|---|---|---|
| 1 | Gear Bag (soft sided) | | | |
| 2 | Mask | | | |
| 3 | Snorkel | | | |
| 4 | Bifins | | | |
| 5 | Buoyancy Control Device | | | |
| 6 | Power Inflator | | | |
| 7 | SCUBA Cylinder #1 (63 cu. ft. min.) | | | |
| 8 | SCUBA Cylinder #2 (63 cu. ft. min.) | | | |
| 9 | Regulator | | | |
| 10 | Alternate Air Source (Octopus, AIR II, etc.) | | | |
| 11 | Dive Computer | | | |
| 12 | Pressure Gauge (may be included in Dive Computer) | | | |

| | | | | |
|---|---|---|---|---|
| 13 | Depth Gauge (may be included in Dive Computer) | | | |
| 14 | Underwater Compass | | | |
| 15 | Exposure Suit | | | |
| 16 | Hood | | | |
| 17 | Gloves | | | |
| 18 | Booties | | | |
| 19 | Weight Belt (Freshwater), or Weight System | | | |
| 20 | Weight Belt (Saltwater), or Weight System | | | |
| 21 | Knife, Sharp (or Shears, Line Cutter) #1 | | | |
| 22 | Knife, Sharp (or Shears, Line Cutter) #2 | | | |
| 23 | Visual Signal Device (strobe, flare, etc.) | | | |
| 24 | Auditory Signal Device (whistle, etc.) | | | |

**UNIFORM EQUIPMENT**

| No. | Item Name | Serviceable | Non-Serviceable | Not Inspected |
|---|---|---|---|---|
| 25 | Red jacket with Authorized Patches | | | |

**ANCILLARY EQUIPMENT**

| No. | Item Name | Serviceable | Non-Serviceable | Not Inspected |
|---|---|---|---|---|
| 26 | Underwater Light #1 | | | |
| 27 | Underwater Light #2 | | | |
| 28 | Side Cutters | | | |
| 29 | Marker Buoy (Pelican Float, etc.) | | | |
| 30 | First Aid Kit | | | |
| 31 | Spare Parts Kit | | | |
| 32 | Small Mesh Bag | | | |
| 33 | Waterproof Decompression Tables and Worksheets | | | |
| 34 | Redundant Air Supply (e.g., Pony Bottle with Regulator) | | | |

**DEPARTMENT / TEAM-ISSUED EQUIPMENT**

| No. | Item Name | Serviceable | Non-Serviceable | Not Inspected |
|---|---|---|---|---|
| 35 | SAR Raingear W/ Authorized Patches | | | |
| 36 | OTS Full-Face Mask | | | |
| 37 | OTS Second Stage Regulator | | | |
| 38 | OTS Buddy Phone | | | |
| 39 | Full Face Mask (FFM) Carrying Case | | | |

| | | | | |
|---|---|---|---|---|
| 40 | SAR Badge (the star) | | | |
| 41 | Sheriff's Office ID Card (has your name on it) | | | |
| 42 | Office of Emergency Services (OES) Card | | | |
| 43 | Call-Out Kit | | | |
| 44 | Mini Mother | | | |
| 45 | Ascending / Descending Line | | | |
| 46 | Surface Marker Buoy | | | |
| 47 | Finger Spool | | | |

**SPECIALIZED SEARCH EQUIPMENT**

| No. | Item Name | Serviceable | Non-Serviceable | Not Inspected |
|---|---|---|---|---|
| 48 | Six-foot Buddy Line | | | |
| 49 | Search Line W/ Rings @ 30" Intervals #1 | | | |
| 50 | Search Line W/ Rings @ 30" Intervals #2 | | | |
| 51 | Wrist Bungee | | | |
| 52 | Double-Ended Snap | | | |
| 53 | Anchor (25 pounds) | | | |
| 54 | Search Reel #1 (120 ft) | | | |
| 55 | Search Reel #2 (100 ft) | | | |
| 56 | Perimeter Marker with Anchor or Weight | | | |
| 57 | Area Marker with 10- | | | |

| | | | | |
|---|---|---|---|---|
| | pound Anchor | | | |
| 58 | Safety Clip | | | |
| 59 | Slate and Pencil | | | |
| 60 | SMB or Lift Bag<br>Dedicated Inflator Hose | | | |

**SWIFTWATER EQUIPMENT (Only for Swiftwater Rescue Trained People)**

| No. | Item Name | Serviceable | Non-Serviceable | Not Inspected |
|---|---|---|---|---|
| 61 | Helmet | | | |
| 62 | US Coastguard Approved Type III or Type IV Personal Floatation Device (PFD) | | | |
| 63 | Knife (attached to PFD) | | | |
| 64 | Whistle (attached to PFD) | | | |
| 65 | 3-4mm Wetsuit | | | |
| 66 | Gloves | | | |
| 67 | Booties or Tennis Shoes | | | |
| 68 | Short, "Boogie" Style Bifins | | | |
| 69 | Throw Bag | | | |

**EQUIPMENT INSPECTED BY:** ______________________________

**COMMENTS:**

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# CHAPTER 4 ORGANIZATION AND PLANNING

The success of any search and rescue (SAR) operation is directly related to efficient organization and thorough planning. Organization begins with the first responding SAR member to arrive on the scene, who must act as the operations leader or "Divemaster" until they is relieved of that responsibility by more experienced Dive Team personnel. Normally there will be a law enforcement, fire, or other official on scene who can provide information to the SAR Divemaster. However, at times the Divemaster may have to sort order from chaos and begin organizing the SAR operation with nothing more than the initial call-out information that they received.

The Divemaster must manage the search and recovery effort according to the scope of the operation that is determined by four factors:

1. **The Search Objective:**
   - Rescue of a drowning victim(s)
   - Recovery of drowning victim(s)
   - Recover weapon(s)/evidence/contraband
   - Locate/salvage wreckage
   - Locate/remove hazardous objects
   - Inspect equipment/structures
   - Recover personal property
2. **The Magnitude of the Search Area:**
   - Broad area / vague location (e.g., surfer disappeared in surf zone, etc.)
   - Confined area / localized (e.g., object fell off end of pier, fisherman missing from anchored boat, etc.)
3. **Site Environment:**
   - Search locale (ocean, lake, stream, etc.)
   - Dive site base (beach, boat, pier, etc.)
   - Time of day (night/day, remaining daylight)
   - Water conditions (tide, current, surge, depth, and visibility)
   - Surface conditions (wind, waves, visibility, temperature, presence of watercraft, etc.)
4. **Available Resources:**
   - SAR divers responding (number, qualifications)
   - Equipment available
   - Transport vehicles (boat, barge, personal watercraft, and helicopter)

- Assisting agencies (Coast Guard, Harbor Patrol, Fire Dept., etc.)

Although the Divemaster must assume control and leadership of the operation, they will normally be assisted or even directed by an official from the Sheriff's Department who will assume the role of Incident Commander (IC). The incident Commander may be the SAR liaison or other Sheriff's official. As operations manager, the Divemaster's basic functions are:

1. **ASSESSMENT** of the situation.
2. **ORGANIZATION** of resources.
3. **PLANNING** of the operation specifics.
4. **IMPLEMENTATION** of the plan.
5. **TERMINATION** of the SAR operation.

These basic functions are always performed within the scope of the operation as defined by the previously mentioned factors of search objective, magnitude of the search area, site environment, and available resources.

## ON SCENE ASSESSMENT

The first SAR diver arriving at the scene must report to the law enforcement official or other person in control (fireman, lifeguard, etc.). As Divemaster, this diver must interview (or cause to be interviewed) the official and any other appropriate persons (witnesses, etc.) to determine exactly what the objective of the SAR operation is. Notes should be made regarding the statements of all parties. It is critical that the following concept be adhered to:

The first SAR team member on the scene must not enter the water or otherwise leave the scene. they must fulfill the responsibilities of Divemaster until relieved of that function. (EXCEPTION: If a rescue of a drowning victim is possible, the first diver on-scene should endeavor to affect the rescue.)

When the objective is clearly understood the Divemaster then seeks out the best person(s) on site to obtain information and data, which will lead to the determination of the "most probable location" of the search object. Especially in the case of an accident, eyewitnesses are infinitely better than those who talked to the witness, or those who talked to those who talked to the witness. Second- and third-party information is notoriously inaccurate.

Utilizing the directions of a present eyewitness to identify the "most probable location" will significantly reduce the area of uncertainty. The Divemaster should consider immediately deploying a marker buoy if such a maneuver is possible and practical.

If the situation calls for knowing what the water conditions are, such as depth, visibility, current, etc., the Divemaster will deploy a diver or dive pair (with or without SCUBA depending on the depth and other apparent conditions) to make this assessment.

The Divemaster also assesses the local terrain features such as: water entry/exit locations, amount of beach at high tide, ease of access to site for equipment required, nature of adjacent topography, etc.

Communicating with the Deputy Sheriff, or other official, enables the Divemaster to assess the need for and availability of resources (SAR personnel responding, SAR equipment and assisting agencies) that are, or will be, at their disposal.

The Divemaster must then conduct a risk/benefit assessment, in other words: an evaluation of the benefit to be gained from the operation vs. the risk involved to personnel. Keep in mind that it is far easier to avoid problems than it is to solve them. Potential problems should be anticipated and identified in the assessment stage.

The security of the scene must be considered in the early stages of any operation. Unauthorized access to the area must be prohibited. The physical area of the occurrence (both land and water) must be taken into account. The unauthorized removal or destruction of evidentiary items must be prevented. Likewise, the inadvertent deposit of items into the area that might later be mistakenly interpreted as evidence cannot be permitted.

## ORGANIZATION OF THE SEARCH

The Divemaster selects the most practical base site from which they and the SAR team will conduct the operation. they should organize their resources based on the scope of the operation and availability and/or limitations of personnel and equipment.

Depending upon the scope of the operation, the Divemaster will appoint SAR personnel as required to assist him at the base site (Incident Command System / ICS System). Normally, these assistants will be team members who cannot dive because of health problems or who are not qualified for the type of dive required. However, if such persons are not immediately available and the

Divemaster needs assistance they should not hesitate to appoint healthy and qualified divers to assist him, at least on an interim basis, until others arrive.

It is the responsibility of the Divemaster to ensure that necessary equipment and supplies are present. If the base site is accessible to the public the Divemaster will need to assign the responsibility of securing the area. Provisions must be made for the security of personal and team equipment that is to be utilized for the operation. On most occasions the Divemaster will need help in sorting out and bringing certain equipment to the base site, then in the preparation and placement of the equipment, and finally implementing the operation.

On a small scope operation, the Divemaster may not require anyone out of the water to help. On a large scope or complex operation, they may require any number of assistants.

The Divemaster could organize their assistants as "Squad Leaders" depending on the scope of the operation and organizational concept. **Squad leaders don't dive**. They are responsible for the various tasks that the Divemaster may assign, but, additionally, they are each responsible for supervising a dive team consisting of any number of divers.

NOTE: If the assistants and/or Squad Leaders are fit to dive they should be "suited up" and be available to exchange roles with divers who have made a dive or with later arriving team members who are not fit to dive.

In summary, the purpose of <u>organization</u> is to establish order and eliminate chaos. The resources available to the Divemaster are the personnel and accessible equipment at their disposal. It is the Divemaster's duty to organize these resources seeing that:

- All SAR personnel have an appropriate assignment, and
- Proper equipment is prepared and ready for use

Some form of organization should be in place prior to planning and implementing the operation; otherwise, the chances of the operation having a successful outcome are greatly reduced.

## PLANNING A SEARCH

The Divemaster has assessed the situation and organized the available resources; they now directs their efforts in planning the specific actions to be taken. **PLAN THE WORK.**

First, the Divemaster formulates their best effort concept of how the operation should be conducted. they may, or may not, solicit ideas from others at this initial stage. It is important that a concept has "birth" and the Divemaster must take the initiative.

Next, the Divemaster presents their conceptual plan to participating personnel inviting comments, questions and criticism. The Divemaster should be a good listener during this briefing. Some good ideas may be presented which should be incorporated into their plan. Or, quite possibly, a different and better approach to the problem might be introduced which should result in the Divemaster adopting a new plan. It is imperative during this briefing, that personnel express any pertinent ideas and concerns. It is important that the plan be simple. All personnel must understand the plan and their role in the operation. If team members ask excessive questions or seem to be confused about the implementation of the plan, then it is probably more complicated than it needs to be.

The Divemaster must then make a final decision regarding the plan to be implemented and inform all participating SAR personnel of the plan and various assignments. If appropriate, the Divemaster should formulate a contingency plan in the event that implementation of the original plan proves to be ineffective.

It is important during the planning stage to develop a strategy for dealing with anticipated problems. Many times, injuries to personnel have occurred as a result of a failure to develop a practicable plan. If problems are predictable – they are preventable.

## IMPLEMENTING A SEARCH

In implementing the operational plan, the Divemaster should:

- First and foremost, always be alert to the safety and wellbeing of the divers. Be on the lookout for potential dangers to the divers. Assure that the divers' entries, exits and the bottom times are being logged.
- Act decisively according to the plan. Make decisions and give direction, otherwise coordinated team actions will deteriorate into uncoordinated individual actions.
- Keep on top of what is happening. Supervise. Assure that assignments are being properly carried out in a timely manner. Mistakes will probably occur. Correct them quickly to minimize their effect.
- Be alert to changes in conditions that may affect the plan.
    - Examples: one hour of daylight remaining, tidal changes, changes in wind intensity, current is picking up or changing direction, etc.
- Be flexible toward changing or modifying the operation. Information obtained during the ongoing search may indicate that a change in plans and/or implementation is called for. If a change is required, make it and inform squad leaders and/or assistants.
- When the object is recovered, notify the responsible official on scene. Make sure that a coordinated effort is made to inform team members, both in and out of the water, of the find -- in the case of the recovery of a drowning victim, this must be done discreetly. (The Divemaster should not get careless at this point by neglecting divers in the water. Those divers are still at risk and must be attended to by signaling them to the surface and watching over them until they are out of the water. The Divemaster must make sure that the squad leaders and/or assistants attend to the divers after the find).
- Maintain (or cause to be maintained) an accurate log and diagram of the area searched. In the event of multi-day operations, this information will assist in avoiding deployment in areas already searched.
- Be responsible for delivering the object to the appropriate official Coroner, Deputy, or other official on the scene.

## TERMINATING A SEARCH

In terminating the operation, the Divemaster should:

- Assure that the Sheriff's dispatcher is informed that the operation is terminated. The officer in charge at the scene should be able to call this in at the request of the Divemaster.
- Retrieve, clean, and store equipment. This is inclusive of watercraft, communications equipment, sonar, etc.
- Make note of any equipment that was damaged in the operation and in need of repair.
- Poll all SAR personnel to determine if any injuries and/or equipment losses have occurred. If so, report them to the SAR liaison officer.
- Critique the operation before SAR personnel disperse. Information about conditions at the site may prove to be beneficial for future operations in that area. Additionally, the success of future operations demands that problems that were encountered on the operation be identified and discussed. Planning for your next operation begins with a critique of your last.

# CHAPTER 5 COMMUNICATIONS

On any given operation, it seems that the establishment and maintenance of effective communications is one of the most challenging aspects affecting the dive team. Establishing efficient communications during any sub-aquatic operation is difficult to say the least. Topside, various types of radio communications can be utilized by surface support personnel, as necessary. However, radios are not 100% effective in transferring communications due to a myriad of mechanical and environmental factors. Neither are radios appropriate for communicating with divers as they position themselves on the surface in preparation for an underwater search.

Communications from surface support personnel to divers at the surface and vice versa can be accomplished through a series of prearranged signals that must be understood by all personnel involved in the search. Methods of communications can involve prearranged hand, light, or whistle signals or a system where each diver is assigned a separate number corresponding to a number painted on a card or board large enough to be easily seen at distance. A second board displaying a large arrow is utilized to indicate the direction in which the diver should move for correct positioning (i.e.: away from shore, toward shore, right, left, etc.). The availability of a large easel or a vehicle which can be utilized to hold these boards will serve to alleviate fatigue in support personnel on shore who otherwise must hold up such signs.

In order to facilitate communications from the diver at the surface to shore, prearranged hand signals and/or signals utilizing a piece of equipment are effective. We have developed such a communication system by utilizing a mast capable of being attached to/detached from the diver's surface float (mini mother). Should the number of personnel in the dive team warrant, each individual diver can identify their float via a prominently displayed number (badge number) attached thereto.

Underwater, communication can be accomplished by electronic communications devices, hand signals, light signals, rope pulls or in the case of very low visibility, and where divers are positioned close together by hand squeezes.

## ROPE PULL SIGNALS

We use the following rope pull signals:

- 2 pulls (squeezes / flashes) = Stop
- 3 pulls = Go
- 2 pulls twice = Stop/Up
- Constant pulls = Help!

The problem with either hand or light signals is that the recipient of the communication must be looking at the sender, in other words they must be able to see the sender's hand or light. If not, communication is not effective. Hand and light signals are slow in that in order to confirm receipt of the message, the recipient must return the signal to the sender.

The same problem occurs with both rope pulls and hand squeezes. They are slow. In order to effectively communicate a message, all signals must travel down the line from diver to diver and then be returned to the source to indicate that the signal was received. Only then can the mechanical act called for by the signal by performed.

Another problem with such signals is that they are not by any means standardized. Should anyone choose to investigate different publications covering this topic it will become obvious. For example, one nationally known organization in the field of underwater search and recovery teaches that one pull on a line means, "Are you O.K?" Our experience has taught, however, that one pull on a line means nothing specific. For example, a diver may find it necessary to tug the line in order to free a snag; they may inadvertently tug the line when getting into position or repositioning himself; a tender may snag a line inadvertently as they move about a boat or dock, etc. Where visibility allows, rope pulls are best utilized as an attention-getter between divers and followed up with appropriate hand signals that are standardized in the diving community. Hand signals are, of course, simple and therefore many times, the quickest and most efficient way to communicate provided that the diver with whom you are communicating is looking at you and sees the signal. Simplistic hand signals have been developed by the sport diving community and are adequate for that purpose. These signals are however, many times not sufficient for the communication of more complex concepts during an underwater search and/or recovery. Hand signals developed by the cave diving community are helpful in this regard.

Several underwater communications systems have been developed and may be useful in an underwater search. These systems are not without limitations, however and vary in effectiveness due to inherent deficiencies or environmental difficulties.

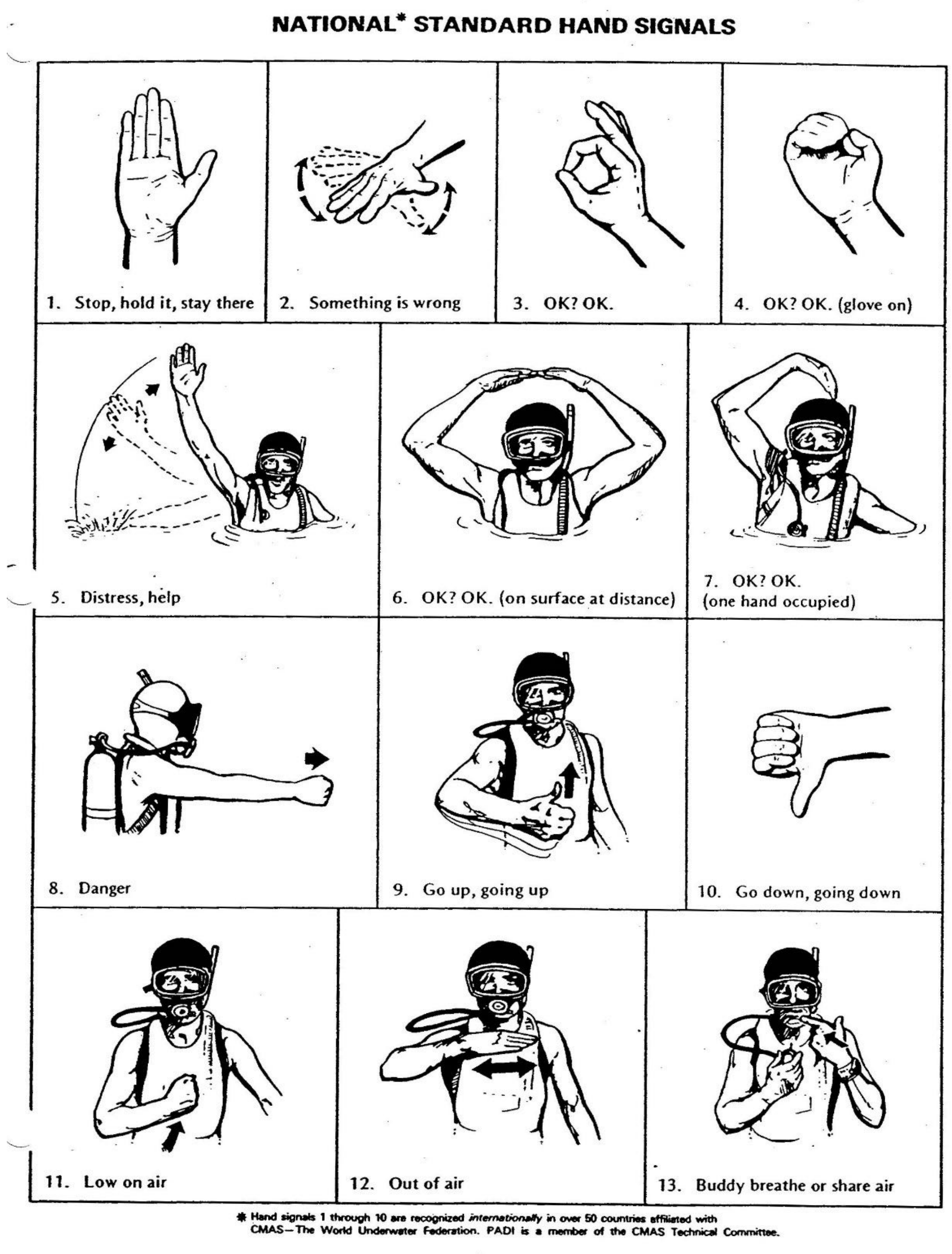
A "hardwire" communications system may be of value when conducting a search utilizing one searcher in a straight sweep or semicircular sweep or when it is desirable to communicate with only one of a number of searches on a line. Rope pulls can be utilized as backup communications for the hardwire.

There are a variety of systems that will allow underwater communications amongst a number of divers; however, these too have their limitations. Some are voice activated (VOX) others have a push-to-talk (PTT) switch. These systems are invariably directional, meaning that the transducer on the diver must be in direct line with the transmitter/receiver. This can be a problem when the diver's body blocks the path between the transducer and the transmitter/receiver, or where underwater obstacles are present. These systems are also affected by the engines of watercraft in the area, as well as by thermoclines.

Regardless of the communications system selected, the intelligibility of transmitted messages improves significantly if divers are trained to talk properly when using the equipment. Speech, in order to be understood, must be simple, and delivered at a normal tone and pace. Divers must take care not to exhale while speaking lest exhalation bubbles interfere with the speech signal. Divers must also understand that just like in the bygone days of telephone party lines - everyone cannot talk at once!

# HAND SIGNALS

## NATIONAL STANDARD HAND SIGNALS



# COMMONLY USED HAND SIGNALS

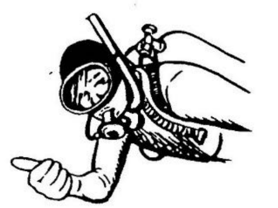
## COMMONLY USED HAND SIGNALS

14. Come here

15. Me, or watch me

16. Under, over, or around.

17. Level off, this depth



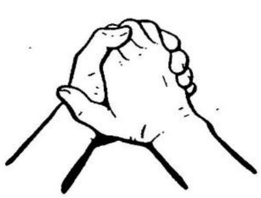
18. Go that way

19. Which direction?

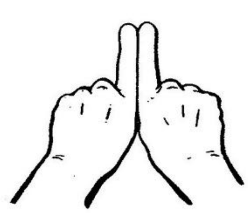
20. Ears not clearing

21. I am cold

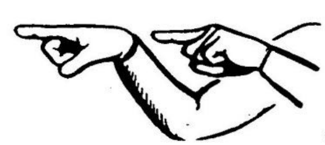
22. Take it easy, slow down



23. Hold hands



24. Get with your buddy



25. You lead, I'll follow

## DIVE TEAM CALL OUT PROCEDURE (NOTIFICATION PROCEDURE)

Notification of Dive Team members of team call-outs and/or training functions is accomplished via the Sheriff's Office "Everbridge Emergency Notification System". This notification system will contact any number of telephones, email addresses, etc. that an individual team member designates and leave a pre-recorded message, either in voice, text (SMS) or email form.

In order to facilitate the quickest notification and elicit the most rapid response of Dive Team personnel, it is necessary for each team member to maintain a personal cellular telephone. Electronic notification is made on a rotational basis to the cell phone, followed by the home phone, and any other phone that a team member designates. Should a team member elect to place their work phone into their personal notification bank, they must insure that no other person at their place of employment will ever answer their telephone. Once the system connects with one of the designated points of contact, the message is delivered and further attempts to deliver that message cease.

Upon receiving a call from the Everbridge system, a team member is prompted by voice recording to press "1" to receive the message. Following delivery of the message, the recipient is again prompted to press "1" to acknowledge receipt. In the event that a team member does not fully comprehend the message and wishes for it to be repeated, they should hang up and wait for the call to recycle back to the phone they is using. Team members must instruct family members to hang up on any Everbridge call received at the home where the team member is not present in order to keep the notification cycle active. The announcement upon answering the phone is: "This is an important (or emergency) message from the Ventura County Sheriff's Office."

# CHAPTER 6 SEARCH PATTERNS

There are a variety of search techniques that are applicable to the underwater environment. While in theory, some patterns based upon land or air search patterns should work… in practice they prove to be inadequate underwater due to such factors as limited visibility, chaotic bottom contour, and submerged obstacles and hazards. Experience has shown that to be efficient underwater, a search pattern must be simple. The simpler – the better. The more complex the search system or search method, the more likely it is apt to fail.

All search techniques rely on one common element: the adoption and execution of a defined search pattern. **The pattern must commence at a known point, cover a known area, and terminate at a known end point.** A search is conducted by employing search sweeps that slightly overlap. **The last known position of the object of the search is utilized as a starting point.** It is important to determine the PLS (Point Last Seen) early in the search operation. Many an underwater search has proven unsuccessful due to a poor PLS being utilized.

Different search patterns lend themselves better to one type of search than others, depending on:

- Bottom topography
- Depth
- Visibility
- The number of divers available
- The size of the missing object
- How the base of operation is established

Eleven search techniques (patterns) are listed below. There may be others that are more practical to utilize under ice, in rivers, or in dams where the bottom is filled with trees, or debris; however, an imaginative combination of two or three of these patterns will prove effective in almost any instance.

- THE CIRCULAR SEARCH PATTERN
- THE SEMI-CIRCULAR SEARCH PATTERN
- THE STRAIGHT SWEEP SEARCH PATTERN
- THE GRID OR CHECKERBOARD SEARCH PATTERN
- THE STRAIGHT SWEEP IN CURRENT
- THE STRAIGHT SWEEP ALONG A SHORELINE

- THE SEARCH WITH A WEIGHTED LINE
- THE PLANING BOARD SEARCH
- TOWING DIVERS BEHIND A BOAT
- THE COMPASS SEARCH
- THE JACK-STAY OR "Z" SEARCH

It is critical, regardless of the type of search pattern selected that each diver participating in the search be able to guarantee one of two things:

1. The object **is located** in their assigned search area (assuming only one object is being searched for, only one diver will be able to say this). OR
2. The object being searched for **is *positively* NOT located** in their assigned search area.

Divers participating in a search must keep in mind that the search can be greatly complicated by stirring up the bottom. **Everything possible should be done to keep from disturbing the bottom and stirring up sand, silt, etc.**

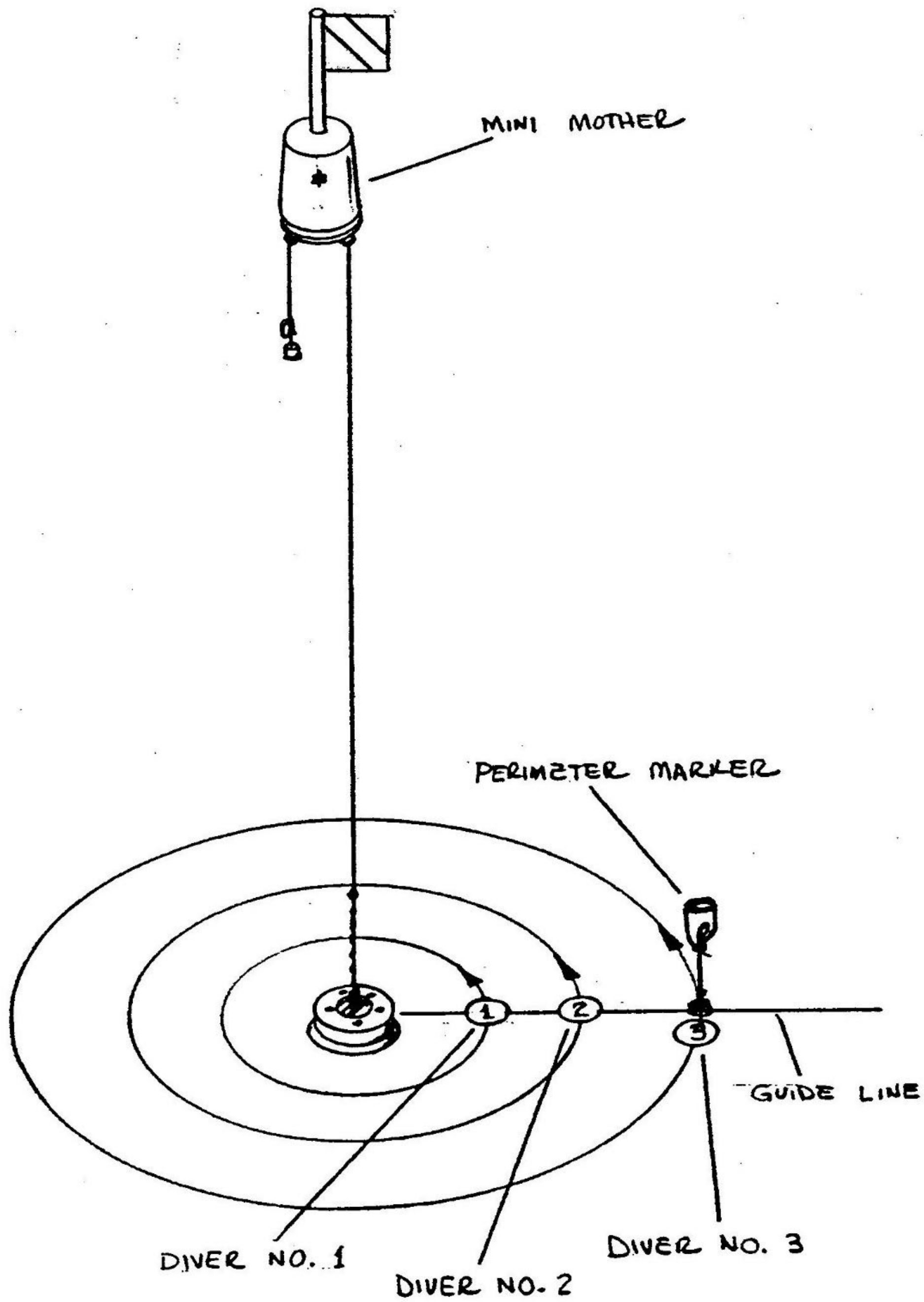
Silt or bottom disturbance is normally prevented by:

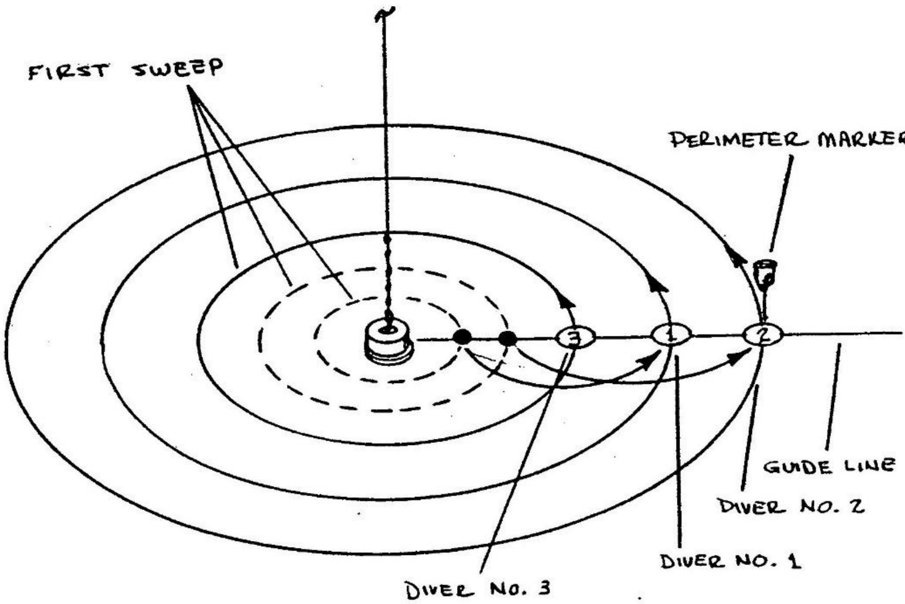
- Maintaining proper attitude in the water
- Maintaining neutral or slightly positive buoyancy
- Keeping the fins above the cylinder in order to not stir up silt
- Clipping all gauges, tools, reels, and other equipment into the diver's torso as closely as practicable in order to eliminate dragging such items along the bottom.

Divers should refrain from:

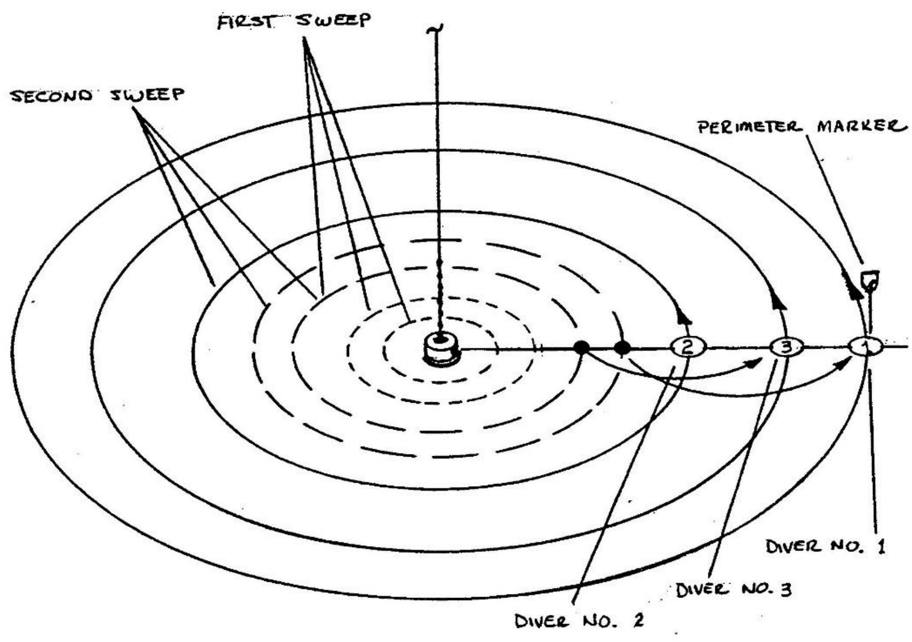
- Wading about in the water adjacent to the search area (both upon ingress and egress)
- Treading in shallow water in a vertical position
- Touching the bottom with hands, fins or any part of the diver's body or equipment
- Deploying weights and anchors by dropping them from the surface.

## THE CIRCULAR SEARCH PATTERN






SECOND SWEEP




THIRD SWEEP

In setting up the circular search pattern (or any pattern for that matter) the first thing to be done is to establish the point last seen (PLS) or most likely location of the object of the search. This location can be established through eyewitness placement, GPS coordinates, best estimates utilizing a range finder, or most likely location due to such factors as current or wave movement, etc. A Mini-Mother is then set up at this location.

Subsequent areas to be searched are established utilizing the first placed Mini-Mother as a benchmark. In other words, dependent upon the object of the search, underwater visibility present, water temperature, depth, bottom topography, current running, surge, etc., a decision is made by the divemaster regarding the size of each individual search pattern to be run (IE: 50 ft, 60 ft, etc., out to 100 ft.). A marked line is utilized to establish the distance between Mini-Mothers and the pattern of fixed search areas is established on the surface. From the establishment of the first circular pattern, an infinite number of overlapping patterns can be established as necessary in any and all directions in order to ensure effective coverage of the search area.

Suppose, for example, that it is determined that individual patterns are to be run utilizing a triangular grid at a distance of 100 ft. between anchor points. The first Mini-Mother will be positioned at the PLS. The second will be positioned by a diver at a distance of 100 ft. from the first. The third Mini-Mother will be positioned, 100 ft. from each of the first two Mini-Mothers. Depending upon the direction that the pattern is desired to be expanded, the fourth Mini-mother will be placed 100 ft. from any of the established Mini-Mother positions (#1,2, or 3) and equidistant between them. In order to insure proper of the search area, each diver will dive a 55-ft. search pattern, which will result in a 5 ft. overlap of each pattern with its adjoining patterns. Thereafter, this grid can be expanded in any direction desired.

The circular search pattern can involve any number of divers, yet it is most efficient for a single diver. The first item of importance in using this pattern is to ensure that the anchor used as the base of the ascending/descending line is of the correct shape and weight to remain fixed during the search. A swimming diver can easily pull an anchor that is too light out of position. The starting point of the circular pattern must be marked (perimeter marker) in order that the diver will know when they have completed a 360-degree search pattern.

The search line snap is secured to the anchor chain and one (ideally) or more divers are spaced along the expanding search line according to the visibility and or bottom topography. When a 360-degree sweep is completed the diver furthest from the anchor remains in position, otherwise the size of the first sweep will not be known and a small object might be missed as a result of the larger second sweep.

The number of expanding circles made from one reference point is dictated only by the length of the search line, underwater visibility, decompression considerations due to depth, and air supply. It is the responsibility of the diver on the outside circumference of any given circular sweep to keep the line taut. Consequently, this outside diver swims over more area; yet searches less area than do the others.

If the object is not located from the first point of reference, the location of the first anchor is marked with a weight and surface buoy (Area Marker). The Mini-mother and its anchor can then be relocated and the search repeated.

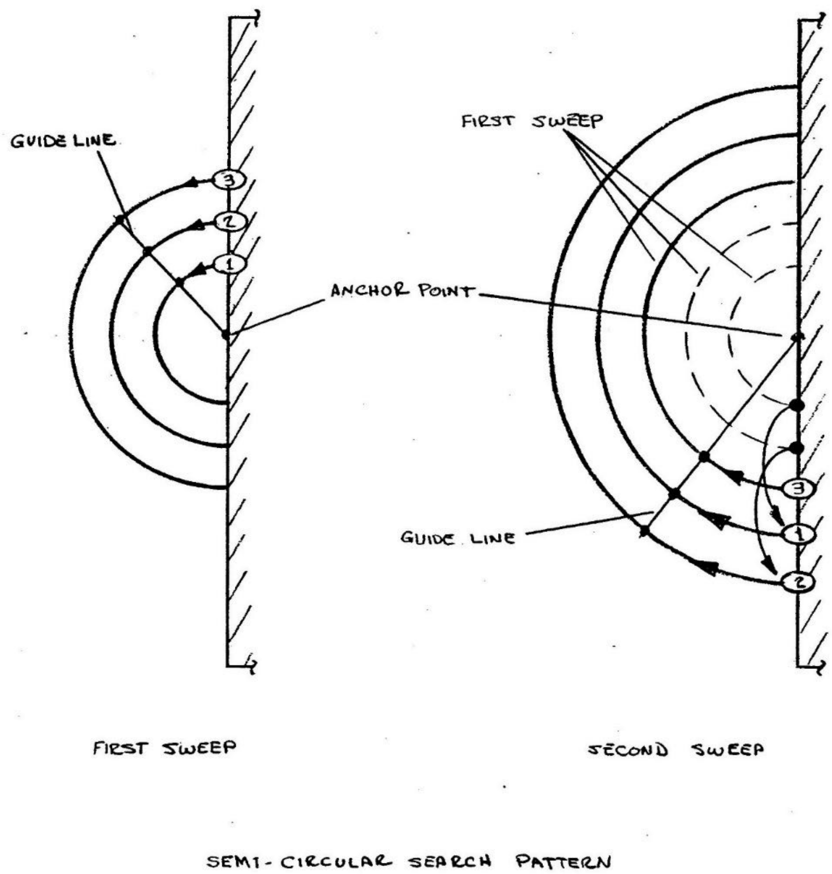
We utilize a flat-bottomed 25–30-pound weight (brake drum, lead dome, or other similarly configured object; attach a 2-foot length of galvanized chain to the anchor with a swivel at each end. The chain will extend above the silt and provide a location for snapping on the search line; the swivel allows the chain to rotate with the moving search line to prevent fouling of the search line and ascending / descending line.  Alternatively, a long line snap can be utilized to "bite" directly onto the ascending / descending line eliminating the chain. The ascending / descending line is clipped into the chain opposite the anchor and runs vertically to the Mini-Mother at the surface. Excess line (scope) is suspended from the Mini-Mother with a 4-5 lb. counter weight below the surface to account for wave action, swell, tidal change, etc.

The mast / flag of the Mini-Mother is used for ranging and positioning from the beach. Two pulleys spaced at least 12-inches apart are used to keep the ascending / descending line from fouling with the line scope and counter weight. In low-zero visibility searches, the diver uses the ring line and a double snap to attach to the chain.

The search line is utilized in searches involving better underwater visibility, and a "ring-line" utilized in conditions of low/no visibility. In either case, a perimeter marker is utilized to mark the starting and ending points of each circular sweep. Expansions of the circular pattern are accomplished by the diver(s) remaining inside the already been searches circumference of the pattern, and unwinding an appropriate amount of line (or rings) from the reel (depending on visibility and/or topography), moving simultaneously to the new search perimeter, marking it with the perimeter marker, and repeating the pattern.

NOTE: Care must be taken in setting up multiple circular patterns giving due consideration to depth, underwater visibility, bottom topography, etc., so as not to space Mini-Mothers so closely as to constitute a hazard to divers from entanglement by other diver's search lines.

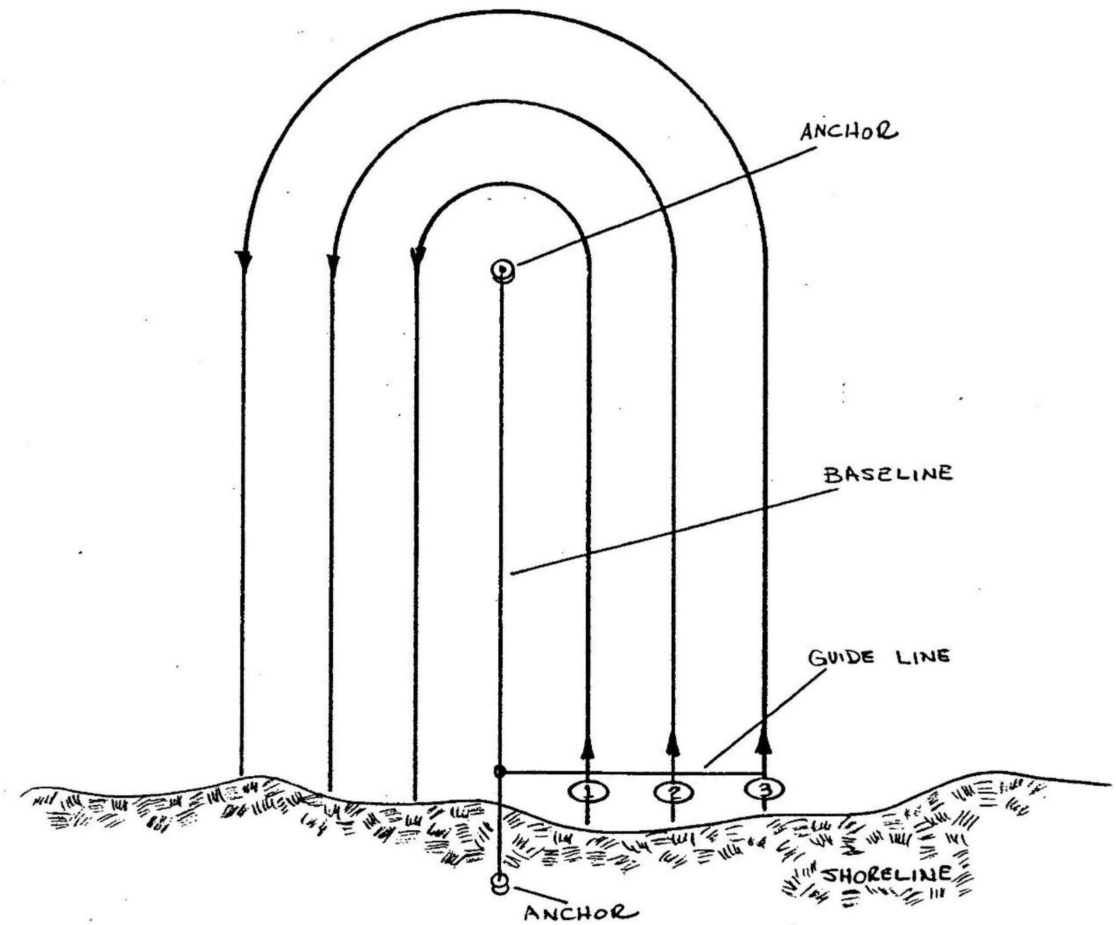
## THE SEMI-CIRCULAR SEARCH PATTERN




The semi-circular search pattern is most effectively used from a pier, or possibly a straight shoreline. The search line is affixed to a piling near the bottom or to an anchor. The pilings themselves from the start and termination points of each sweep and indicate points of expansion. From shore, shallow water or the banks of the shore itself will give the diver the parameters of the sweep. Divers can be either shore tended if deemed advantageous to do so, or self-tended.

The semi-circular search can be effectively utilized to locate large objects (i.e.: vehicles, boats, etc.). This is accomplished by beginning the pattern with an expanded search line and “snagging” the object of the search as the diver passes by it.

## THE STRAIGHT SWEEP SEARCH PATTERN




STRAIGHT SWEEP

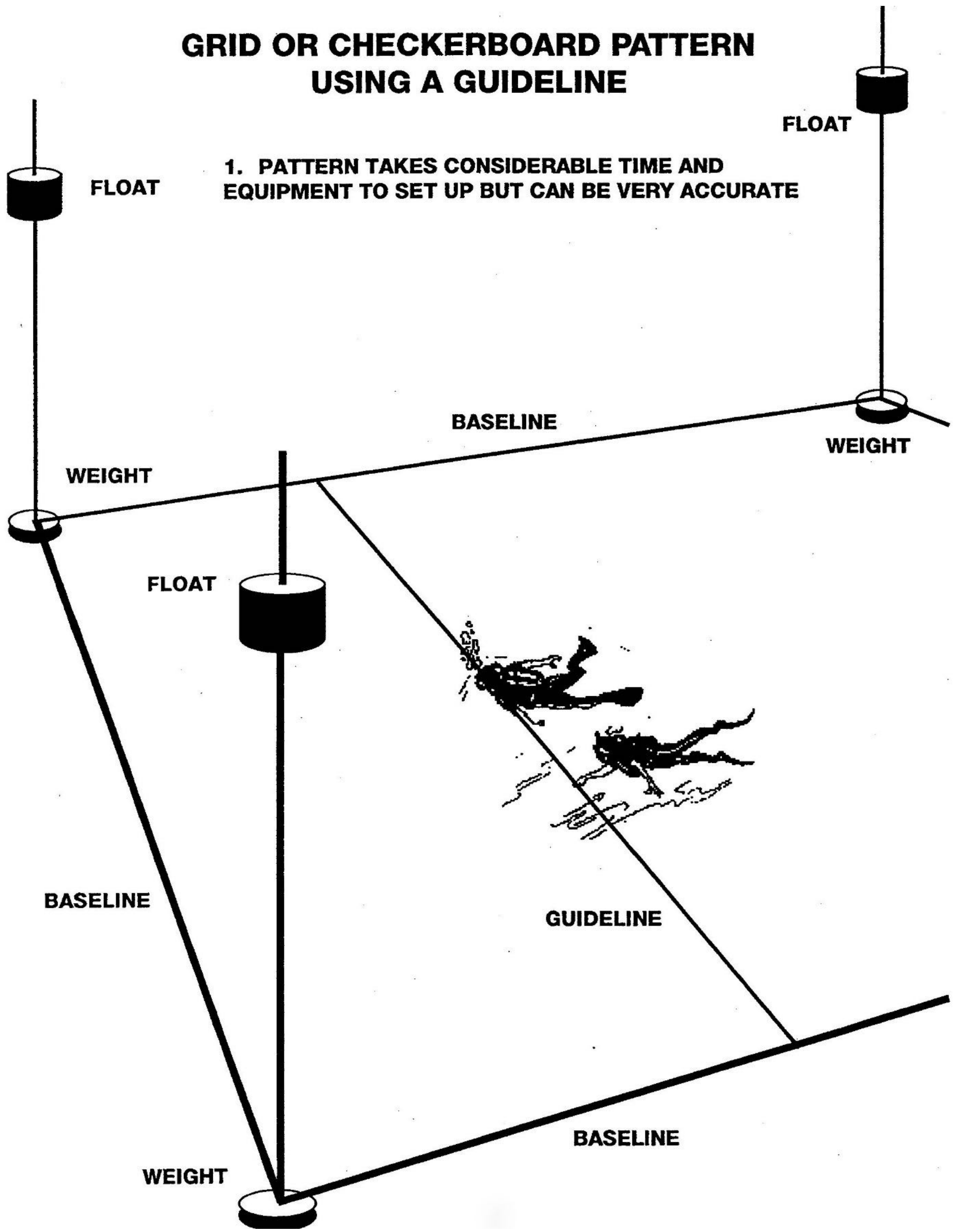
A straight sweep from a single guideline is generally used when there are many divers participating and there is a fair amount of visibility. A straight sweep can also be accomplished in low-zero visibility water by placing divers along the line in close proximity to each other, however such a dive is extremely difficult to coordinate.

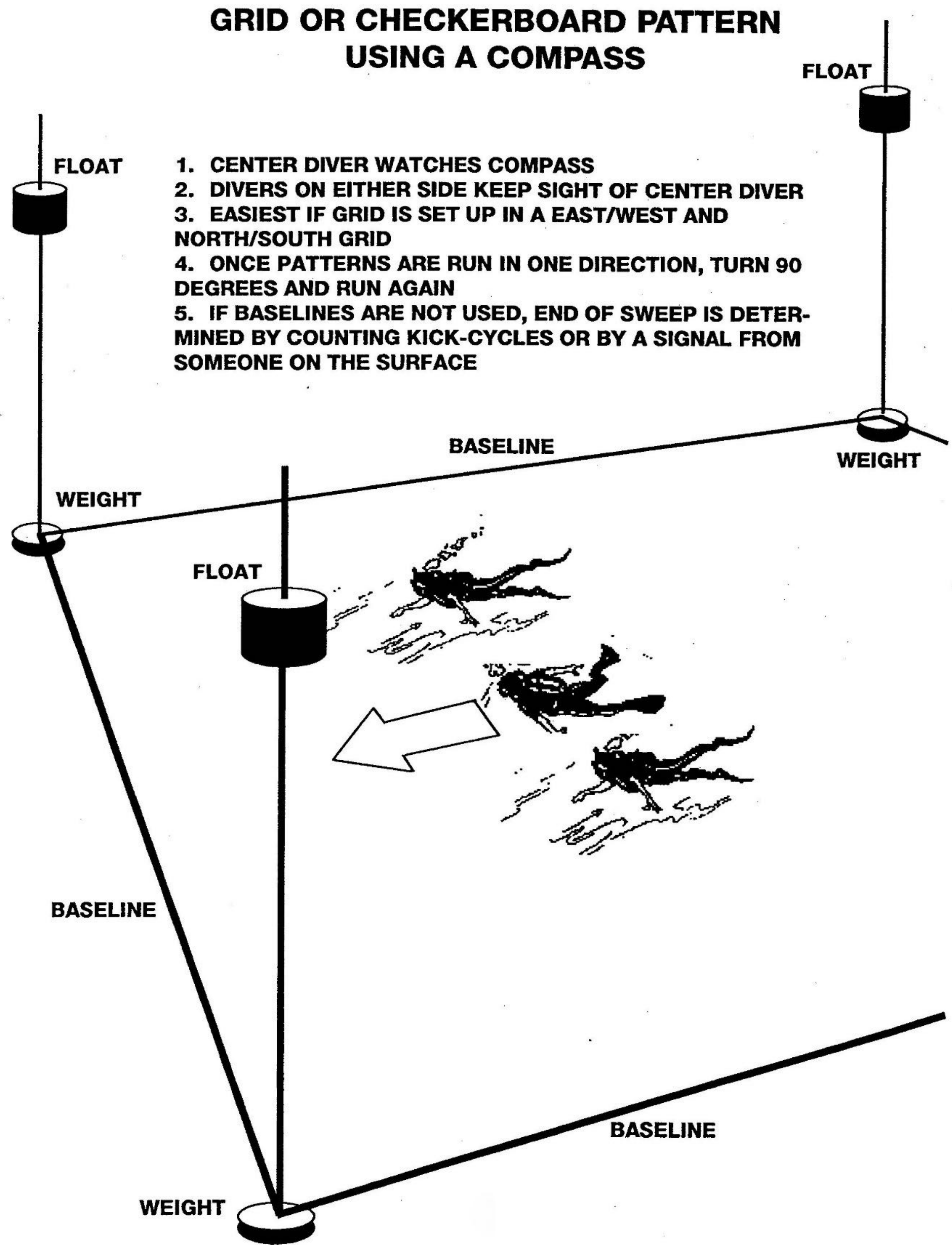
An anchor should be placed sufficiently beyond the point where a lost object is thought to be. The guideline is made taut from the anchor to a point on shore, and a search line (along which the diver's swim) runs at a right angle to the guideline. The line is then clipped to the guideline or tied with a loop.

The divers swim out to the anchor. The diver closest to the anchor holds their position while the others swim a 180-degree arc so that they are headed back toward the start point. They determine that they are in line by passing prearranged signals down the search line via line tugs, or alternatively in low visibility by hand squeezes.

In theory, ten divers, assuming 10-foot visibility, can in one sweep cover a 200-foot area. In practice, this is a very difficult feat to accomplish. More often than not, the straight sweep deteriorates into an exercise in confusion. One problem is that the anchor deployed in the water must be very heavy as this deployment requires that the line be kept taut and the fin thrusts of ten divers will be pulling against the anchor. A second problem is that it is very difficult to keep very many people abreast in the water without utilizing something rigid like a pole. A rope just doesn't work well. Divers do not swim at the same rate, breathe at the same rate, adjust buoyancy simultaneously, nor equalize easily all the time – there are simply too many things to go wrong.

## THE GRID OR CHECKERBOARD SEARCH PATTERN





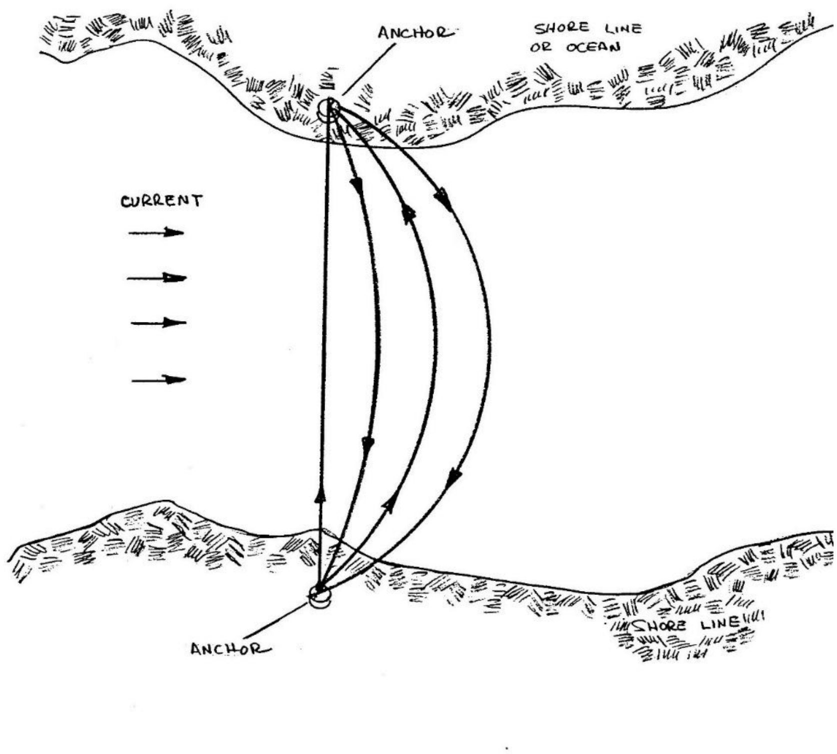

The grid search pattern requires four anchors and four floats. Guidelines beneath the surface may be used. The divers may swim the guidelines or, if none are utilized, may swim a compass heading back and forth within the area designated by the buoys.

In this pattern, as in others, it is possible to control the divers by a signal from the surface. If there are no obstructions on the bottom, the divers may use a line between them to maintain their positions as they swim the pattern. Upon reaching one edge of the pattern, a surface tender with a line to one of the divers signals him of this fact. Line signals alert the other divers who then make a turn and another sweep according to prearranged instructions.

If bottom obstructions or kelp prevents the use of a line between divers, signals from the surface tender can be sent to the divers by pounding on a hollow pipe partially submerged in the water. The divers in this situation swim compass patterns. **This is an especially useful technique when searching deep water.**

If the search is expected to be fairly extensive, enough of a pattern is laid out to last the approximate duration of one tank of air.

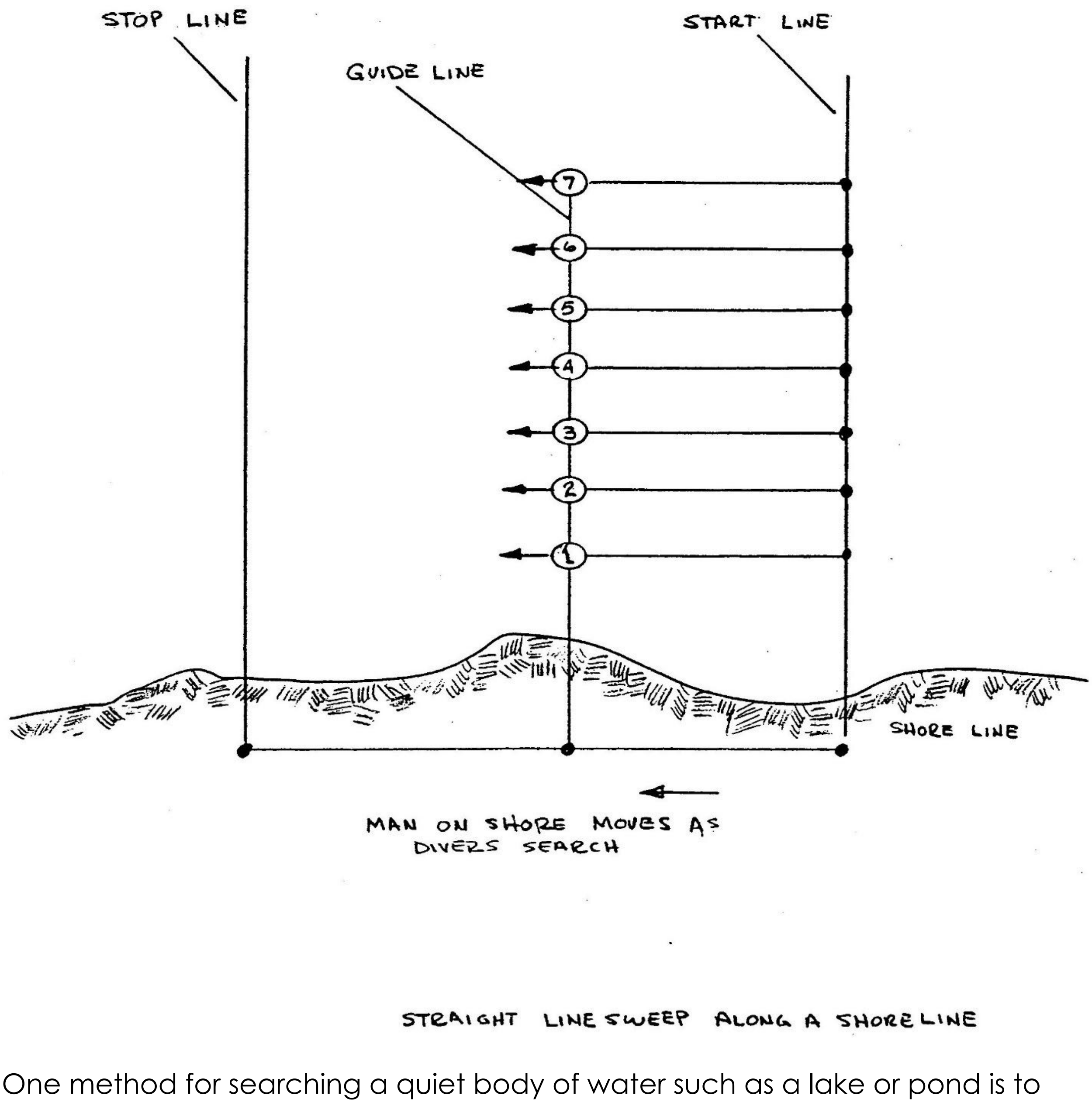
## THE STRAIGHT SWEEP SEARCH PATTERN IN CURRENT




CURRENT SWEEP IN RIVER OR OCEAN

In locations where there is current in one direction (e.g., a river) the current sweep can be used. The anchor is secured to a fixed location, and line is played out from shore each time the diver(s) swims across the current. Consider starting the search in a current downstream in order to avoid stirring up the search area thereby lessening visibility.

## THE STRAIGHT SWEEP SEARCH PATTERN ALONG A SHORELINE




One method for searching a quiet body of water such as a lake or pond is to have divers spaced along a guideline, as visibility will permit. A tender on shore holds the guideline and walks along with the swimmers as they search. If the object is not found, the last diver on the guideline holds their position and the others take a position further out on the guideline and another sweep is made.

This type of search is effective when searching for small children who may have drowned, as they will generally be close to shore.

## SEARCH PATTERN WITH A WEIGHTED LINE

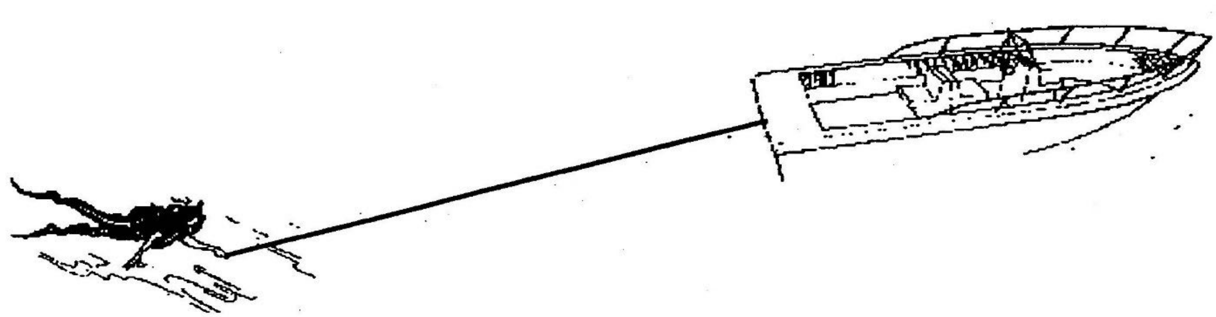
When a search is required around a pier that is oddly shaped or one that has pilings to provide boat slips, divers may swim from a guideline, which is held by a topside tender on the pier.

Using the heavily weighted line to the surface as a reference point, divers may take positions along a search line. It is important that they swim slowly so that they do not get ahead of the guideline and swim under the pier.

The heavy weight will keep the line taut while the tender walks around the edge of the pier.

## THE PLANING BOARD SEARCH TECHNIQUE

**SURFACE TOW OR PLANING BOARD**



**1. SURFACE TOW CAN BE MADE WITHOUT SCUBA IF VISIBILITY IS GOOD AND THE DEPTH PERMITS**
**2. PATTERNS ARE CONTROLLED BY THE SKIPPER OF THE BOAT**

If a large area is to be searched and the object being sought is a large one, it is possible to use a planing board (sea sled) towed behind a boat or PWC. The planning board is best utilized in conditions of good visibility. The diver riding the board can stay near the bottom, if necessary, but must be conscious of the presence of any underwater obstructions. The diver utilizing a planing board must always be conscious of the fact that rapid ascents can result in serious problems. At the termination of a planing board search, the diver must drop off the board and make a normal ascent and safety stop.

Planing boards are viable for search when visibility exceeds 10-15 feet. Should visibility diminish, divers should release the board and make a normal ascent to the surface.

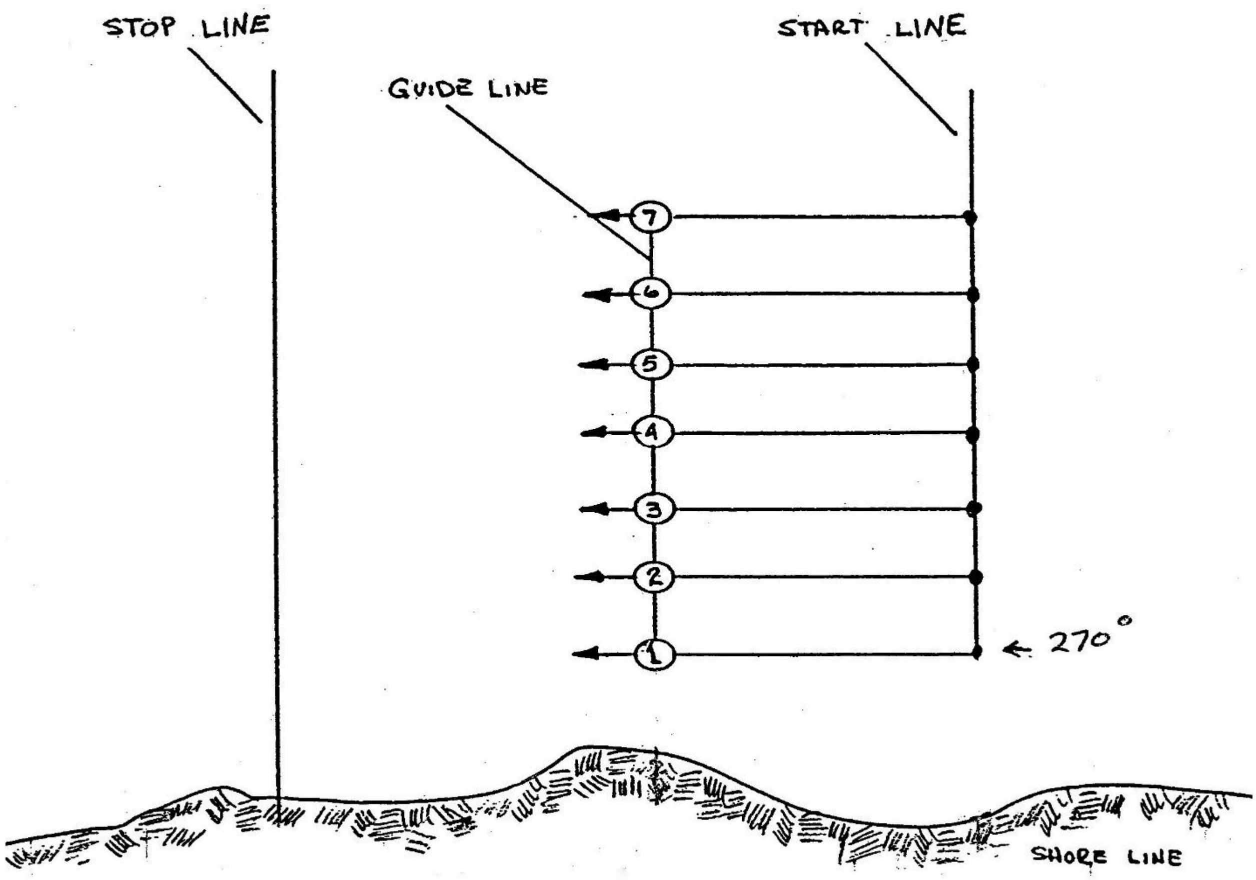
When using this search technique, the diver should carry a marking device (small float). When the object of the search is sighted, the diver merely drops from the board and swims to the object. They then attach the float line to the object and releases the float to the surface. In this manner, the crew aboard the boat or PWC driver is alerted to the discovery and it can be assured that the object can be easily re-located for recovery.

## SURFACE TOW TECHNIQUE

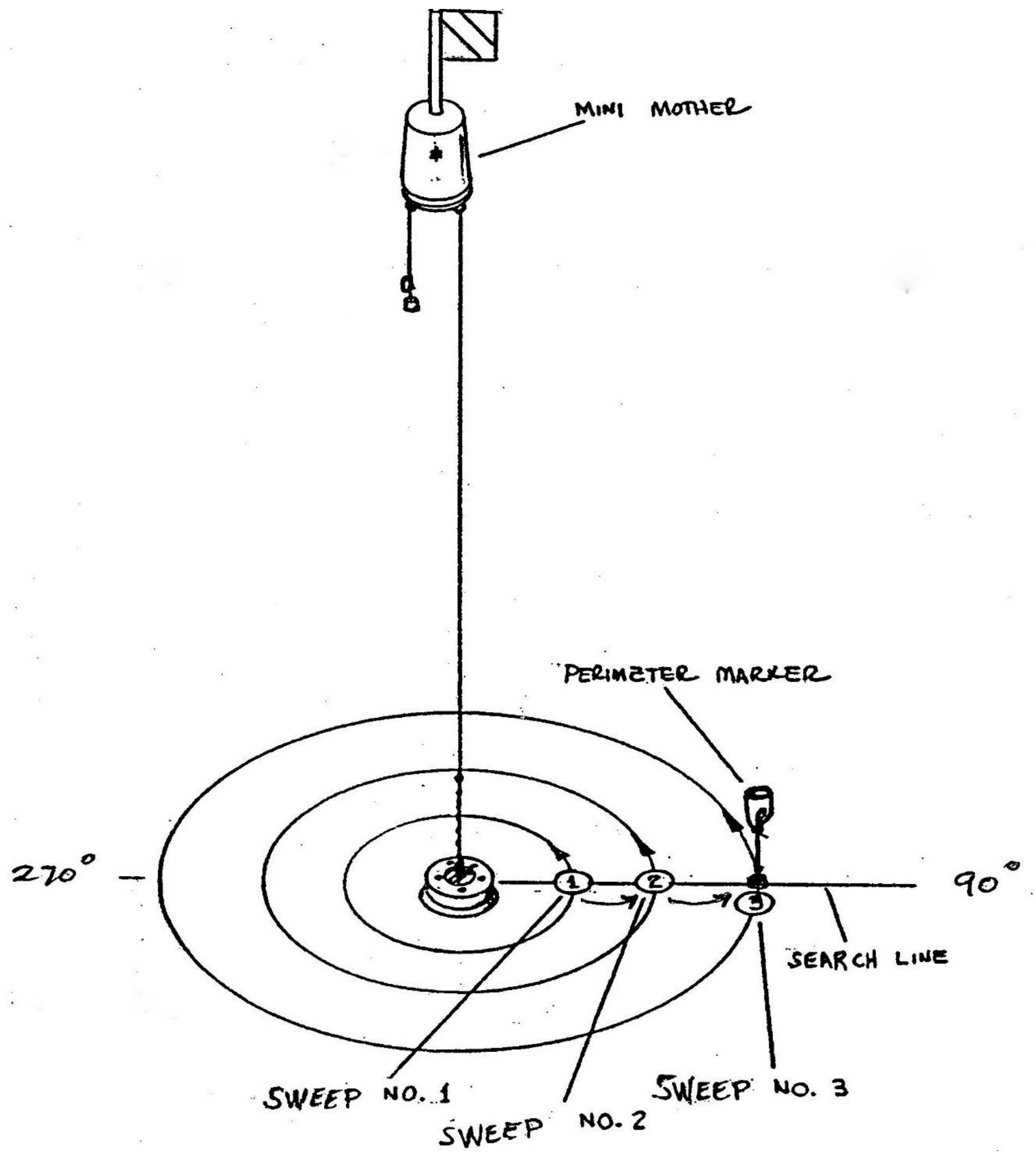
In situations where it is possible to see the bottom from the surface, divers can be towed behind a boat or PWC without the aid of a planing board. The number of divers towed depends on the current of the water and speed of the boat. The best method for this search is to have a towline for each diver being pulled.

The same marking technique is used in this search as was used in the search by means of planning boards.

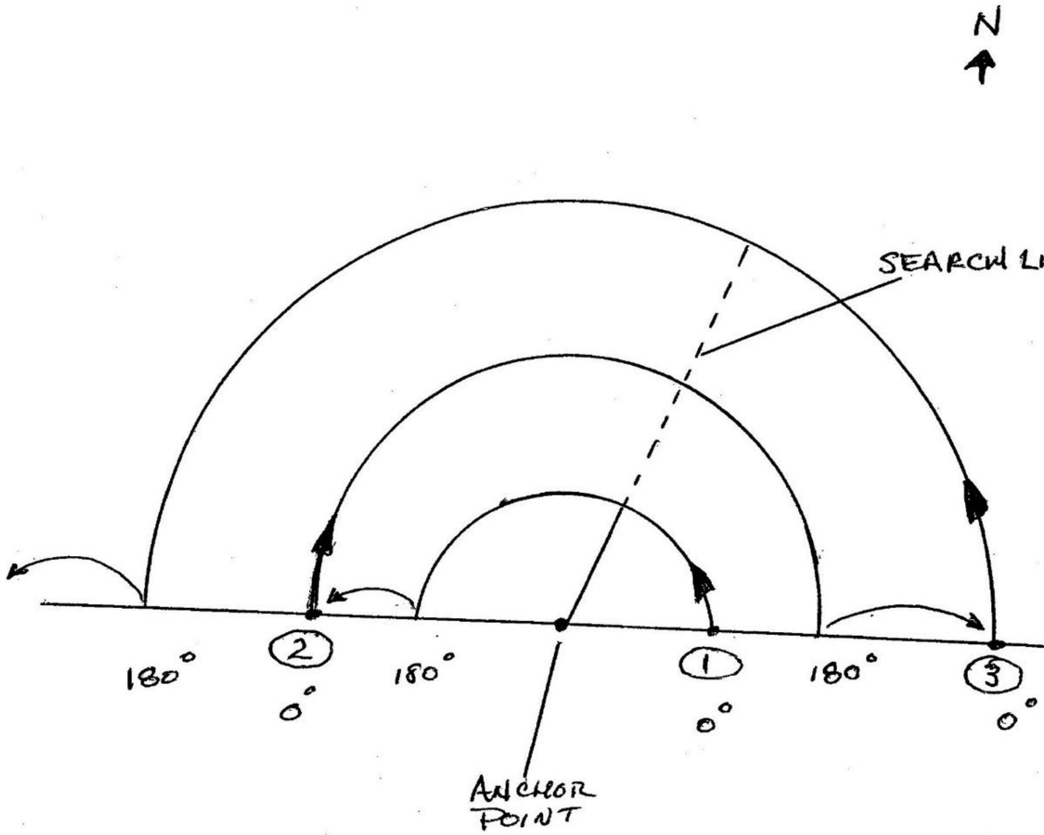
# THE COMPASS SEARCH TECHNIQUE




STRAIGHT LINE SWEEP
WITH COMPASS




CIRCULAR SEARCH WITH COMPASS



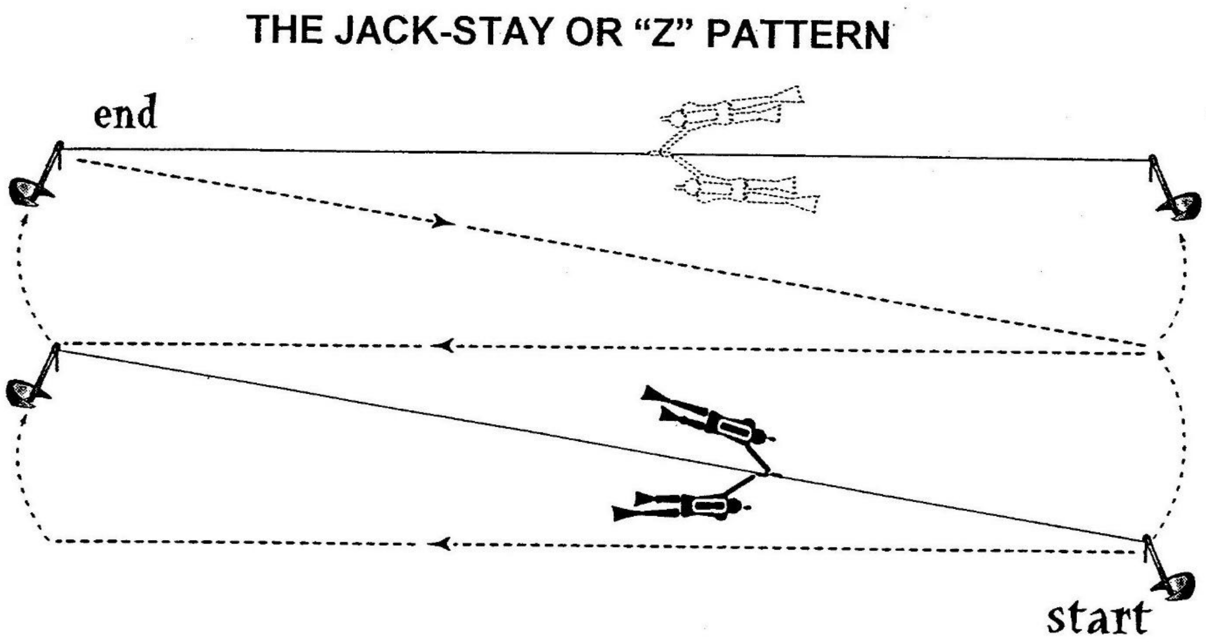

SEMI-CIRCULAR SEARCH PATTERN WITH COMPASS

At times, conditions are such that it is not feasible to use search lines. When such is the case, a search can be conducted using an underwater compass. Visibility permitting, the use of the underwater diver propulsion vehicle (DPV) provides an efficient method of searching an area through the use of the compass. The underwater vehicle not only allows the diver to search a given area more rapidly than does swimming, but also greatly increases bottom time by reducing expended effort and thus air consumption.

The compass is additionally and effective searching method in conjunction with the scanning sonar whereby divers are directed to specific identified "targets" which appear on the sonar screen.

The compass can be used effectively in almost any search. For example, in a circular search where a diver has forgotten or misplaced their perimeter marker, the compass can be utilized as a means of determining the start / stop point of a circular sweep.

## THE JACKSTAY OR "Z" SEARCH PATTERN




The jackstay pattern can be utilized when searching a given area involving a steep embankment. The advantage of this search method in this circumstance is that the diver(s) can conduct a search from deeper water to shallower depths.

NOTE: The use of a circular pattern requires a diver(s) to consistently change depths when conducted on an embankment. This may not be an issue where the diver remains in close proximity to the anchor, or where the grade of the embankment is slight: but where the diver is searching a steep embankment at distance from the anchor, a circular pattern will result in a dangerous "saw-tooth" dive profile.

Disadvantages of the jackstay search are:

- Excessive duplication of effort – each successive sweep of the pattern covers a minimum of 33% of the area covered by the previous sweep.
- The jackstay is slow to set up and deploy.
- The jackstay makes maneuvering around large obstacles (IE: trees, large rocks, etc.) difficult.

The jackstay rig consists of two down lines with floats. Attached to each float is an anchor. A length of guideline 50-75 foot long is attached at each end to the two anchors. Longer lines tend to be hard to control and do not work as well. An advantage of the down lines and surface floats is that surface personnel can readily see and plot the progress of the search.

One diver (or two divers maximum) swims along the guideline from anchor to anchor. Upon reaching the opposite anchor, the diver moves the anchor in a predetermined direction keeping the guideline taut. The distance that the anchor is moved is dependent upon the visibility and the size of the object of the search. The diver(s) then reverses direction somewhat overlapping their previous pattern and repeats the sequence.

A diver(s) terminating a search simply ascends on one of the two down lines. Should it be necessary to continue this pattern, another diver can descend the same down line and pick up where the first diver(s) left off.

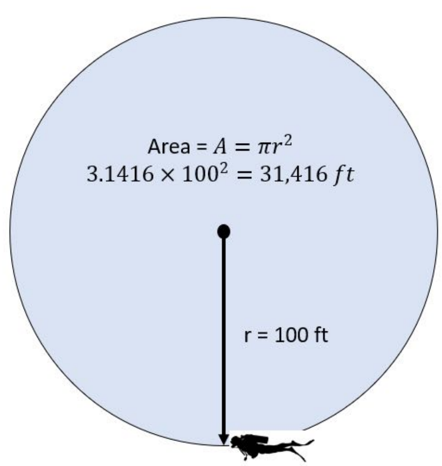
## SEARCH PATTERN DIAGRAMS

The following diagrams illustrate how to set up specific search patterns and how to calculate their associated covered areas.

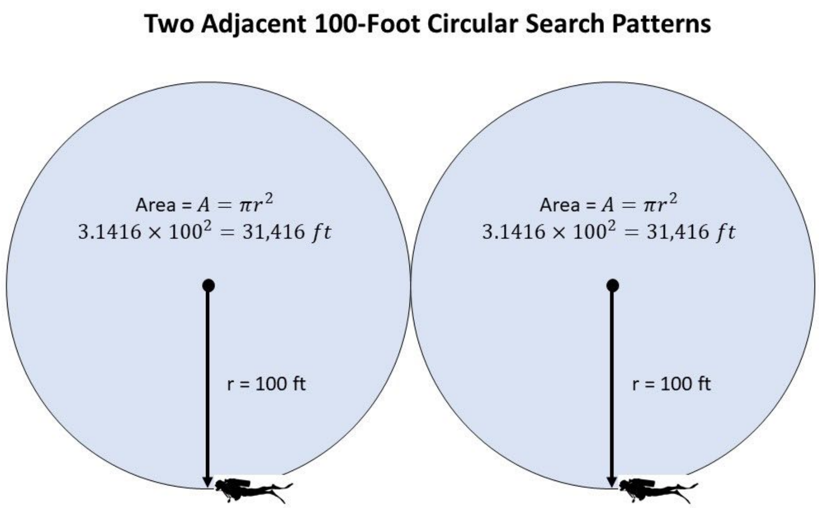
### STANDARD CIRCULAR SEARCH PATTERN COVERAGE EXAMPLES

#### 100-FOOT CIRCULAR PATTERN SEARCH, 1 DIVER

**100-Foot Circular Search Pattern**

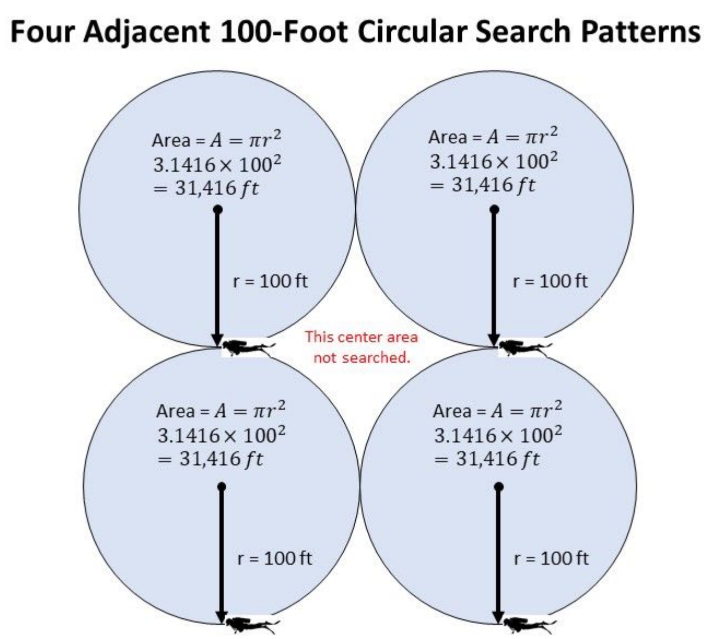


## (2) 100-FOOT CIRCULAR PATTERN SEARCH, 2 DIVERS




$$2 \times Area\ = 2 \times A = 2 \times \pi r^2 = 2\ \times 3.1416 \times 100^2 = 2 \times 31{,}416\ =\ 62{,}832\ ft^2$$

## (4) 100-FOOT CIRCULAR PATTERN SEARCH, 4 DIVERS: "SQUARE GRID SEARCH PATTERN"

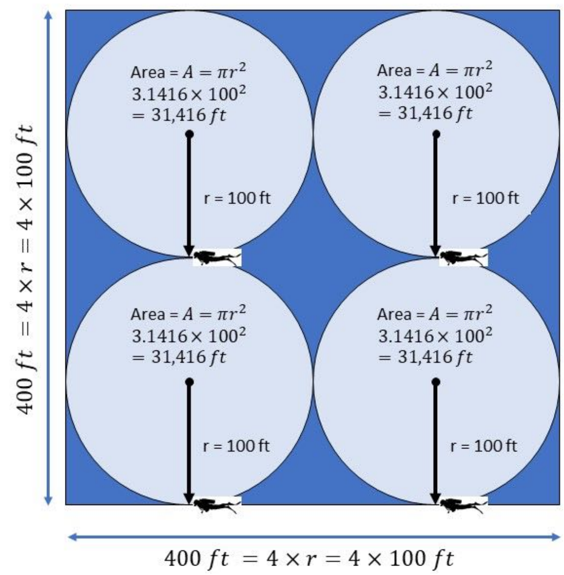



$$4 \times Area\ = 4 \times A = 4 \times \pi r^2 = 4\ \times 3.1416 \times 100^2 = 4 \times 31{,}416\ = 125{,}664\ ft^2$$

## IDENTIFYING MISSED SEARCH AREAS

Any areas in light blue indicate searched areas. Dark blue areas indicate "missed" or "not searched" areas. These areas still need to be searched or evidence and/or bodies may be missed.

**How Much Area is Missed by Four Adjacent 100-Foot Circular Search Patterns in a 400 $ft^2$ Section of Water?**




**Area of Searched Circles**

$$4 \times Area$$
$$= 4 \times A = 4 \times \pi r^2$$
$$= 4\ \times 3.1416 \times 100^2$$
$$= 4 \times 31{,}416$$
$$= 125{,}664\ ft^2$$

**Total Area of Water**

$$(4 \times r)^2$$
$$= (4 \times 100)^2$$
$$= (400)^2$$
$$= 160{,}000\ ft^2$$

**Total Area <u>Not</u> Searched**

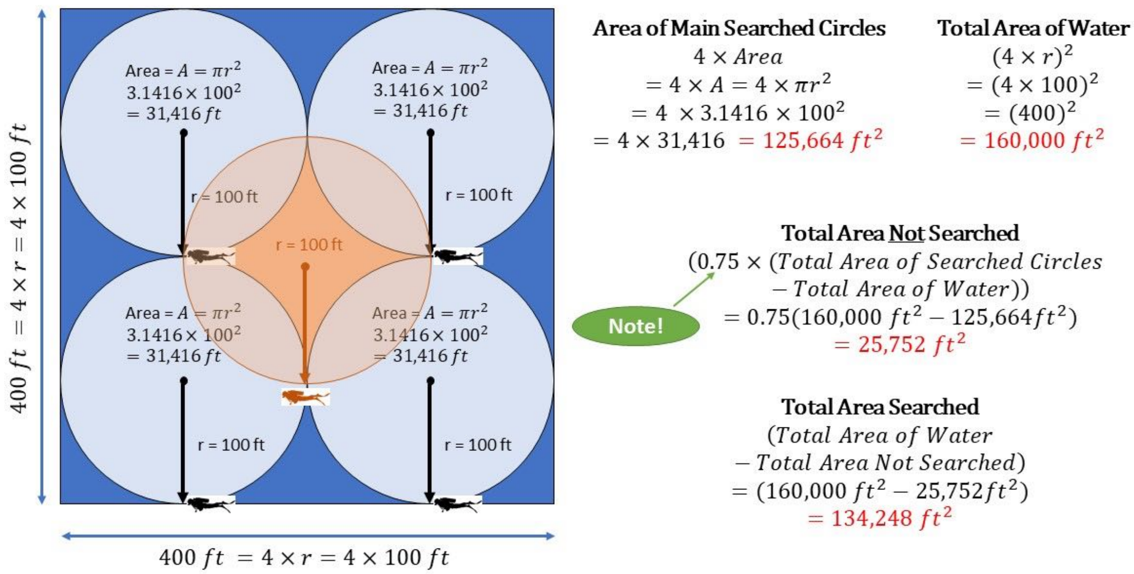
$$Total\ Area\ of\ Searched\ Circles$$
$$-\ Total\ Area\ of\ Water$$
$$= 160{,}000\ ft^2 - 125{,}664 ft^2$$
$$= 34{,}336\ ft^2$$

In this example, only 72.7% of the total possible search area is actually being searched, leaving roughly 27.3% of the **total searchable area unsearched**.

$$\frac{Total\ Area\ Not\ Searched}{Total\ Area\ of\ Searched\ Circles} = \frac{34{,}336\ ft^2}{125{,}664 ft^2} = 0.27323 = 27.323\%$$

In order to cover unsearched sections, additional divers can be added. Here is an example of how adding a fifth diver to a square grid pattern can help to cover a previously unsearched area.

**Adding a Fifth, 100-Foot Circular Search Pattern to a Square Grid Pattern in a 400 $ft^2$ Section of Water**




By adding the fifth diver as a "fill in" to the center of the prior four-diver, square grid, pattern, the total area searched increases from $125,664\ ft^2$ up to $134,248\ ft^2$ or by a total amount of $8,584\ ft^2$.

**Wasted overlap**, meaning an area where two or more divers have duplicated their efforts and performed a search in the same area, is indicated in the above graphic in a light orange color. Whenever possible, it is advantageous to minimize the amount of wasted overlap in a search to be able to more efficiently use personnel resources and reduce the time to search.

## MODIFIED CIRCULAR SEARCH PATTERN COVERAGE EXAMPLES

In a modified circular search pattern only four divers are used. Their mini mother dive floats are set to deliberately overlap with each other to ensure that no searchable area in the center between them is missed.

In order to set this pattern:

1. First start by anchoring one mini-mother.
2. Have a diver swim out a line twice the length of each circular search radius. If the circular search radius is to be 100 ft, then the diver will swim out 200 ft.
3. Anchor the next mini mother at that location (e.g., 200 ft away in this example). You have now created the hypotenuse of a right triangle.
4. Have one diver start at each anchored mini mother with a line connected to the anchored mini mother's line.

# CHAPTER 7 IMPROVING IN-WATER EFFICIENCY

Search and Rescue diving operations are both time and manpower intensive. They are also of critical importance. The locating of evidence disposed of in an aquatic environment is crucial to the criminal justice process. Likewise, the recovery of a victim from underwater gives the family of the deceased the closure that is so very necessary following the drowning death of a loved one. It is important that each individual diver functions as efficiently as possible in order to maximize their contribution to the overall effort of the SAR team toward the successful accomplishment of the operational mission.

There are a myriad of search patterns and techniques that can be employed in searching an underwater environment. The selection and utilization of any given method is dependent upon such factors as terrain, visibility, depth, water movement, the nature of the object being sought, etc. Some of these techniques will prove themselves to be more efficient than others depending upon the environmental variables involved. Beyond this however, the swimming technique utilized by the searching diver as they follow the designated search pattern is crucial to efficiently conducting an underwater search.

This is not a critical concern in clear open water where limited visibility is not a factor. In such cases a horizontal attitude and a normal fining technique such as a flutter kick, or even a scissor kick, can be effectively utilized. However, in those environments prone to silting, normal fining and swimming position will undoubtedly stir up silt, effectively reducing what visibility may be naturally present in the water to a black water (zero visibility) situation.

In potential silting environments it is critically important that the diver stay off the bottom. A diver who thoughtlessly moves in close proximity to a silt bottom, can reduce their visibility from inches (or even feet) to zero in very short order. Even in those situations where a dive begins in black water, a diver may find that as they move through the water column that they will acquire some visibility, providing of course that they is not contributing to their own vexation by fining up suspended particulates.

Buoyancy control in this regard is critical. Over weighting is the most significant factor affecting poor buoyancy control. The vast majority of divers tend to be over weighted. Ideally, a diver should wear only enough weight to remain neutral in a horizontal position at safety stop depth (15-20 feet of water) with an empty BCD and a near-empty cylinder (approximately 500 PSI). Buoyancy control should, for the most part, be accomplished through breathing control.

Proper weighting has a tremendous effect on establishing and maintaining in-water efficiency. Excessive weight worn by a diver causes several problems:

Over weighting and/or improper trim of weight will cause a diver to swim through the water at a very inefficient attitude. Gravity causes the weight belt to pull the diver's lower body down; excess weight on the belt pulls the lower body even further down. The air that must be carried in the BCD (in order to counteract the ballast weight) simultaneously pulls the shoulders up. The more weight carried by the diver; the more air must be carried in the BCD to counter the negativity of the weight. This exposes an excess of frontal surface of the diver and increases hydrodynamic drag, which must be overcome through the excess expenditure of energy. Such an in-water attitude makes for a very tedious search, especially on sloping terrain where the diver must battle with the forces of gravity and buoyancy. Matters become even more complicated when the area to be searched consists of an embankment where buoyancy is constantly changing as the diver moves throughout the search area in a circular pattern.

## AIR CONSUMPTION

Increased air consumption results from "hauling" excess weight through the water. Extra weight requires more work to move it. This is a principle of simple physics. The harder a diver works, the more air is consumed and at a faster rate, resulting in a shorter bottom time and less of the search area being covered.

Increased air consumption results from the added bulk and drag of an over-inflated BCD. If the BCD is not inflated to compensate for the extra weight, the diver's buoyancy is significantly negative causing constant kicking to counteract gravity and maintain position, thus increased air consumption accompanied by decreased visibility. Conversely, if the BCD is inflated to counteract the over weighting, then excess drag is encountered due to the additional frontal area of the diver presented in the water. Once again, physics comes into play: as Dr. Albert Einstein pointed out, resistance increases as the square of velocity (E=mc2). To overcome even small increases in resistance requires the expenditure of a disproportionate amount of energy. For example, if the surface area of an object (IE: BCD) is doubled, and swam through the water, the resistance that it presents to the water amounts to four times what it originally was. The energy now required to move this BCD is sixteen times greater than the energy required to move it in its original configuration. Again, excess drag translates to harder work thus too, increased air consumption as well as a decrease in both bottom time and area searched.

Increased air consumption, results from lack of or poor streamlining of equipment. Dangling gauges, consoles, inflator/exhaust hoses, lights, tools, slates, "octopus" regulators, etc. increase drag, thus increase workload, and thus increase air consumption. Dangling equipment will also affect a diver's position in the water. Additionally, dangling equipment exposes a diver to entanglement hazards and can drag on a silt bottom destroying visibility. All equipment must be secured by snaps, etc. or stored in secure pockets or pouches to make the diver and gear as streamlined as possible. Dive operations must be planned considering the objective of the mission and the tools and equipment likely to be necessary to achieve the objective. Tools and equipment that are not anticipated to be needed on the dive should be left topside.

Working harder than necessary due to the combined effects of carrying extra weight or improperly positioned weight and fighting excess drag causes a diver to become tired quicker. Fatigue also results in increased air consumption, decreased bottom time, and decreased size of the search area covered. Fatigue is particularly dangerous to a diver in that it can result in poor attention span, poor decision-making, and increased danger of DCS.

Increased work causes an increased demand for oxygen thus results in increased and deeper breathing. Increased breathing rate results in a greater absorption of nitrogen. An increased nitrogen level can cause potential decompression problems.

## CAUSES OF HYDRODYNAMIC DRAG

- **Frontal Resistance** – Occurs due to poor attitude in the water as a result of improper trim of weight. A diver is most efficient if their body follows the "hole" in the water created by their head. As a diver's position varies from horizontal, the surface area that the water bears upon is increased, thus increasing frontal resistance. Excessive ballast weight also increases frontal resistance by virtue of the additional air in the BCD which is required to render the diver neutral.

- **Skin Resistance** -- Occurs when water passing over the diver's body and equipment slows as a result of the frictional forces that develop. For example, various lumps and protrusions in gear, wrinkles in dry suits, poorly fitting wetsuits, mesh tank wraps, etc. all increase skin resistance.
- **Eddy resistance** – Occurs in as much as water passing over an object tends to "fill in" at the edge of the object. Examples of eddy resistance occurring are at the bottom of the cylinder, and behind snorkels, loose straps, and various hanging objects.

## PROPER DIVING POSITION & BUOYANCY

When properly weighted and trimmed and neutrally buoyant, a diver at rest in the water should be in a horizontal position absent any tendency to roll in any direction. As they move through the water column, absent any terrain changes that necessitate adjusting the amount of air in their BCD, they should ideally be able to adjust / control buoyancy through such subtle means as breathing control and through movement of the head by use of the planing surface of the facemask. BCD integrated weight systems are recommended over weight belts as they better position a diver to control buoyancy.

In order to stay clear of the bottom and thus avoid fining up silt, it is important to keep the fins above the diver in the water column. This can be accomplished in two ways:

- Maintaining absolute neutral buoyancy with the knees bent and fins positioned above the diver's torso.
- Maintaining slightly positive buoyancy. In order to stay in position, it is then necessary to dive in a head-down / feet-up position utilizing the fins to counteract the increased buoyancy of the BCD.

If a searching diver is over weighted when diving in a head-down / feet-up position, they must arch their back in order to look in front of him. When swimming in this attitude, excessive weight worn on the waist places tremendous strain on the lower back.

It is possible to alleviate this problem somewhat by efficiently trimming weight:

- Carrying only that amount of ballast weight necessary to enable the performance of a safety stop at the end of the dive.
- Raising or lowering the tank on the BCD will have some effect, however care must be taken to ensure that the diver can reach the cylinder valve.

- Removing some of the weight from the weight belt and placing it at the level of the upper torso will help to naturally achieve this desired in-water position and alleviate pressure on the lower back. There are many means of accomplishing this trim adjustment inclusive of:
    - BCD integrated weights
    - Tank mounted weights
    - Backpack mounted weights
    - Weight pouches integrated into the rear of the BCD
    - Weight harnesses

A diver’s choice of fin will have an effect. Negatively buoyant (seawater) fins are ideal with a dry suit as some air can be retained in the ankle area of the suit to counteract the negative buoyancy of the fins. Positively / neutrally buoyant fins are more conducive to wet suit diving. A wetsuit diver wearing negatively buoyant fins will find it advantageous to carry a small amount of ballast weight in the trim pockets located near the shoulders of some BCDs to counteract the negativity of the fins.

Any of these can be utilized singularly or in combination to supplement or even replace the weight belt. However, a diver must take care to maintain enough ditch-able weight to ensure that, in an emergency, they possess the ability to ascend to the surface.

Some divers endeavor to utilize ankle weights in an effort to remove weight from the weight belt and trim weight, or for the purpose of countering fin buoyancy. This is not advisable in SAR diving in as much as ankle weights tend to pull the feet (thus fins) down and result in a tendency for the feet to drop from horizontal and thus for fining to stir up bottom sediment, plus a greater expenditure of energy required to move fins through the water.

A diver wearing a pony bottle will discover that they are better trimmed and balanced in the water if they place an appropriate amount of weight on the tank band opposite the pony bottle. This amount of weight will vary with the size and in-water buoyancy characteristics of the pony and redundant first stage regulator utilized.

Although the practice of over weighting is the catalyst for numerous problems for a diver, it is true that some degree of over weighting is desirable and even necessary in certain conditions (e.g., searching in strong current or heavy surge). However, adding supplemental weight to a diver must be done with deliberation and circumspection. Some divers feel that if two extra pounds of weight is good; then four, six, eight, or even ten pounds is better. Unfortunately, over weighting has resulted in the deaths of several SAR divers.

In the event of a BCD failure, a diver should be capable of swimming himself and all of their equipment (including weights) to the surface. Seldom do divers in a stress situation think of ditching the weight system. Over-weighting can prove to be an extremely dangerous practice.

For some reason, divers wearing weight belts seem to forget that when on the surface, if they are over weighted and remove their BCD, that they then closely resemble the physical properties of an anchor, and tend to function accordingly. When intentionally over-weighted for specific operations, divers must remain cognizant of this fact and conduct themselves appropriately.

This translates to removing the weight belt first – a simple, basic SCUBA principle – but all too often either forgotten or disregarded.

Pre and post dive, it is a common practice for divers dressed in street clothing to wear their weight belts about their waists in transit to and from a boat. In subscribing to this practice, an individual is grossly over-weighting himself for a water immersion. Accidents are unintentional, unplanned events, but they obviously do occur. Should the diver be surprised by a sudden immersion into the water (e.g., slip and fall, inadvertently pushed, etc.) it is highly unlikely that the diver will have presence of mind to release the weight belt to save himself, and will most likely drown. Likewise, it is poor practice to wear a BCD laden with integrated weight to and from a boat. Divers aboard boats are discouraged from wearing their weight belts between dives. Remember that in an emergency, the vast majority of divers do not jettison their ballast weight.

## FINING TECHNIQUES

Fining technique is the second part of the efficiency equation. A full-on flutter kick produces excessive turbulence toward the bottom and will, in short order, reduce visibility in a silt-prone environment from inches, or even feet, to zero.

Even the diver who is searching by means of an expanding circular or semi-circular pattern, although their fins are affecting primarily the "already been searched" zone, will find some boil over of turbidity into areas yet to be searched. To avoid this problem, it is suggested that in calm water, an alternative fining method be utilized.

Fining methods utilized by freshwater cave divers are particularly appropriate for avoiding silt out include:

- **Flutter Kick** – the standard "swimming kick" universally utilized by SCUBA divers. This kick involves alternately moving the legs and feet vertically.
- **Scissor Kick** – an exaggerated kick accomplished by spreading the legs wide and kicking from the hip.
- **Modified Flutter Kick** – this is accomplished by bending the knees slightly and shortening the kick stroke. When maintaining a head-down / feet-up position, all fin movement takes place above the center plane of the diver's body thereby minimizing the movement of water below the diver. If necessary, the modified flutter kick can be employed using only one fin for propulsion – the other fin is placed in a stationary position below the kicking fin in order to deflect downward fin wash.
- **Shuffle Kick** -- is a variation on the modified flutter kick utilizing a more exaggerated bend in the knees which positions the fins over the diver's back. This kick moves the fins approximately half the distance of the modified flutter kick.
- **Frog Kick** – There are several variations of the frog kick. The frog kick is performed by spreading the legs laterally, rotating the bottom of the fins inward, and bringing the fins together. Variations of the frog kick involve changes in the intensity of the kick as well as fin positioning during the kick. The frog kick restricts the thrust and turbulence in the water to the area immediately to the rear of the diver.
- **Ankle Kick** – is an extremely controlled flutter kick. The legs are kept relatively straight and movement of the fin is through the ankle from heel to toe. This kick is most applicable in confined environments where there exists little physical space to generate an alternative kick.
- **Sculling** – involves a gentle, steady back and forth fin movement with the fins angled slightly. The ankles are utilized to move the fins in a kind of oval pattern. Absent any current, sculling allows the diver to hold and maintain a stable, stationary mid-water position.
- **Dolphin Kick** – utilizes the entire body to "crack" like a whip. The dolphin kick runs from the chest to the toes. This kick requires a lot of energy to maintain and is unsuitable near the bottom where a silt stir-up is likely.

Conversely, when diving in moving water (current or surge), nothing works well short of a full straight leg kick from the hip. The problem with this technique is that few divers possess the strength and stamina to constantly maintain this kicking technique for very long. Divers are well advised to develop more than one strong kicking technique that they can utilize effectively. By so doing, alternative kicks can be utilized, thus reducing muscle cramping and fatigue.

## SPEED OF SWIMMING

The effort required to increase swimming speed is disproportionate to the result achieved. Doubling the swimming speed of a diver takes four times the output of energy (E=mc2). As discussed above, as increased energy is expended (work is increased) so also is increased air utilized. The movements of a diver underwater should be slow and methodical. Slow, short fin strokes are more efficient than rapid or wide strokes.

## ADEQUATE EXPOSURE PROTECTION

Thermal protection appropriate to the diving environment encountered should be worn. Ideally, a diver should be neither overheated nor chilled. While true that even slight changes in body core temperature will result in a marked decrease in diver performance and efficiency, it is likewise true that a diver's body core temperature is likely to remain relatively stable due to the fact that as chilling occurs, blood is shunted to the core from the extremities.

- Temperature in the extremities however is a different matter and can alter significantly, having an adverse effect on both kicking efficiency and manual dexterity.
- A warm, comfortable diver will operate much more efficiently, utilize less air, is at less risk for potential decompression problems, is less susceptible to nitrogen narcosis, is more attentive, will make better decisions, and be sooner ready to make another dive, if required, than will a diver who is either chilled or overheated in the water. It must be recognized however, that excess thermal protection may overheat a diver and requires the wearing of additional weight. The thicker the neoprene material in a wetsuit, the greater the buoyancy change at depth.

## PROPER BREATHING

Breathing affects underwater efficiency from the aspects of both air consumption and buoyancy. Breathing should be slow, and relaxed. Deeper breathing results in an increase in buoyancy; shallow breathing results in a decrease on buoyancy. Slow inhalations followed by a brief pause, and slow exhalations and another pause will make the most efficient use of the air supply, deliver the best supply of oxygen to the lungs, and most efficiently off-gas carbon dioxide. It is no accident that martial artists, many athletes, stage performers, combat warriors, and those who practice yoga utilize this breathing pattern. Slow breathing purges the body of more carbon dioxide and improves concentration and ability to focus the mind.

The average adult human has a total lung volume of approximately 10-14 pints of air, depending on physical stature. Residual lung volume (the amount of air that constantly remains in the lungs in spite of respiration) amounts to approximately 2 pints. The amount of air moved into and out of the lungs through normal breathing (tidal volume) amounts to approximately one pint. The vital capacity of the lungs (which is the amount of air moved through respiration when inhaling and exhaling deeply) amounts to approximately eight pints. However, there is wide variation in this volume due to such factors as physical size, physical condition, age, and disease. For example, a small woman may have a vital lung capacity of 6 pints of air; whereas a large-statured male athlete can have a vital capacity of as much as 12 pints. Each pint of air equates to approximately one pound of buoyancy. Thus, by merely adjusting their breathing, the average diver can affect their buoyancy by as much as 6-8 pounds.

**Divers should never endeavor to conserve air by "skip breathing."** This technique does not conserve the air supply -- it actually results in greater air consumption due to hypercapnia (excessive carbon dioxide build-up in the bloodstream) eventually resulting in an increased demand for oxygen invariably leading to increased breathing rate, a $CO_2$ headache, and, in severe cases, to unconsciousness and death.

## LINE HANDLING

The search reel should be clipped to a D-ring on the diver's harness in the area of the solar plexus. This results in several circumstances that will render the searching diver more effective:

- It leaves the diver with two free hands that can be utilized for searching; for equalizing and adjusting buoyancy; for mask-clearing; for locating and dislodging entanglements; for handling tools; and for handling a drowning victim or securing evidence.
- It gives a safety diver direct access to a diver in trouble.

- It permits the diver to conduct an accurate search pattern due to the fact that: the tether point is always at the exact place on the diver's body throughout the entirety of each search sweep; and it is easier for the diver to keep the search line taut than it is when hand-holding the reel.
- Unless the diver can handhold the search reel in the exact same position throughout a search, there will be "holes" in the search pattern and the object of the search can easily be missed.
- It eliminates the fatigue involved with endeavoring to handhold a taut search line; enables the diver to keep the search line taut with- out discomfort and with minimal effort.
- A change in positional angle of the search line will indicate to the diver that the line is snagged.

## EQUIPMENT CONSIDERATIONS

There are some equipment issues that although subtle, can be critical with respect to avoiding entanglements and therefore promote efficient in-water diver operation:

- Loose ends of mask and fin straps should either be taped down or the straps inverted.
- Knives should be carried on the torso where they are readily retrieved as opposed to the inner calf of the leg, which is traditional amongst sport divers.
- Snorkels are useful for surface swims but cause drag and pose an entanglement hazard underwater. Snorkels should be clipped to the diver's harness or stowed in a pocket during an underwater search.

## PHYSICAL FITNESS

A diver who maintains good cardio-vascular efficiency will operate most efficiently in the underwater environment. The physically fit diver has a better air consumption rate, is more capable of heavy workload and exertion commonly required of SAR divers, is better capable of coping with the demands of changing or unexpected water conditions, is better capable of coping with the extremes of heat and cold, and is less at risk for decompression illness.

Few SAR divers are employed in the diving industry (diving instructors, commercial divers, etc.) and it is difficult with all of the other demands of life (work, family, finances, etc.) to do enough diving running, weight lifting, bicycling, racquet ball, hiking, etc. etc. all contribute to an overall level of fitness which will serve to improve diving efficiency in order to remain physically fit and capable for SAR diving operations. Obviously, the best exercise to keep in shape for diving is diving itself. However, other aerobic and resistance training is of benefit such as swimming, running, brisk walking cycling, etc.

## PROPER NUTRITION

The human body performs most efficiently and effectively when proper nutrients are ingested. A healthy diet has a tremendous effect on diver performance. Proper diet not only furnishes the calories to be burned to produce energy, but also contributes to a diver's overall comfort in the water as well.

## HYDRATION

Hydration is critically important. Dehydration contributes to fatigue, cramps, hypothermia (excessive chilling), hyperthermia (excessive heat build-up), and decompression illness.

## DRUG AVOIDANCE

Obviously, illicit substances are to be shunned. But beyond this, legal drugs such as tobacco, alcohol and now marijuana can cause physiological complications for a diver.

## TOBACCO AVOIDANCE

Tobacco use can cause the following:

- Reduction in tidal volume of the lungs
- Reduction in oxygen saturation of the tissues
- Increase in carbon dioxide retention
- Long-term tobacco usage can result in chronic lung disease (e.g., emphysema) which increases the chances of pulmonary barotraumas and arterial gas embolism

## ALCOHOL AVOIDANCE

Alcohol usage prior to diving causes the following:

- Dehydration, which contributes to DCS
- Mental incapacitation resulting in poor judgment
- Slow reaction time

- Poor visual tracking
- Reduced attention span
- Decreased ability to multi-task
- Reduced athletic ability

## MARIJUANA AVOIDANCE

Marijuana use increases the dangers of:

- Mucus plugs
- Altered mental status
- Altered judgment
- Altered Neurological physiology
- Slowed physical reflexes
- Increased heartrate
- Trapping of air in the lungs
- Arterial Gas Embolism (AGE)
- Chronic Obstructive Pulmonary Disease (COPD)

## CHOOSING PRESCRIPTION MEDICATIONS CAREFULLY

Both prescription and over-the-counter remedies can likewise cause problems. Some medical conditions do not lend themselves to being able to dive safely. Likewise, some medications are non-diving compatible. Medications are metabolized differently in the high-pressure underwater environment. Divers taking medication(s) for some medical condition should obtain clearance from a diving physician prior to making a dive.

## MENTAL ATTITUDE

A diver whose "head is not in the game", who is preoccupied by problems with work, family, finances, etc. or a diver who is stressed by, or apprehensive about the nature of an underwater operation or assignment or is worried about some equipment problem or mal-function, will operate less efficiently than will a diver who is relaxed, rested, comfortable, and confident.

For more information on this topic please view the Fitness to Dive section.

## WEIGHTING CALCULATIONS FOR IN-WATER EFFICIENCY

The following information and formulas are designed to assist the diver in determining the proper amount of ballast weight to be worn.

### DETERMINING CYLINDER WEIGHT DIFFERENTIAL

Cylinder weight differential is the difference in the weight of a given cylinder when it is full of compressed air, as opposed to when it is empty of air.

As a diver breathes up (uses up) the air in any given cylinder, that cylinder **loses** ballast weight (e.g., becomes lighter).

Useful Numbers to Know:

- An Aluminum 80 cu. ft. cylinder holds 77.4 cu. ft. of compressed air when full.
- One cubic foot of dry compressed air weighs 0.075 pounds.
- 12.8 cu. ft. of compressed air weighs one pound…. We round to "13" for simplicity.

**To calculate the weight of air in a full cylinder, divide the capacity of the cylinder (cubic feet) by 13.**

For example: How many pounds of air are there in a full, 80 cu. ft. cylinder?

(77.4 / 13 )= 5.95 or, to round off, there are 6 pounds of air in a full 80 cu ft cylinder

The following are the weight differentials of cylinders commonly used by this team:

| Cylinder Size | Weight of Air (Full) | 500 psi Difference |
|---|---|---|
| 130 cu ft | 10 lbs. | -9 lbs. |
| 100 cu ft | 7.7 lbs. > 8 | -7 lbs. |
| 80 cu ft | 5.9 lbs. > 6 | -5 lbs. |
| 72 cu ft | 5.5 lbs. > 5/6 | -4/5 lbs. |
| 63 cu ft | 4.8 lbs. > 5 | -4 lbs. |

In using the above chart, the diver would determine the weight differential of their particular cylinder, then compensate for the weight loss during the dive by adding the corresponding weight to their ballast. The diver may wish to allow for a one-pound weight difference to compensate for the weight of air still held in the cylinder during their safety stop (e.g., 500 psi = 1 pound).

## DETERMINING SALT WATER WEIGHTING ACCORDING TO THERMAL PROTECTION WORN

An alternative method of determining the amount of ballast weight to be worn by a diver takes into account the body weight of the diver and the type of thermal protection worn.

These figures are approximations and will require some fine tuning:

| Type of Thermal Protection Suit | Initial Weighting (Salt Water) |
|---|---|
| 3mm Full Suit | 5% of Body Weight |
| 5mm Spring Suit (Shorty) | 5% of Body Weight |
| 6-7mm Full Suit | 10% of Body Weight + 3-5 Lbs. |
| Neoprene Dry Suit* | 10% of Body Weight + 7-10 Lbs. |
| Shell Dry Suit* | 10% of Body Weight + 3-14 Lbs. |

(*) Note: Dry Suit weight is determined primarily by the buoyancy of the underwear worn.

## DETERMINING WEIGHT ADJUSTMENT BETWEEN SALT WATER AND FRESH WATER

The below Body Weight Differential chart can be useful for determining a switch from fresh water to salt water and vice versa.

Example:

- A 125-pound diver, when moving from fresh water to salt water, would need to **add** 4 pounds of weight.
- The same 125-pound diver, when moving from salt water to fresh water, would need to **remove** 4 pounds of weight.

| Diver Body Weight | Weight Adjustment |
|---|---|
| ≤ 125 pounds | +/- 4 Lbs. |
| ≤ 155 pounds | +/- 5 Lbs. |
| ≤ 185 pounds | +/- 6 Lbs. |
| ≤ 215 pounds | +/- 7 Lbs. |
| ≤ 254 pounds | +/- 8 Lbs. |

## THE MOST ACCURATE METHOD OF DETERMINING WEIGHTING

The most accurate method of determining a diver's weighting in **salt water** requires that the diver determine their proper weighting for fresh water, then weigh themselves while wearing all of their gear (including whatever weights they wear in fresh water).

Keeping in mind that:

- The water density for fresh water is **62.4 lbs. / cu. ft.**
- The density of salt water varies between 64.1 – 64.9 lbs. / cu. ft. (**we'll use 64.2 lbs. / cu. ft.**)

The following formula is applied:

$$\left[\frac{Fresh\ Water\ Density}{Salt\ Water\ Density}-1\right] x\ 100 = Density\ Difference$$

$$\left[\frac{62.4\ lbs./\ ft^3}{64.2\ lbs./\ ft^3}-1\right] x\ 100 = Density\ Difference$$

$$[0.972-1]\ x\ 100 = Density\ Difference$$

$$[-0.028]\ x\ 100 = Density\ Difference$$

$$-2.8\% = Density\ Difference$$

Fresh water is 2.8% **less dense** than salt water. Thus, to convert this diver and their gear from diving fresh water into diving salt water, the total weight of the diver and all gear would be multiplied (e.g., increased) by 2.8%. This amount of weight would be needed for the diver to dive in salt water.

Note: Mathematically the conversion factor of 2.8% = 0.028

Example: A diver weighs 200 lbs. they carries 50 lbs. total of gear and equipment in fresh water. they also wears a total of 10 lbs. of weight. How much additional weight would they need to add on in order to dive in salt water?

(200 lbs. + 50 lbs. + 10 lbs.) = 260 lbs. = Total Weight in Fresh Water

Total Weight in Fresh Water x Conversion Factor x 1 = Weight to Add for Salt Water

(260 lbs.) x (0.028) x (1) = 7.280 lbs.

As standard dive weights don't come in fractions, we round down from 7.28 pounds to 7 pounds. *Thus, this diver would require 7 lbs. more weight to dive in salt water.*

Example: A diver weighs 130 lbs. She carries 40 lbs. total of gear and equipment in salt water. She also wears a total of 12 lbs. of weight. How much weight would she need to remove in order to dive in fresh water?

(130 lbs. + 40 lbs. + 12 lbs.) = 182 lbs. = Total Weight in Salt Water

Total Weight in Salt Water x Conversion Factor x -1 = Weight to Remove for Fresh Water

(182 lbs.) x (0.028) x (-1) = -5.096 lbs.

As standard dive weights don't come in fractions, we round down from 5.096 pounds to 5 pounds. *Thus, this diver would require 5 lbs. less weight to dive in fresh water.*

# CHAPTER 8 RESCUE

"Rescue" has become a primary focus for many public safety agencies. In the State of California, the Sheriff is legally responsible to "search for and rescue persons who are lost or are in danger of their lives within the immediate vicinity of the county" (Govt. Code Sec. 26614). Many fire departments display "FIRE RESCUE" on their vehicles.

Many people in our society have been raised in an environment where someone has always looked out for them and taken care of them. Many have an expectation that this will always be the case. They suffer from "911 Syndrome." That is, they believe that no matter what misfortune should befall them, that it is the responsibility of government to take care of them and that there is an army of rescuers waiting in the wings to come to their aid and rescue them……all they have to do is dial "911".

There is a potential problem associated with the "advertising" of an agency or an entity within as being a "rescue" service (IE: Dive Rescue, Ice Rescue, Water Rescue, etc.) which centers about the capability of the individual unit or agency to perform the service advertised. An agency can expose itself to intense public criticism, and even to civil liability by holding themselves out to be capable of performing rescue services, if such is not in fact the case.

There is a training course offered by a leading public safety diving training agency entitled, "Rapid Deployment Search and Rescue / Recovery." "Rescue" is big business requiring high dollar expenditures for training and equipment. The Sheriff's Office has a program in place for rapidly responding to accidental aquatic events. Helicopter crew chiefs at the Sheriff's Aviation / SAR Unit are certified in SCUBA and water rescue techniques. They can deploy to any area of the County for water related event and be on-scene and deploying a two-man dive team for a "hasty search" within ten minutes. This is truly "rapid deployment." However, the "water rescue" portion of the equation is not so simple. Aside from on-scene resources that may happen to be physically present at the time of an event, any other rescue efforts are pretty much based upon wishful thinking. A human being can survive for weeks without food; days without water; but only minutes without air. It is an unfortunate reality that drowning victims simply cannot wait to be rescued.

**Due to the time lag involved in the notification, response, and deployment of SAR divers following a drowning, it is rare that rescue is feasible.** The present standard of care and public expectations require that an attempt be made to resuscitate any drowning victim who has been submerged for one hour or less. Although realistically, **in drowning situations, the "golden hour" only applies when resuscitation efforts are begun within ten minutes of submergence and the victim receives trauma center care within one hour.**

- When affecting a rescue of a drowning victim, it is important to isolate the time that the victim was last seen breathing.
- Once submerged, a drowning victim will begin to "breathe" underwater within 3-4 minutes. After an additional 3-4 minutes, cardiac arrest occurs.
- On land, following cardiac arrest, an additional 4-6 minutes will elapse before irreversible brain damage occurs, however underwater this survival time may be extended. Cold water (colder than 50-degrees F.) can protect tissues from the effects of oxygen deprivation under some circumstances.

Due to **immersion reflex** *, a phenomenon of a primitive physiological response, a spark of life is maintained and under the right conditions, a victim can be revived long after death would have occurred on land. A pooling of blood in the body core and the greatly reduced metabolism that occurs following cold-water drowning, is believed to be explanation for the reason that people can sometimes be revived following drowning for periods exceeding ten minutes of submersion. Some experts in this field attribute this phenomenon to a body core temperature reduction brought on by a sudden precipitous drop in temperature: the faster the body core cools, the greater the victim's chance of survival. This would seem to explain the fact that it is young children with a smaller body mass to surface area that most often survive these submersions.

** NOTE: Immersion Reflex is not the same as that first discovered in Beavers (otherwise known as the 'Mammalian Diving Reflex") and is also developed in other aquatic mammals such as whales, dolphins, sea lions, and otters. The Mammalian Diving Reflex is what allows these animals to remain submerged for extended periods of time without air.*

Such an episode constitutes "**near drowning**" and absolutely **requires medical attention.** Immersion reflex is most notable among the very young who drown in extremely cold water. However, successful resuscitations have been performed with few ill effects on older people. The longest submersion and successful resuscitation to date occurred in 2002 in Norway where a 29-year-old woman fell into a frozen river and was recovered 93 minutes later.

Immersion reflex is greater in cold water than in warm water. When the body is suddenly submerged in water or in a freezing environment, the major physiological systems slow nearly to a halt, increasing the chances of survival by minimizing the need for oxygen. Immersion reflex includes three factors:

- <u>Bracycardia</u> – a reduction in the heart rate (up to 50 % in humans).
- <u>Peripheral Vasoconstriction</u> – a decrease in blood flow to the extremities, in order to increase the blood supply and oxygen to the vital organs (brain, heart, lungs, liver, etc.)
- <u>Blood Shift</u> – a shifting in blood plasma to the thoracic cavity to avoid lung collapse brought on by the increased pressure of water.

Statistically, a victim of a drowning has a good chance of recovery if the following factors are present:

- The drowning occurs in water temperature below 10-degrees C. (50-degrees F.). (NOTE: Water temperatures in Ventura County, even in winter, tend to be considerably warmer than 50-degrees F.).
- The victim is recovered within five minutes of submersion, although some experts in this area refer to the "golden hour" as being the cut-off time between rescue and recovery.**
- The victim is given CPR immediately upon being brought to the surface. (The protective effect of immersion reflex is lost immediately upon removal of the victim from the water).
- The victim has NOT ingested alcohol. A victim who has ingested alcohol prior to drowning will physiologically respond differently to the drowning as compared with the "sober" victim due to a depressed state of brain and body functions brought on by the alcohol. This depression of vital functions results in a poor chance of successful resuscitation.
- The victim is relatively young (older than three years, and younger than 15 years of age.) The younger the victim, the better the chance of recovery (immersion reflex is more pronounced in children than in adults). Best recovery results have been experienced in children between the ages of 4-14 years.
- The victim is female.
- The drowning occurs in clean, clear water. The clearer and cleaner the water, the better the chance of recovery.

*** NOTE: Historically, the concept of the "golden hour" was developed at Johns-Hopkins Hospital in Baltimore, MD by Dr. R. Adams Cowley who found that a critically injured trauma patient who received initial care within 6-10 minutes of the incident and thereafter arrived at an advanced life care facility within one hour, had a better than average chance of survival. Dr. Cowley's "golden hour" was based upon surface events involving trauma patients, not drowning. Underwater events require quick recognition, recovery, and resuscitation efforts. Drowning victims stand the best chance of successful resuscitation if they receive medical treatment within 10 minutes of submersion. In most open water drowning scenarios, this is an unlikely time frame for rescue except by personnel on-scene at the time of the event. However, the one-hour time frame has been almost universally accepted and recognized as standard practice and requires an attempt at resuscitation.*

**The best success of recovery involving immersion reflex involves the drowning of young children that occurs in cold, clear freshwater.** Although theoretically whether a drowning occurs in fresh water or seawater is of no consequence, there is at present, only one incidence of saltwater drowning survival where immersion reflex was a factor. This incident involved a forty-minute submersion in Alaskan waters.

Although chances of a successful resuscitation of a drowning victim diminish as the water warms, as time of submergence increases, and as the age of the victim increases; successful resuscitations have occurred in water as warm as 68-degrees F. For this reason, any drowning victim recovered within one hour of submergence may have a chance of successful recovery. It is critical that Search and Rescue divers understand that **a drowning victim recovered within one hour* of submergence must be immediately resuscitated (CPR) upon reaching the surface, and subsequently transported to a medical facility ASAP. Such a victim may have a chance for successful recovery.** However, personnel must also realize that nothing is certain. A victim may be successfully resuscitated at the scene and later die due to "secondary drowning".

## RECOVERING SUBMERGED DROWNING VICTIMS

Upon locating a submerged drowning victim, unless entangled or on SCUBA, the diver will usually discover the body to be in the "**classic drowning position**": a jackknife position, with buttocks high and head, arms and legs below the trunk (due to the absence of gas pockets in these areas of the body). If rescue is feasible, the **victim should be raised in a face down position until reaching the**

**surface** to prevent the introduction of additional water into the airway. Additionally, **the victim's mouth and nose should be covered during ascent**.

Upon reaching the surface, the victim should be rolled into a face–up position and their mouth and nose kept covered to prevent additional water from entering the airway and lungs until they can be removed from the water onto a solid platform to support CPR.

## RECOVERING UNCONSCIOUS / UNRESPONSIVE SCUBA DIVERS UNDER WATER

In the case of an unconscious, unresponsive SCUBA diver in the water, the critical issue is assuring the victim reaches the surface. Remove the diver's weight system and swim him toward the surface. As the unconscious diver becomes more buoyant, the rescuer should release the victim to ascend while, himself, maintaining a safe ascent rate. **An unconscious diver cannot hold their breath; thus, air embolism is not a concern. DCS, as a result of rapid ascent, is a secondary concern to getting the victim to the surface as rapidly as possible.**

In-water ventilation has been shown to be an effective technique when performed by trained lifeguards. However, and effort at in-water ventilation performed by a SAR diver is generally discouraged for the following reasons:

Due to available surface support and relatively close distances thereto, transport to shore or a support vessel can be accomplished relatively quickly.

In-water ventilation will delay the victim in reaching a stable platform – necessary for administering CPR.

In-water ventilation will likely be ineffective due to buoyancy and positioning problems. Insufficient ventilation will increase the chance of pulmonary edema.

An effort at in-water ventilation will likely induce significant quantities of water into the victim's airway. As little as one eyedropper of seawater introduced into the lungs will cause pulmonary edema and a substantial risk of subsequent death.

Removing the facemask and regulator of the SAR diver in order to effect in-water ventilations may subject the rescuer to potential danger from surf, swell, etc.

Invariably, the administration of in-water ventilations requires direct mouth-to-mouth contact with no protective barrier in place, potentially subjecting the rescuer to contracting a communicable disease.

However, a SAR diver should consider providing in-water ventilations to a victim if there will be a delay involved in getting the victim aboard a watercraft or to some other suitable platform where CPR can be administered.

**Automatic Electronic Defibrillators (AEDs)** are becoming more and more evident in public places, or in areas where the public is served, including dive boats. Aggressive CPR and early defibrillation are the two actions proven to increase the survival chances of a victim of cardiac arrest. In order to have the best effect, defibrillation must occur as soon as possible following cardiac arrest. Modern AEDs conduct a minimal amount of electricity to bystanders during defibrillation. As long as a rescuer does not have contact with the victim's chest during defibrillation, they are not at risk for any significant electrical shock – even in wet conditions or on a metal surface. Those bystanders and rescuers on a conductive surface (metal or water) may feel a tingle, at most.

Upon reaching shore or a support vessel, CPR (ventilations and chest compressions) should begin immediately utilizing a pocket mask, ambu-bag, or other appropriate device. In addition, the victim should be treated for hypothermia. Hypothermic victims may present a very slow or irregular heartbeat and should be evaluated for the presence of a pulse for a full minute prior to administering CPR.

It is critical that every resuscitated victim of drowning or near drowning be transported to a medical facility without delay. There have been instances of drowning victims being revived at the scene, refusing further medical care, and succumbing to "secondary drowning" which is actually "**Acute Respiratory Distress Syndrome**" (ARDS). Approximately fifteen percent of those drowning victims who are revived will succumb to ARDS, irrespective of receiving the best medical care possible.

## CHAPTER 9 DROWNINGS

Drowning is the fourth leading cause of accidental death among the general population. The majority of drownings occur in freshwater: swimming pools, bathtubs, lakes, ponds, rivers, streams, etc. Unfortunately, many drownings result from the application of what has come to be known as the "**deadly formula**":

Hot weather + alcohol + cold water = drowning.

Drowning is caused by an inhalation of water. Even though a submerged victim may hold their breath, carbon dioxide buildup in the brain will eventually force an inhalation of water. Inhaled water is drawn from the lungs into the bloodstream causing the heart to arrest due to the excessive amount of water in the blood. Thus, **a drowning victim actually dies of a heart attack.**

### AQUATIC DISTRESS

A person in distress in the water may exhibit any of the following signs prior to the drowning process occurring:

1. Appearance of climbing an invisible ladder.
2. Attempting to roll over onto the back in order to bring the face out of the water.
3. Attempting to swim, but not making headway.
4. Vertical in the water, head tilted back with mouth open.

Those in aquatic distress can still assist in their own rescue by grabbing a lifeline, etc.

### THE DROWNING PROCESS

Drowning occurs in several stages:

1. Initially, the victim is surprised. they will attempt to keep their head above water, inhale deeply, and make involuntary downward movements with their arms.
2. The victim will not wave or call for help and may eventually panic and may become hysterical. they will hyperventilate and struggle violently resulting in negative buoyancy.

3. Submergence occurs within twenty to sixty seconds accompanied by reflex breath holding. As available oxygen is consumed from the air remaining in the lungs the urge to breathe becomes stronger.
4. After 23 minutes a combination of brain depression due to anoxia (severe oxygen deficiency) and the overwhelming urge to breathe caused by carbon dioxide buildup results in the victim breathing underwater. Although unconscious, in order to prevent the entrance of water into the lungs, the victim will reflexively swallow water, triggering retching and vomiting. As a result, most drowning victims will have a stomach full of water.
5. As available oxygen is consumed, the urge to breathe becomes even stronger. Unless a spasm of the larynx (immersion reflex) shuts off the flow of water into the lungs, the victim will unconsciously take a strong deep breath resulting in a filling of the lungs with water and more negative buoyancy.
6. Due to a lack of oxygen, brain function becomes more depressed and deprivation of oxygen to the heart results in cardiac arrest. Brain damage begins after approximately 5 minutes of oxygen deprivation on land, however in water this time may be extended due to cold water immersion reflex.

## DROWNING VICTIM SEARCH PROCEDURE

Prior to conducting a search for a drowning victim, any witness(es) must be interviewed to establish the last seen location (PLS) of the victim in the water. Each witness should be taken separately to the exact spot (if possible) from where they last saw the victim and told to point out the location. Avoid asking the witness to estimate the distance and avoid also accepting any estimate of distance from a witness as such estimates over water are extremely difficult to judge and experience has shown them to be notoriously in error. Most eyewitnesses will over-estimate distances over water by at least 25%.

Once the witness has pointed out a location, divert their attention. Have him stand with their back toward the area they indicated or if necessary, remove him from the area while the interviewer solicits additional information from the witness.

Out of view of the witness put a swimmer into the water (diver in freediving gear) and have him swim to the location that the witness indicated. Do not allow the witness to watch the swimmer as they moves to the location indicated, as it will affect their judgment with respect to the last location of the victim.

With the swimmer in place, return the witness to where they indicated they was when they last viewed the victim. Confirm with the witness that the swimmer is in the exact location. If the witness wishes, allow him to relocate the swimmer. Once the location is confirmed have the swimmer mark the location, deploy divers, and commence the underwater search.

In a drowning event where several witnesses are involved, follow the same procedure for each witness. It is important however that each witness not observe the marker placed as a result of another witness's placement of the PLS. In these instances, short line the marker(s) in order that it (they) cannot be seen by other witnesses who are identifying a PLS.

Different witnesses may designate differing locations, or even differing areas as the PLS. This is not a problem; very seldom do two people witnessing the same event see it in exactly the same way. On lakes, many coves look very much like the next cove, or the next. The establishment of varying PLS locations will give the dive team alternate areas to search should they not locate the victim in the most likely location identified.

In still water, a drowned body will drop straight down. However, most bodies of water of any significant size will have some water movement that will tend to move the body along as it descends. As a rule, in lakes, a drowned body will be located within a radius of the depth of the water at the location of the drowning. In the ocean, where strong currents may exist, a drowning victim may be moved a considerable distance prior to reaching bottom. In moving water such as a river, the location of a body will depend on several factors: depth of water; the volume of moving water; velocity of the water; presence of strainers; and bottom contour. In swift moving water, a body may be transported several miles.

## SCUBA DIVER DEATHS

Upon locating the victim of a SCUBA diving accident, the position of the body will be dependent upon several factors:

- Whether the body is on the surface, in mid-water, or on the bottom.
- The buoyancy characteristics of the cylinder.
- The amount and position of ballast weight.

- The occurrence of an entanglement.

The primary causes of SCUBA diving deaths are listed as follows:

1. Hypothermia: Physical and/or psychological problems (e.g., cardiovascular problem, hypothermia, arterial gas embolism, seasickness, etc.).
2. Environmental Conditions: e.g., surf, cave, current, etc.
3. Buddy System Failure
4. Equipment Difficulties: e.g., misuse of, lack of, lack of knowledge concerning, etc.
5. Running Out of Air
6. Ascent Difficulties
7. Entanglement

**The vast majority of SCUBA deaths, regardless of the attributable cause(s), are a direct result of diver error precipitated by the occurrence of several small events as opposed to one primary causal factor.**

Prior to recovering the body of a deceased SCUBA diver, take time to make a mental inventory of the diver's equipment and its condition and make notes on a slate concerning applicable factors:

- Mask: In place? Flooded?
- Snorkel: Attached to mask? Affixed to BCD? Stored in a pocket?
- Regulator: Second stage in mouth? Mouthpiece affixed?
- Alternate Air Source: Octopus regulator, pony bottle, or Air II?
- Buoyancy Control Device: Properly fit, properly worn? Inflator hose connected?
- Exposure Protection: Type of suit (wet or dry)? Fully suited? Condition? If dry suit, is suit inflator connected?
- Pressure: Reading of pressure gauge at depth?
- Computer: Operational?
- Tank: Valve open? How much?
- Weight System: Belt on? Quick release inaccessible or jammed? / Integrated weights in place?
- Knife: Accessible?
- Fins: Both on?
- Other Miscellaneous Equipment: Speargun, goodie bag, camera, etc.?

Should you discover any necessary equipment to be missing, mark the body with a surface buoy and check the immediate area around the body. Chances are, any missing equipment will be located. Prior to recovery of the diver, turn off the air in the tank. Do not manipulate the diver's equipment in any other manner except as is necessary to facilitate recovery. (e.g., removing weight belt) Send all equipment involved in a SCUBA death to the Coroner's Office with the body.

## SEARCH AND RESCUE SCUBA DIVER DEATHS IN THE UNITED STATES

It is an unfortunate fact of life that those charged with the responsibility of underwater search and rescue / recovery occasionally, themselves, become victims. In the past 59 years (1960-2019) 72 incidents resulting in 78 fatalities involving SCUBA divers participating in SAR activities have been reported. As might be expected, search and recovery operations accounted for a large percentage of these fatalities (54%); however, training exercises also accounted for a rather high percentage (43%) of these deaths.

The breakdown of activities being performed by divers, which resulted in these 76 deaths, is as follows:

- Victim Search / Recovery – 28 (37%)
- Evidence Search – 8 (11%)
- Property Recovery – 7 (9%)
- Training – 33 (43%)
- Unknown – 2 (3%)

The direct and/or contributing causes can be determined in 69 of the 78 fatalities. Some of these deaths were attributed to only one cause, however most involved two or more contributing factors. The factors known and/or suspected to have caused these deaths of Public Safety Divers are as follows:

- **Excessive Current / Delta-P – 14 (20%)**
    - These incidents involved divers being sucked into siphon or drain pipes, or pinned against rocks, etc. in swift moving water, or simply swept away.
- **Entanglement – 14 (20%)**
    - Of the thirteen deaths involving entanglement, five involved the divers' own search / tether lines. The remaining seven involved entanglement with the object of the search and recovery.
- **Failure/Inability to Ditch Weight – 12 (17%)**

    - The bodies of these divers were recovered with their weight systems still in place. In four of these cases, divers were significantly over weighted. In one case, the diver's "ripcord" weight release system failed to ditch their weight – later examination and testing of their twelve other team members' "ripcord' weight releases resulted in similar failure.
- **Out of Air – 10 (14%)**
    - These divers were recovered with little or no air remaining in their tanks.  In one of these incidents the victim diver initiated a 100-foot dive with a partially filled SCUBA tank. In one incident the victim diver fell overboard with their air turned off. In another, a diver having completed an 85 fsw dive, ran out of air at their 20 fsw safety stop. they signaled their buddy diver and in the ensuing attempt to help both divers lost their face masks and neither was able to access their emergency air supply.
- **Inexperience – 10 (14%)**
    - Three of these deaths occurred during initial SAR dive training. One of these incidents involved the attempted performance of a "bailout" in 35 feet of open water. One death involved a diver who had not made a dive in over a year. Five deaths involved divers who although trained, had been a part of their team for only a brief period of time. One fatality occurred during a diver's participation in their team's annual training day.
- **Medical Problem – 11 (16%)**
    - Eight divers reportedly suffered heart attacks - one of these occurred in confined water (swimming pool); two divers drowned as a result of underlying heart conditions; two had previously undiagnosed heart conditions; while another suffered fatal exhaustion while attempting to board a boat following a dive.
- **Deep Water – 9 (13%)**
    - These deaths occurred at depths greater than 60 fsw.
- **Overhead Environment – 8 (12%)**
    - Four of these incidents involved diving under overhead ice, one involved a submerged vehicle, and one involved the hull search of a sunken boat.
- **Equipment Failure – 7 (10%)**
    - Of these instances, two involved malfunctioning "J-valves" which had been improperly installed; one involved the malfunction of a

dry suit valve; one involved the use of a home-built surface-supplied air system; one involved the failure of both the BCD inflator valve and the weight system quick release; one involved the underwater loss of a Full Face Mask (FFM) and air supply; and one is believed to have involved the loss of the second stage regulator underwater.

- **Lack of a Safety Diver or Poor Safety Diver Procedures – 5 (7%)**
    - Three of these deaths were partially attributed to having no safety diver available, while another involved the deployment of a safety diver who was ill equipped to perform the function.
- **Communication Breakdown --4 (6%)**
    - Two incidents involved confusing rope-pull signals, while two others involved a breakdown of underwater voice communications.
- **Panic – 2 (3%)**
    - One diver is known to have panicked when the release of their weight belt did not result in the expected immediate ascent. Another is known to have held their breath upon ascent and embolized.
- **Inappropriate Breathing Gas – 1 (1%)**
    - This incident involved the mistaken deployment of EAN 36 on a 212-foot dive.
- **Overconfidence in Abilities – 1 (1%)**
    - In one instance, a diver was given specific instructions as to what they was to do, verbally stated that they was not going to comply with the instructions, and intentionally violated those instructions.
- **Nighttime Operation – 1 (1%)**
    - One incident involved a nighttime training situation in 17 fsw.
- **Unknown – 9 (13%)**
    - Due to a variety of factors such as poor information collection, or the reluctance of some agencies to supply information on these deaths, causal and or contributing factors cannot be determined in nine of these instances.

## CONCLUSIONS ON SEARCH AND RESCUE DIVER DEATHS

There is no single primary cause of SAR diver fatalities. Entrapment due to strong current, differential pressure issues, and entanglement contribute heavily to these fatalities. As might be expected, the majority of these fatalities (57%) occurred during actual search and recovery operations. What is rather disturbing is that 43% are known to have occurred during involvement in training exercises. This emphasizes the importance of taking training seriously and conducting training operations with all safety procedures in place.

Diver inexperience seems to have played a significant role in several underwater SAR fatalities. However, in many other instances, the divers involved were seemingly well experienced. Thus, it appears that experience is a factor that cannot be counted upon to ensure safety.

It is apparent from the deaths of those divers that occurred early in their SAR experience that in at least one incident, basic SAR training was not so basic after all. How many other early training incidents occurred due to the diver being tasked beyond their training and/or capabilities? Particularly disturbing is that a failure to employ basic procedures with respect to the ditching of weights and/or failure to understand and apply buoyancy principles as they relate to weighting, account for a significant number of these deaths. Basic skills must be practiced and refreshed until they occur automatically and without conscious thought. Basic principles such as proper weighting and weight belt removal prior to other gear must be periodically reinforced. Equally disturbing is the fact that one of these fatalities occurred as the diver participated in their team's annual training exercise. Training must be on-going, documented, and verified.

It becomes apparent from the statistics that the presence of other divers in the water cannot be considered a safety valve. The old adage concerning there being "safety in numbers" appears to have little validity when applied to SAR diving. Six of these incidents (8%) involve the simultaneous deaths of buddy pairs of divers. In thirty other incidents (42%), buddy divers were in the water and in close proximity to the victim divers. This accounts for 50% of these fatalities occurring while employing the buddy system – which supposedly makes diving safer.

In addition to the 76 deaths of SAR personnel, there were an additional 11 "close calls" associated with these deaths. Seven of these involved buddy divers while nine involved safety divers, all of whom endeavored to assist the victim divers and nearly became victims themselves.

The sport diving community has in recent years began to question the effectiveness of the buddy system in as much as statistics seem to indicate that it has been largely unsuccessful in accomplishing its primary purpose – diver safety, even in relatively clear, open water.

Much of what constitutes SAR diving activity, both training and actual operations, is conducted in low/no visibility water. To what degree might the difficulties associated with lack of visibility have contributed to these deaths? In SAR diving, the buddy system is a definite disadvantage in that it is extremely difficult to orchestrate and coordinate the movements of divers who cannot see each other.

Perhaps surface tended / tethered diving is not as safe an operation as it is touted to be. Sixteen of the victim divers (21%) were tethered and being surface tended at the time of the incidents. Of course, tethering can be accomplished in two ways:

1. With a surface tender controlling the line and search pattern; or
2. With the diver himself controlling the expansion and direction of the pattern.

In either case, the diver must be clipped into to the line. One SAR diver fatality involved a diver with a handhold on a line losing their grasp and being swept away by current, entrapped in a canal grate, and drowned in five feet of water. Another death involved a tender line becoming snagged in heavy (12-knot) current and eventually snapping, leaving the diver stranded. Perhaps the diver-controlled tether pattern offers a margin of safety that a tender-controlled operation does not.

There have been only four of the seventy-eight victim divers (5%) who are known to have been diving solo at the time of their deaths. Not that it is necessarily applicable in every diving circumstance, but it appears that when appropriate to the environment being searched that a well-trained, competent, self-sufficient and self-controlled solo diver may enjoy a greater margin of safety than does either the buddy team or the surface tended diver.

## SUICIDAL DROWNING

Drowning suicides are generally carefully planned. They are almost always unwitnessed events. Generally, a suicide note will be left where it can be readily found. Clothes and personal effects are many times found neatly folded at the point where the individual entered the water. In such events, binding of the wrists and ankles is common, as is supplemental weighting.

## ADULT DROWNING VICTIM RECOVERY

The in-water weight of an adult drowning victim is between 8-16 pounds. Children weigh between 4-10 pounds in water. Toddlers and infants are generally positively buoyant in water. Scuba divers will weigh considerably more due to the weight of the tank and ballast weight.

There are several methods that can be utilized in the recovery of the body of a drowning victim:

<u>Grab and Go</u> – This method is the simplest in that it requires no additional equipment. The diver simply grabs the victim (an ankle is generally recommended) and swims to the surface. This method is generally discouraged due to the fact that:

- Any complications arising with the diver's ascent will more than likely result in the victim being released and resulting in the possible necessity of an additional search.
- Depending on the length of time that a body has been submerged, off-gassing may have commenced in which case the body may well beat the diver to the surface.
- Possible evidence can be lost from the body of the victim during the ascent and recovery process.
- The body must be "bagged" on a beach or aboard a boat, which might be within view of family members, media, or other on-lookers.

<u>Bagging Underwater</u> – This method consists of placing the victim into a body bag on the bottom and buoying the victim with a closed-circuit lift bag(s). Open-circuit lift bags are not appropriate for this purpose in as much as they tend to spill air upon reaching the surface and thus, also can result in the necessity of initiating a second search. Underwater bagging is complicated by poor visibility, but is the recommended method of recovery in any case where evidence might be present on the body of the victim, or where privacy during the 'bagging process is desired.  It is suggested that divers "stage" the body bag by unzipping the zipper that secures the body within and re-folding the bag prior to submergence. This will result in a less cumbersome procedure for the divers bagging the body.

Strap Lift – This method entails affixing a strap system (e.g., 2" webbing with buckle, pickoff strap, or a Hanson Harness) around the victim, attaching a closed-circuit lift bag, and sending the victim to the surface. This method is advantageous in that one lifting device is generally sufficient to buoy the body to the surface. The disadvantages are that evidence might be lost and also that the body must be bagged on the beach or aboard a boat.

A body submerged for more than a couple of days indicates a preference for underwater bagging. It is desirable to move the body bag around the body, as opposed to moving the body into the bag in order to best preserve any evidence on the body. At any rate, the body should be placed into the body bag out of the view of onlookers, witnesses, and especially family members. Divers should then await the arrival of Coroner's officials prior to transporting the body to shore. It will be important for the Coroner to know at what depth the body was found, the position of the body, any conditions which existed such as entanglements, etc. and any modifications which were performed to the body and/or its clothing during the recovery.

## DEAD BODY RE-FLOAT TIME APPROXIMATIONS

Dive personnel are often asked about the amount of time that it will take the body of a drowning victim to re-float. Personnel are to avoid making any such time estimates due to the fact that there are too many variables involved to be able to do so with any degree of accuracy.

This information was compiled by John Sanders, Dr. John Whittington, and Mark Williams of the National Underwater Rescue-Recovery Institute and should only be used for dive team purposes for estimating when a body should float. **This information should not be shared with relatives / friends of a drowning victim / media representatives, etc.**

| Water Temperature | Number of Days for Body to Resurface |
|---|---|
| 40 Degrees (F) | 14-20 Days |
| 50 Degrees (F) | 10-14 Days |
| 60 Degrees (F) | 7-10 Days |
| 70 Degrees (F) | 3-7 Days |
| 80 Degrees (F) | 1-2 Days |

A variety of factors will influence body refloat time including:

- Depth – The deeper the body, the longer the refloat time. Victims that are 100 feet or deeper may not surface at all due to the combination of pressure and temperature.
- Water Temperature – The colder the water, the longer the time involved for re-float. In extremely cold water at extreme depths, a body may never re-float.
    - Victims that have drowned in 30-40 degree F water will not surface until water warms.
    - In water warmer than 50 degrees F., unless other variables come into play, a body will generally eventually re-float.
- Type of Water (fresh water, salt water, brackish water) – Salt water supports more bacteria than does fresh water. Murky water supports more bacterial action than does clear water. Bacteria speeds the production of body gases and thus re-float time.
- Organisms and Wildlife in the Water – Certain organisms and animal life will feed upon the body and may assist, inhibit or even prevent re-float.
- Clothing Worn by Victim – Heavy clothing that becomes waterlogged will delay re-float. Tight fitting clothing will inhibit re-float. A tight-fitting belt can restrict abdominal bloating.
- Air in Lungs - Any amount of air trapped in the victim's lungs will contribute to the victim's eventual buoyancy.
- Amount, Type, and Time of Last Food Ingestion – The type and nature of food last ingested may prove to be a significant factor in re-float time of a body.
    - Food consumed within six hours of drowning which is high in carbohydrates (sugars, beer, soft drinks, hot dogs, potato chips, burritos, etc.) will produce increased amounts of hydrogen sulfide, carbon dioxide and ammonia which may result in re-float of the body in as little as 12 hours.
- Body Type (e.g., lean, fat, muscular) – The leaner or skinnier the body of the victim, the longer the time to re-float.
- Any Added Weight (e.g., jewelry, keys, coins, tools, etc.) – Items with weight provide ballast to the body inhibiting re-float. A scuba diver with cylinder and weights affixed to their body may never re-float.

- Mode of Death (e.g., drowning vs. boating accident, etc.) – Wounds can allow the venting of body gasses and thereby delay or prevent re-float.
- Medications, Drugs, or Alcohol in the System
- Age, Weight, and Height of Victim
- Last Known Activity – What was the person doing at the time of drowning? E.g., hunting, fishing, swimming, or skiing…
- Suicidal Drowning by Self Weighting
- Bottom Temperature – Currents, spring fed, stagnate, polluted water presents different problems for determining bacteria in intestinal tract.
- Debris – stumps, trees, fencing, fishing line, etc. that could cause entanglement. Watersheds and most State Parks are flooded farmland

In a dead body, bacteria in the digestive tract will produce gasses that cause bloating of the body. As a body bloats, it will tend to slowly re-float. As a body becomes more buoyant it is subject to the effects of water movement. Upon surfacing, it is possible for the body to vent enough gas to again submerge. Warm water and shallow depth increase the production of gasses in the digestive system. In water warmer than 70 degrees F., a body may refloat in approximately one day, whereas in water colder than 38 degrees F., a body may never resurface. * Depth of a body also plays a factor and where depths exceed 65 feet, water pressure may be strong enough to cause venting of built-up gasses inhibiting re-float.

Adult men and women on the bottom weigh about 6-15 lbs. negative. Children weigh less and may not sink unless intentionally weighted. Some kids will float face up.

Victims who are dead before they enter the water will not sink. (A victim thrown in the river from a motorcycle accident traveled 175 miles in 3 days).

Most adult victims will float face down due to the weight of arms and legs.

Body recovery can be an emotionally traumatic and disturbing experience, particularly in cases such as the drowning deaths of children or the recovery of dismembered bodies. There are documented instances wherein divers performing body recoveries have developed acute psychosis, which manifested itself in physical symptoms resembling decompression illness (e.g., severe headache, joint pain, memory loss, disorientation, cognitive dysfunction).

Divers are reminded that assistance is available and in place through the Sheriff's Department for the treatment of such disorders and personnel are encouraged to avail themselves of these services.

** NOTE: In August of 2008, this team dove on a male drowning victim at Lake Piru. The depth of the water was 30-35 feet; water temperature was 70-degrees (surface to bottom). The bottom was relatively clean except for some large tree branches and trunks. The team conducted an eight-day search. On the eighth day, the victim surfaced approximately 200 yards south of the PLS in an s area known as "Diablo Cove" as divers prepared to enter the water. This area was heavily searched by a mutual aid dive team using side-scan sonar. Water movement in Lake Piru primarily occurs at the surface and is always in a northerly direction.*

*An almost identical situation occurred in July of 2020. This search involved a heavy undergrowth of brush. Side-scan sonar was heavily utilized in the area of the drowning – again, by another mutual aid dive team with negative results. The female victim surfaced on the seventh day following a drowning in the same general area described above.*

# CHAPTER 10 RECOVERY AND SALVAGE

Upon locating the object of your search, if it is small enough, an immediate retrieval and recovery can be initiated. It is a good idea to carry a mesh type "Goodie Bag" to assist in transporting the object to the surface. However, should the recovered object be of evidentiary value in court, special handling might be required. If possible, evidence should be photographed as it is found, prior to being moved or tampered with in any way. In any case, a sketch of the item of evidence and its relationship to nearby objects is required. Evidentiary items that may harbor additional evidence (e.g., fingerprints on a gun, bloodstained clothing, etc.) should be placed into a container containing the same liquid as that surrounding the item and additionally a sample of the bottom from where the object is recovered.

Larger objects will require that additional measures be taken. It is recommended that a marker buoy be attached to the object prior to beginning recovery. This will serve to accomplish two things:

- Your surface support will be aware that you have located the object, and
- Should you later lose sight of the object you will avoid repeating the search. There have been instances wherein divers located an object, failed to mark it, lost it, and were unable to locate it again to recover it.

Plan ahead with respect to the mode of recovery to be utilized. Decide what you will do with the object once it is at the surface. Depending upon the size of the object you may have to utilize either an apparatus to buoy the object to the surface or alternatively a surface line secured to the object. The use of a surface line is probably the safest method, however requires the use of a watercraft capable of carrying the added weight of the object. Either block and tackle or a power winch system can be utilized. However, you might first ascertain the weight of the object (out of water) in order to ensure that the lifting apparatus and its mounts are sufficient in strength to handle the load. There are several cases on record where would be salvers have "winched" the stern transom from their boats, or instead of hauling an object up, have pulled the bow of their vessel underwater resulting in a new dive site for the enjoyment of the wreck diver or underwater photographer.

The use of inflatable devices is the most commonly used and most practical method of underwater recovery. This technique involves attaching containers (lift bags) to the object to be raised, then filling them with air until the positive buoyancy of the container equals the negative weight of the object. The object will then rise to the surface. Although any number of devices may be used to float an object including air spaces or inflatable compartments in the object itself, commercial closed circuit lift bags are recommended for this type of recovery. One must take care however to ensure that all lifting devices be equipped with either a line or chain strong enough to handle a load of at least three times the lift capacity of the device. When utilizing a lifting device, be sure to utilize one appropriate for the size of the object.

In order to lift an object, you must determine the size and weight of the object to be raised. This can generally be ascertained by checking known sources. For example, if a diver is interested in raising an outboard motor, check with a local dealer, manufacturer's representative, or find a similar object and check its weight. For an "on the spot" salvage attempt, however, you will need to apply a different method of determining the approximate weight.

- You can simply make a "blind guess" at the approximate weight, and then provide extra flotation equipment to over buoy the object.
- You can calculate the weight by using a basic formula: Weight = (volume) (specific density). As an example: If you know that the specific density of iron is 437 pounds per cubic foot, and estimate that the iron object you wish to lift contains a total of 3 cubic feet of material, then ...weight = (3 cubic feet) X (437 pounds) = 1,131 pounds gross weight.

Engineering manuals are available which list the specific densities of materials (see pages 10.12 – 10.15). If the approximate size of the object can be determined in terms of a cubic measurement, you can find the approximate weight of any object. You can then concern yourself with the device(s) necessary as a lifting force.

Assume that you have located a section of steel pipe that you wish to raise, and the estimated weight of this pipe is 850 pounds. The question would now be, "How much floatation will be needed to effectively lift this pipe section to the surface?" Assume that the lifting device that you have selected, although "old school", is a 55-gallon drum.

There is one other piece of information that will be needed to solve this problem: the depth of water from which the pipe is to be raised. As the depth (pressure) of the water will have a direct bearing on the volume of gas required to fill the lift device to positive lifting capacity.

You find, as an example, that one (1) 71.2 cubic foot cylinder compressed at 2,475 p.s.i. (2250 + 10%) will completely fill nine and three fourths (9 3/4) 55-gallon fuel drums at the surface. This same cylinder will only fill four and seven eighths (4 7/8) drums at a depth of 33 feet, (sea water). A 55-gallon drum contains 7.33 cubic feet of gas at sea level.

In order to calculate the volume required for lifting devices, use the following formula:

- Number of gallons capacity 7.5 (the number of gallons in a cubic foot) = cubic feet of air contained.
- To determine the gas requirement "at depth", you would now apply Boyle's Law to the cubic feet of gas required at the surface.

Now that you can calculate the amount of gas required to fill a given device, how do you determine the actual lifting capacity of that device? To begin, one cubic foot of air will lift 64.2 pounds of dead weight in seawater. A cubic foot contains approximately seven and one-half (7.5) gallons. One gallon of air will lift eight and one half (8.5) pounds of dead weight in seawater. There are 1,728 cubic inches in a cubic foot.

One cubic inch of air will lift approximately four one hundredths of one pound (.0372) of dead weight in seawater (64.2 pounds per cubic foot). One cubic foot of air will lift 62.4 pounds of fresh water, 3% less.

With the 55-gallon fuel drum as an example, you can figure an approximate lift capacity of just under 420 pounds. To arrive at a lift capacity figure for any given container, you must have the following figures:

1. The liquid capacity of the container (expressed in gallons).
2. The fact that one (1) cubic foot of liquid = 7.5 gallons.
3. The specific weight of water (62.4 pounds per cubic foot for fresh water and 64.2 pounds per cubic foot for seawater).
4. The weight of your container (weight at surface).

With this information, you can now supply the following formula:

L.C. = (V) - (7.5) X (ws fluid weight) - weight in air.

In this formula, we find that L.C. = lift capacity, (V) = volume (in gallons of liquid) of the lift device, (7.5) = the figure used to convert "gallons of liquid" into cubic feet (since cubic foot is equal to 7.5 gallons), ws fluid = the specific weight of water (62.4 pounds per cubic foot for fresh water and 64.2 pounds per cubic foot for seawater) minus the weight in air = the weight of the container when it is weighed empty at the surface. (The weight of the average 55-gallon steel drum is 53 pounds).

If you now put this formula to work, you find that L.C. = (V) gallons - (7.5) X ws fluid, minus 53 pounds. So, the lift capacity of the 55-gallon drum is found to be approximately 418 pounds in seawater (405 pounds in freshwater).

Returning now to the hypothetical salvage problems of the 850-pound section of pipe, you find that we will need two (2) 55-gallon drums, and that at a depth of approximately 33 feet in seawater you will need slightly less than the contents of one-half of a standard diving cylinder (71.2 cubic feet at 2,475 p.s.i.).

The reason more lifting devices are not needed is because there is a specific density differential between the sea water and the steel pipe of 64.2 pounds per cubic foot of iron, which must be subtracted from the weight of the iron pipe in salt water. So assuming the iron pipe contained approximately 2 cubic feet of steel at 437 pounds per cubic foot, for a total of 874 pounds on the surface; it would only weigh 746 net pounds in seawater. (Archimedes Principle).

A sinking object will displace its material mass or size in a liquid. The amount displaced is a working force that can be deducted from the material weight of the item in a liquid when determining the lifting force necessary to make buoyant that sunken object. But in order to lift the object from the sea, the lifting device used in this case should be designed to handle the surface weight of the object.

Rather than performing the mathematics exercise above to determine the lifting capacity of a given device, it is simpler to determine the specific density of a material from a chart, then estimate its size in cubic feet and obtain an appropriately rated lifting device.

When deciding on the lifting device to be used for any particular salvage attempt, one must keep in mind the fact that if the device is filled with compressed air "at depth" that volume of compressed air is going to expand as the device ascends to the surface (Boyle's Law). With this in mind, one must be certain that the expanding air can escape, or the lift device may rupture before it reaches the surface, or conversely upon reaching the surface tip and spill over becoming negatively buoyant. In either case, the recovery will be unsuccessful in as much as the object of the recovery will be rapidly returned to the bottom.

Do not partially fill a container! Fill each container totally, starting with the smallest and finishing with the largest. Install the largest lift in the center and balance lift from both ends. If you partially fill multiple containers, the air in each container will expand as the object ascends creating a rocket effect at the surface. If open circuit lift bags are utilized, spillage of lifting gas followed by descent of the object is almost a certainty.

## WHEN SHOULD A LIFT BAG BE USED?

A lift bag(s) should be utilized to raise any object that weighs more than about 15 –20 pounds.

Divers sometimes endeavor to transform themselves into human lift bags by over inflating their BCD’s and towing an object to the surface by hand. This is a dangerous practice as:

- If the object is dropped, the diver may find himself on a rapid, uncontrolled ascent with no time to make buoyancy corrections.
- A dropped weight endangers any other diver(s) who might be below.

Equally dangerous is a diver accompanying a lift bag to the surface, attempting to vent air from the bag in the process.

- If air cannot be vented quickly enough, the diver will be making too rapid an ascent.
- If too much air is vented, the lift bag and object will be making a rapid descent to the bottom.

## SPECIFIC USES OF LIFT BAGS

There are several specific uses for lift bags in SAR recovery work.

**Body Recovery:**

It is preferable to bag a recovered body in the water. Any evidence on the body is better preserved, and to onlookers it presents a more professional operation than a diver swimming a body to the surface. This is best accomplished by staging the body bag on the surface by unfolding it, unzipping the security zipper, and refolding the bag. The diver(s) then transport the body bag and 80-pound closed circuit lift bag to the location of the body. The bag is unfolded and draped over and around the body. The body is then turned over with the bag, which will place the body within the bag and the zipper of the body bag on top. Remember, the in-water weight of an adult human is approximately 8-16 pounds, with children weighing considerably less. A fully equipped SCUBA victim weighs between 35-45 pounds in water and can be easily buoyed up by an 80-pound closed-circuit lift bag.

**Evidence Recovery:**

Items of evidence should be packaged in PVC evidence canisters. The canister should then be clipped to the diver's ascending/descending line with the carabineer supplied and sent to the surface via closed circuit lift bag.

**Large Item Recovery (e.g., Boats, Motor Vehicles, Safes, etc.):**

The Dive Team has an array of large capacity lift bags (pillow bags) available with lifting capacities of 500-2000 pounds. These bags have provisions for attaching a SCUBA cylinder for filling, or alternatively being filled from the surface, depending on the depth of the object.

**Mini-Mother Anchor Recovery:**

Following completion of a search pattern, it will be necessary for a diver to recover their search system in order to either terminate an operation, or alternatively to relocate their search system to another area to be searched. A diver has some options with respect to recovery of their Mini-Mother anchor:

1. Swim the anchor (25+ pounds) to the surface (not recommended, as stated above).
2. Pull the anchor up by hand from the surface.
3. Have a boat available with divers to pull the anchor and search system aboard.
4. Utilize a small lift bag (25 pounds) to assist in anchor retrieval.

The lift bag option can be employed by putting enough air into the lift bag to assist the diver, but not necessarily lift the anchor off the bottom. Prior to adding air to the lift bag, it is important to break any suction that the anchor may have made with the bottom. The diver can then swim up their ascending/descending line, making any required stop(s) and thereafter surface and easily recover the anchor and line, winding the line onto the reel as they do.

## TYPES OF LIFT BAGS

Lift bags come in two types:

1. Open Circuit (open bottom)
2. Closed Circuit

There is a definite advantage in utilizing a closed-circuit bag in as much as the bag cannot "spill over" and return the object to the bottom as has happened numerous times with open circuit lift bags. Care should be taken however to ensure that closed circuit lift bags are equipped with an overpressure valve for the relief of overly expanding air. Any closed-circuit device (e.g., some "safety sausages") not equipped with a relief valve are intended for surface deployment and if deployed from underwater must be used very cautiously lest they be overfilled and burst on their way to the surface.

### TYPES OF LIFTING

- Direct Lift: The lift bag and connecting line or straps should be attached to the salvage object in a manner designed to minimize drag once the lift begins. A minimum number of knots should be tied in any line utilized. Straps should be cinched down to place the lift bag as close to the salvage object as possible with consideration for sharp edges on the object that could damage the lift bag.
- Stage Lift: Depending upon the size, weight and depth of the object to be recovered, it may be advisable to perform a stage lift. This is accomplished by attaching a line of sufficient strength for lifting the

object running from the surface to the object itself. At a predetermined distance (say hypothetically ten feet), loops are tied into this line. All lift work is then performed at the ten-foot level. Lift device(s) are attached to the line in ten feet of water and the object is raised ten feet at a time. Once the lift device reaches the surface, another device(s) is attached to the line at the ten-foot loop and the process repeated. This process will result in the object being raised only ten feet at a time, and divers working in shallow water to accomplish the recovery. This is considerably safer than attempting a deep-water buoyant lift of an object.

- Buoyancy Assisted Lift: Controlled by a line from the surface. The weight of the load is reduced by the use of a lift bag -- too small to support the weight of the load when full. This makes for a faster lift by hand or by winch, depending upon the weight of the load. (e.g., use of a 25 lb. lift bag to assist in recovering a Mini-Mother anchor – see below).

The inflation of a lift bag should never be accomplished by means of a diver's primary regulator, or alternate air source. Ideally, lift bag inflation should be accomplished with an air source independent of the diver's air supply. It is strongly recommended that a diver use a separate cylinder and regulator for filling a lift bag.

A diver using either their primary regulator or octopus for filling a lift bag places himself in jeopardy of rapidly depleting their own air supply by:

- Regulator malfunction: caused by a sticking purge valve.
- What is known in physics at the "Joule-Thompson" effect: the rapid movement of air from the high pressure of the cylinder through the first stage to the much lower intermediate pressure of the second stage, during which process a considerable drop in temperature of the air occurs. This rapid temperature drop (especially in cold water) can cause a rapid formation of ice crystals within the second stage causing freezing of the second stage, thus either shutting off the air flow to the second stage or, more commonly freezing the valves into an open position resulting in a free-flow of air. This phenomenon is known to have caused the death of at least one salvage diver in the process of deploying a lift bag.

## HOW TO USE A LIFT BAG

1. Prior to beginning any underwater lifting operation, it is necessary that some planning take place. It is important to know the approximate weight of the object to be raised in order that the lift capacity of the bag can be closely matched to the weight of the object. Using a lift bag with a lift capacity greatly in excess of the weight of the salvage object makes the lift difficult to control and can endanger divers in the water, as well as personnel on the surface. Remember **"Archimedes' Principle":** an object that weighs 100 pounds on land will weigh less in the water in as much as it is buoyed up by the weight of the water it displaces.
2. To initiate a lift, a diver should cautiously inflate the bag adding air in small amounts and assessing its effect prior to adding additional air. If a diver initiates a continuous flow of air into the lift bag until the object begins to rise, they have supplied too much air and the lift bag and attached object will make a rapid ascent to the surface. Remember Boyle's Law: as the lift bag rises, the air within will expand causing an increase in buoyancy and thus an ever-increasing rapid ascent. Enough air should be supplied to the lift bag to render the object neutrally buoyant just off the bottom. A slight upward push of the lift bag and object will cause an ascent.
3. Just prior to beginning the lift, the diver should examine the area above him to ensure that it is clear of obstructions and/or other divers. As the lift bag and object begin to ascend, the diver(s) should move away from the area of the lift to avoid being struck by the descending object should the lift fail for some reason.
4. Should the salvage object be stuck in silt, it is possible that it could require a force of as much as ten times the weight of the object to break it lose from the bottom. Rather than applying excessive lift capacity and air to fill it, the diver(s) should endeavor to free the object by digging and prying around the object. Should these efforts be unsuccessful, it may be necessary to employ an airlift to remove silt and mud from around the object and free it for its ascent.
5. As soon as possible upon reaching the surface, the lifted object should be removed from the water, or secured to a watercraft and towed ashore.

## DENSITY AND SPECIFIC GRAVITY TABLES

The following table lists the density and specific gravity of various materials. The figures represented are approximate and should only be utilized as a general guideline.

**Density** is defined as weight per volume (e.g., pounds per cubic foot, pounds per square inch, etc.)

**Specific gravity** is the ratio of the density of a material to the density of water. Materials with a specific gravity greater than that of water (1.000 for freshwater and 1.035 for seawater) will sink; materials with a specific gravity less than that of water will float. Lead has the highest density and specific gravity (11.35) of all metals, with the exception of gold. Gases also have weight, density and specific gravity.

| Liquid | Density (lb./cu.ft.) | Specific Gravity |
|---|---|---|
| Ice (@ 32 F.) | 56.2 | 0.90 |
| Freshwater (@ 39 F.) | 62.4 | 1.000 |
| Seawater (@ 39 F.)* | 64.1 – 64.9 (64.2 std) | 1.027 – 1.040 (1.035 std) |
| Petroleum Oil | 51.2 | 0.92 |

(*) Seawater varies in salinity from place to place. High evaporation levels cause noticeably saltier surface water in the tropics. Freshwater runoff in some areas causes water to be brackish (diluted seawater).

| Gas | Density (lb./cu.ft.) | Specific Gravity |
|---|---|---|
| Air – dry | 0.0756 | 0.0012 |
| Nitrogen | 0.0781 | 0.0013 |
| Oxygen | 0.0892 | 0.014 |
| Helium | 0.0111 | 0.0002 |

NOTE: a full (3000psi) 80 cu. ft. SCUBA cylinder holds six pounds of air (77 X 0.076 = 5.85). A 13-cu. ft. pony bottle holds one pound of air (13 X .076 = .98).

| Material | Type | Density (lb./cu.ft.) | Specific Gravity |
|---|---|---|---|
| Aluminum * | Metal | 168 | 2.7 |
| Brass * | Metal | 524 | 8.4 |
| Bronze * | Metal | 518 | 8.3 |
| Copper | Metal | 559 | 8.96 |
| Gold | Metal | 1206 | 19.3 |

| | | | |
|---|---|---|---|
| Iron | Metal | 437 | 7 |
| Lead | Metal | 708 | 11.35 |
| Monel * | Metal | 552 | 8.8 |
| Silver | Metal | 655 | 10.5 |
| Steel | Metal | 491 | 7.87 |
| Stainless Steel * | Metal | 490 | 7.85 |
| Titanium | Metal | 283 | 4.54 |
| Uranium | Metal | 1184 | 19 |
| ABS | Plastics | 65.7 | 1.05 |
| Nylon | Plastics | 68.7 | 1.1 |
| PVC** | Plastics | 59.7 | 0.96 |
| Polyethylene | Plastics | 58.7 | 0.95 |
| Rubber | Plastics | 68.7 | 1.1 |
| Balsa *** | Wood | 6.9 – 8.7 | 0.11 – 0.14 |
| Cedar *** | Wood | 30.6 – 35.6 | 0.49 – 0.57 |
| Cork | Wood | 12.5 | 0.2 |
| Lignum Vatae*** | Wood | 80 | 1.28 |
| Red Oak *** | Wood | 28.1 – 41.8 | 0.45 – 0.67 |
| White Ash *** | Wood | 30.0 – 44.9 | 0.48 – 0.72 |
| White Pine *** | Wood | 17.5 – 26.2 | 0.28 – 0.42 |
| Waterlogged wood (all) | Wood | 93.6 | 1.5 |
| Brick | Other | 131 | 2.1 |
| Coal | Other | 84 -- 94 | 1.3 – 1.5 |
| Ceramic | Other | 125 | 2 |
| Concrete | Other | 144 | 2.3 |
| Glass | Other | 162 | 2.6 |
| Granite | Other | 162 | 2.6 |
| Limestone | Other | 125 | 2 |
| Bone | Human Tissue | 115.2 | 1.85 |
| Blood **** | Human Tissue | 66 | 1.06 |
| Fat ***** | Human Tissue | 57.4 | 0.92 |
| Muscle | Human Tissue | 64.8 | 1.04 |

* Can vary depending on the alloy

** Sinks in water anyway

*** Depends on moisture content in wood

**** Blood is, in fact, thicker than water.

***** Fat floats.

# CHAPTER 11 DIVING OPERATIONS GUIDELINES

Diving operations performed by the Ventura County Sheriff's Office Underwater Search and Rescue Team will be conducted under the following guidelines:

- All diving will be conducted with the oversight of an incident Commander (IC) who is a sworn member of the Ventura County Sheriff's Office. The Incident Commander is responsible for:
    - Supplying equipment and resources necessary for conducting the underwater search operation.
    - Communication with SCC (Sheriff's Communications Center) as well as any other Sheriff's Department entities or resources concerned with the operation (e.g., Major Crimes Unit, Patrol, Mountain SAR, etc.).
    - Communication and coordination with entities outside the Sheriff's Department involved in the operation (e.g., U.S. Coast Guard, Medical Examiner, County or City Fire, Harbor Patrol, Lake Management, etc.).
    - Supply of logistical necessities to support the operation (e.g., food, water, shelter, additional cylinders, supplies, etc.)
    - Completion of follow-up notifications and incident written reports.
- All diving operations will be supervised by a "divemaster" who has the experience and training necessary to oversee the diving operation. The divemaster is responsible for directing and supervising the dive operation. Such duties are inclusive of:
    - Cause all witnesses to be interviewed.
    - Establish the PLS.
    - Evaluation of environmental conditions.
    - Organize "hasty search" if appropriate.
    - Determine method of search to be utilized.
    - Advise the IC of any additional resources needed or desired.
- Prior to the water entry of any diver, a standby safety diver will be fully suited as is reasonable for prevailing conditions. The safety diver will be prepared to immediately respond as may be necessary to an underwater emergency situation.
    - Upon instruction of the divemaster, dive team members will prepare their equipment for diving and standby for further instructions.
    - Members of the dive team are responsible for the maintenance and set-up of their equipment (both personal and County issued).

Team members will perform a function check on all their individual equipment in preparation for a dive.

  - Prior to entering the water, a designated "tender" will check and re-confirm the ready status of a diver's equipment. Equipment to be checked is inclusive of the following:
  - Full Face Mask (FFM): Integrity of all connections (e.g., second stage regulator firmly attached, battery connection, activation of diver's communication unit, etc.)
  - Pony Bottle with redundant regulator: affixed to the right side of the main gas cylinder, close to the backpack, valve in a position that can be readily reached by the diver when fully suited. The mouthpiece of the auxiliary regulator must be affixed to the diver in such a manner as to be readily available in an emergency.
  - Dive Mask: worn backward around the neck or contained in a pouch or pocket on the diver's person.
  - Adequate exposure protection.
  - Connection of the BCD power inflator hose to the inflator unit.
  - If dry suit worn, connection of dry suit inflator hose to the suit inflator unit.
  - Diver's possession of two (minimum) cutting instruments.
  - Diver's possession of SMB and spool.
  - Diver's possession of the following gauges: depth gauge, pressure gauge, compass, timing device, dive computer.
  - Weight belt (or weight system) securely attached and readily removable via quick release(s).
  - All consoles, "octopus" regulators, etc. clipped close to the diver's body so as to facilitate streamlining. All clips utilized must be of a positive locking type.
  - Search gear appropriate to the operation.
  - Adequate cylinder pressure for the operation.
- Operations not requiring the use of the FFM / Comm. units may have differing equipment requirements:
  - The dive mask shall have a snorkel affixed thereto, or alternatively the diver must carry a snorkel.
  - If the pony bottle is not utilized, an octopus regulator or air-integrated inflator device (e.g., Air II) must be employed.

- Nighttime, overhead environment or dark water operations additionally require:
    - Light – two (minimum) required (primary light plus a back-up light).
    - Nighttime dive operations require the use of a personal illumination device (e.g., “Cyalume” light stick, personal strobe, or battery-operated light stick, etc.)
    - Nighttime operations are considerably more difficult than are daytime operations due to the following factors:
        - Difficulty posed in communicating with divers on the surface.
        - Difficulty in positioning divers.
        - Difficulty in tracking the movement of divers.
        - Limited visibility of divers (view limited to area illuminated by light beam).
        - Difficulty in coordinating surface support craft.
    - Nighttime operations require that the benefit in conducting them considerably outweigh the risks involved.
- The tender will confirm that there is a safety diver in stand-by mode prior to advising the divemaster of the diver’s readiness to dive.
- In all cases, where a diver is found to have defective / missing equipment, that diver will stand down and not be permitted to enter the water until such time as the deficiency is corrected.
- Upon entry into the water, and prior to final descent, the diver will drop below the surface to confirm their communications capability with the topside communications tender.
    - Communications can be maintained through hand signals (visibility permitting) or line pulls. Note: This is not an efficient deployment of resources.
    - Dive operations can be conducted without the use of FFM and Comm. When necessary and it is reasonable and safe to do so (e.g., surf operations, etc.).
    - It must be kept in mind that not all diving operations are compatible with the utilization of the FFM / Comm. system, and that in such cases the divemaster can make the determination to utilize standard SCUBA facemasks and regulators with the concurrence of the on-scene Sheriff’s Department SAR official.

EXCEPTION: The above procedures and equipment checks are mandated except in those instances where it might be possible to affect an immediate rescue and save a life. Rescue efforts must be closely evaluated after an elapsed time of one hour since the victim was last seen alive.

# DIVEMASTER CHECKLIST

| ASSESS | ORGANIZE | PLAN | IMPLEMENT | TERMINATE |
|---|---|---|---|---|
| CHECK IN WITH DEPUTY AT SCENE | | | | |
| ASSESS RESCUE FEASIBILITY | | | | |
| LOG INFORMATION FROM OFFICIALS | | | | |
| DETERMINE SEARCH OBJECTIVE | | | | |
| INTERVIEW WITNESSES* | BEGIN MAKING INITIAL ASSIGNMENTS | | | |
| CONSIDER RISK/ BENEFIT | SELECT BASE SITE FOR OPERATIONS | | | |
| IDENTIFY SEARCH AREA | HAVE EQUIPMENT BROUGHT TO SITE | FORMULATE PLANS | | |
| CHECKOUT TERRAIN AND WATER CONDITIONS | SECURE SITE AND EQUIPMENT | PRESENT PLAN FOR REVIEW AND CRITIQUE | | |
| DETERMINE AVAILABLE RESOURCES | | ADOPT PLAN TO IMPLEMENT | SUPERVISE OPERATION | |
| | | | BE ALERT TO DIVER SAFETY | |
| | | | WATCH FOR CHANGING CONDITIONS | |
| | | | NOTIFY DEPUTY OF RECOVERY* | |
| | | | RECALL DIVERS | INFORM DISPATCHER OF TERMINATION |
| | | | INVENTORY AND TAG FIND* | RETRIEVE AND STORE EQUIPMENT |
| | | | DELIVER OBJECT AND GET RECEIPT* | DETERMINE AND REPORT INJURIES |
| | | | MAINTAIN LOG | DETERMINE AND REPORT EQUIPMENT LOSSES |
| | | | | CRITIQUE THE OPERATION |

*ONLY IF APPROPRIATE

# VENTURA COUNTY SHERIFF'S DEPARTMENT

## UNDERWATER SEARCH AND RESCUE

## DIVE OPERATIONS PLAN

DATE: ______________________ TIME: ______________

LOCATION: ______________________________________________

NATURE OF CALL: ________________________________________

INCIDENT COMMANDER: ____________________________________

DIVEMASTER: ____________________________________________

PRIMARY MISSION: _______________________________________

SECONDARY MISSION (S): _________________________________

________________________________________________________

CHEKLIST:

CALL ___ CREDIBLE REPORT OF SUBMERGED VICTIM.

___ CREDIBLE REPORT OF SUBMERGED EVIDENCE / PROPERTY.

PERSONNEL: ___ ADEQUATE NUMBER OF PERSONNEL .

___ PERSONNEL QUALIFIED FOR ROLE IN MISSION.

___ SAFETY DIVER ASSIGNED.

LOGISTICS: ___ NECESSARY EQUIPMENT AVAILABLE / ON-SITE.

___ LOGISTICS OFFICER ASSIGNED: ________________

___ SPECIALIZED EQUIPMENT NECESSARY: ___________

________________________________________________________

HAZARDS:

___ HIGH SURF / SWELL

___ CURRENT

___ REDUCED VISIBILITY / BLACKWATER

___ NIGHTTIME

___ DEEP DIVE / DECOMPRESSION

___ OVERHEAD ENVIRONMENT

___ ENTANGLEMEMNT: TYPE: ____________________

___ CONTAMINATED ENVIRONMENT

___ SPECIAL CONSIDERATIONS: ____________________

BRIEFING – CONCERNS RAISED: ______________________________

______________________________________________________

RISK / BENEFIT ASSESSMENT: ______________________________

NOTES:

______________________________________________________

______________________________________________________

AREA SKETCH:

PREPARED BY: ______________________________

# CHAPTER 12 DIVING PROCEDURES

On any and all dives conducted by the Ventura County Sheriff's Office, Search and Rescue Dive Team, individual divers are responsible for the tracking and reporting of bottom times, depths, and surface intervals pursuant to their own activity in support of the team.

Divers are to utilize a dive computer, or alternatively the PADI Recreational Dive Planner (RDP), or the U.S. Navy Dive Tables in order to accurately track nitrogen and/or oxygen absorption. Divers not utilizing a computer are not permitted to rely on the computer information of another diver during a dive.

At the conclusion of each and every dive, the diver will inform the divemaster, or their designee, of the following things to record:

- Their maximum depth from their dive.
- Their total bottom time from their dive.
- The area of coverage of their individual search.

**Bottom time** is defined as the time from the beginning of descent to the beginning of direct ascent to the surface. Bottom time is inclusive of all safety stops made during a dive.

An **ascent rate** is the rate at which a diver ascends to the surface from their dive. Ascent rates should be in the area of 20-30 fsw/min. and should not ever exceed 60 fsw/min. except in an OOA (out of air) emergency situation. Upon ascending from a dive, whenever practicable, a diver will make a 3–5-minute safety stop at 15-20 fsw.

The **no decompression limit (NDL)** is the maximum allowable dive time that you can remain at a specific depth and ascend directly to the surface without requiring staged decompression stops on the way up. Dives exceeding the no-decompression limits are strongly discouraged except where anticipated and planned for and cylinders of breathing gas for decompression are staged at planned, pre-determined depths.

**Reverse dive profiles** (making a dive followed by a deeper dive; or during the same dive, starting shallower and ending deeper) are to be avoided. Even though dive computers are programmed to allow for such dives, the program is theoretical and does not factor such variables as age, physical condition, body fat, etc.

**Saw tooth dive profiles** (those where a diver is continually ascending and descending) are to be avoided. In cases where, for example, an incline is to be searched, a circular search pattern will most likely involve excess ascents and descents by the diver as the search pattern is expanded and repeated. In such cases, a search pattern such as a jackstay or other pattern that will permit the search of deep water first should be utilized.

**Bounce dives** (short, deep dives following a previous dive) to depths exceeding 60 fsw in depth will not be performed.

As a general rule, dives will be limited to a maximum depth of 130 fsw. There are however exceptions in those instances where a "target" is identified at greater depth and the dive involves a fresh diver or dive team and the duration of the dive is anticipated to be brief.

All dives to depths greater than 100 fsw must consider the nature of the operational mission to be performed, surface support available, experience of the diver(s), the actual depth of the operation, visibility, water temperature, etc.

**No dive on SCUBA will be conducted at any depth exceeding 180 fsw.**

No diver will enter the water to perform an actual search operation except:

- When operating in "Rescue" mode; or
- When accompanied by another diver; or
- When a safety diver is designated and suited, ready to enter the water immediately, if necessary.

In order to minimize exposure to decompression illness (DCI), which is inclusive of decompression sickness (DCS) and arterial gas embolism (AGE), it is highly recommended that upon completing a dive that divers adhere to the following:

- If feasible, extend the time of the 15–20-foot safety stop.
- Ensure that a slow ascent (20-30 fsw/min.) is made both from depth to the safety stop; and from the safety stop to the surface.
- Remain at the surface for several minutes, if feasible, prior to boarding the dive platform.
- Remove weights and cylinder in the water, if feasible, and hand them aboard the dive platform.
- Climb aboard the dive platform slowly. (Keep in mind that each rung on the swim-step ladder represents another foot of ascent).

- Avoid exercise or work (e.g., long surface swims, hauling anchors, etc.) immediately following a dive or between dives.
- Rest (but do not sleep) for a period of time following a dive and between dives.

The above recommendations are especially critical after making a lengthy dive, a dive deeper than 60 fsw, exertion (work) during a dive, or repetitive dives. These recommendations become more critical as a diver ages. There is ample evidence of divers suffering what are termed "undeserved hits" of DCS. Meaning that there is no readily apparent explanation for such to have occurred. It is theorized that following a dive, hurrying to get aboard a dive platform, or struggling with the weight of equipment while exiting the water onto the platform may increase the risk of both DCS and AGE for a diver.

## TASK LOADING

It is commonly understood that the simpler a task is, the better it can be accomplished. **Task loading** is the concept of performing more than one task simultaneously.

The greater the task load on an individual, and the more complex the tasks to be performed, the more inefficient they are at performing those tasks – unless they are thoroughly practiced. Excessive task loading is undesirable, but sometimes necessary in SAR diving operations. A diver conducting a search in dark water for a knife that is sought as evidence, must simultaneously handle their search reel, expand their search pattern, hold their dive light, keep the search line taut, maintain proper buoyancy, monitor their gauges, avoid fining up silt, keep track of their perimeter marker, etc. they may additionally be performing other tasks such as operating an underwater metal detector. Due to excessive task loading, it is recommended that divers be deployed in buddy pairs when operating such equipment as the metal detector, navigation board, etc.

Needless to say, a diver's performance under such conditions as described above is likely to be less than perfect.  Should something occur to complicate this process (e.g., entanglement, light failure, etc.) the diver's stress increases exponentially and performance is greatly degraded. This is the primary reason for the loss of such items as the perimeter marker during a search – too many things to do; too much to keep track of – excessive task loading. Task loading is best dealt with through continual practice of techniques until they become second nature. The more experience a diver has in multi-tasking operations, the more competent they will be to perform them. It is additionally the function of the divemaster to reduce task loading of dive personnel as much as reasonably possible through the configuration of diving teams or other assignment of diving personnel to support the operation.

# CHAPTER 13 BREATHING GASES

As a general rule, divers conducting operations for the Ventura County Sheriff's Office will do so utilizing air as their breathing gas. Air contains a volume of 20.98% (21%) oxygen. There are occasions however, where the nature of the search to be performed lends itself to the use of **Enriched Air Nitrox (EAN)** as a breathing medium ranging from in excess of 21% up to 40% oxygen. Aging SAR divers may find it advantageous to breathe EAN as opposed to air while underwater. EAN 32 (32% oxygen) and EAN 36 (36% oxygen) are commonly utilized nitrox mixtures. All divers are individually responsible for knowledge concerning the oxygen percentage of the gas mixture they are breathing.

Divers must hold a "Nitrox" certification from a recognized SCUBA training agency in order to use EAN on any SAR diving operation.

Prior to any dive, each diver is responsible for conducting an analysis of any EAN mixture in their cylinder, as well as advising the divemaster of the gas mixture that they will be breathing for that dive. The divemaster will record the cylinder pressure and gas mixture utilized by each diver for each dive as well as the percentage of oxygen in the cylinder for any breathing gas other than air.

## ADVANTAGES TO ENRICHED AIR NITROX (EAN)

There are advantages to the use of EAN for search and recovery operations occurring at depths between 40—130 fsw. The greatest benefits are found at depths of 40-80 fsw, with lesser benefits at depths of 80-130 fsw.

- When compared with air, breathing Nitrox results in less nitrogen being absorbed on any given dive, thus lessening the risk of decompression sickness (DCS).*
- Longer dive times are possible without decompression stops being required.
- Shorter surface intervals are possible.
- Repetitive dives can be longer.
- More efficient use of the breathing mixture.
- By reducing the percentage of nitrogen in the breathing gas, a margin of decompression safety is added for those divers using air tables or an air computer. Thus, the risk of DCS is reduced when EAN is utilized with air diving procedures in place.

    - NOTE: This benefit is not applicable when diving with a Nitrox computer or tables.
  - EAN may hold some value with respect to decreasing the effects of nitrogen narcosis.
  - The symptoms associated with sub-clinical DCS may be reduced. **

## DISADVANTAGES TO ENRICHED AIR NITROX (EAN)

There are also some significant disadvantages associated with the use of Enriched Air Nitrox (EAN) as a breathing mixture:

  - There exists a risk of oxygen toxicity at depths much shallower than would be encountered when breathing air.
  - Individual susceptibility to oxygen toxicity varies.
  - The observance of depth limits becomes critical with respect to the EAN mixture utilized.
  - Should a Nitrox diver develop DCS, there is a potential for oxygen toxicity of the lungs to develop.
  - Increased cost and decreased availability.

Divers are reminded that all gas mixtures are subject to limitations with respect to their utilization at various depths. Divers are responsible for knowing the depth limits for any breathing gas they utilize and conducting their activities accordingly. The penalties for violating depth limits can result in Oxygen Toxicity with potentially severe results.

## TYPES OF OXYGEN TOXICITY

There are two types of Oxygen Toxicity:

  1. Chronic Oxygen Toxicity
  2. Central Nervous System (CNS) Toxicity (Paul Bert Effect)

### CHRONIC OXYGEN TOXICITY

**Chronic Oxygen Toxicity**, also referred to as **Pulmonary Toxicity, Whole Body Toxicity, or Lorraine Smith Effect**, manifests itself after prolonged exposure (12 hours or more) to relatively low to moderate **partial oxygen pressures (PO2).** Chronic Toxicity is of little concern to the SAR diver. Even in extremely long and deep dives, it is difficult to expose oneself long enough for Chronic Toxicity to become an issue. It is of concern primarily to saturation divers. It is, in effect, impossible for divers utilizing open circuit SCUBA to accumulate a high enough PO2 for Chronic Toxicity to be of concern. Signs and symptoms of Chronic Oxygen Toxicity include:

- Painful breathing and cough
- Shortness of breath
- Diminished aerobic capacity
- Numbness in the fingertips and toes
- Headache
- Nausea
- Dizziness
- Visual problems

## CENTRAL NERVOUS SYSTEM (CNS) TOXICITY (PAUL BERT EFFECT)

**Central Nervous System (CNS) Toxicity**, sometimes referred to as **Paul Bert Effect**, can occur following exposure to high oxygen PO2 of 1.5 ATA or above. There is a wide variance in susceptibility to CNS Toxicity from person-to-person and even from day-to day in the same person. There is a considerable decrease in an individual's oxygen tolerance when underwater submergence and physical exertion are involved. CNS Toxicity must be tracked on every dive wherein the diver either utilizes a breathing medium other than air, or mixes their breathing gases (IE: utilizing Nitrox for one dive and air for another). It is important that divers utilizing EAN be able to recognize the symptoms of CNS Toxicity in themselves, as well as others. Signs and symptoms of CNS Oxygen Toxicity include:

- Tingling and muscular twitching and spasm involving primarily the eyelids, face, and lips
- Visual disturbances (tunnel vision, blurry vision, or spots in vision)
- Dizziness
- Tinnitus (ringing in the ears)
- Mood swings ranging from euphoria to irritability
- Breathing difficulty
- Poor coordination
- Anxiety and confusion
- Fatigue
- Nausea and vomiting
- Convulsions

- Coma

While the above signs and symptoms of CNS Toxicity have been reported, more often than not the first and only symptom to appear is akin to grand-mal seizure, which if occurring underwater, and unattended, will surely result in fatality. The chance of CNS Toxicity occurring increases with exposure time, cold water, exertion, and increased O2 levels in the blood.

**Equivalent air depth tables (EAD)** are based solely upon the mathematics of gas fraction. In comparison with air, Enriched Air Nitrox (EAN) reduces decompression stress, however individual physiological responses are not precise. Due to this, a conservative approach to any decompression schedule is warranted. It is a common misconception that EAN is a breathing gas appropriate for deep diving. It is not.

Divers are responsible for adhering to depth limitations applicable to the breathing mixture they are utilizing. Oxygen exposure limits are to be observed at a maximum of 1.6 ATA with a preference for a lower oxygen exposure. For example: The partial pressure of oxygen with EAN 32 is 1.6 at 132 fsw; the PO2 with EAN 36 is 1.6 at 114 fsw. These are absolute maximum depths for these EAN mixtures – there is no variance, as beyond these respective depths, these EAN mixtures become toxic. Air is considered to begin to be toxic at a depth of 215 fsw; and absolutely toxic at 300 fsw.

Divers involved in strenuous physical activity either shortly prior to submergence (e.g., swimming against strong current) or while underwater (performing physical work, swimming against current, etc.) should avoid partial pressures of oxygen greater than 1.4 ATA. 1.4 ATA is reached at a depth of 111 fsw with EAN32 and 95 fsw with EAN 36, and 187 fsw with air. Divers at rest underwater (IE: during decompression) should avoid partial pressures of oxygen greater than 1.6 ATA.

EAN will not be utilized as a breathing medium in any instance where a diver could inadvertently dive deeper than planned and permitted by the EAN tables. Such instances are inclusive of low/no visibility water, in that a diver may not be able to read their depth gauge to determine how deep they is.

EAN will not be utilized as a breathing mixture in any pony bottle; or sling bottle carried by a safety diver. Any SCUBA cylinder to be utilized as an emergency air source must be safe for breathing at any depth that might be encountered during an underwater search. A pony bottle or sling bottle containing a Nitrox mixture negates the use of that bottle as an emergency air source at any depth beyond the rated depth of the gas mixture.

**NOTE: Medical research published in 2016 by the University of Medicine in Berlin details a definite benefit of Nitrox use by scuba divers. A double-blind crossover randomized trial has proved that breathing enriched air nitrox reduces venous gas bubbles after simulated scuba diving. The conclusion was that breathing EAN reduces venous gas bubble emboli and, avoiding oxygen toxicity limits, EAN increases safety when compared to breathing compressed air.*

*** NOTE: It has been medically determined that many divers utilizing air are likely to suffer subclinical DCS on a regular basis. Subclinical DCS does not require medical treatment. Symptoms are inclusive of any of the following:*

- *Mild fatigue.*
- *Muscle soreness.*
- *Headache.*
- *Unexplained aches and pains.*

## CHAPTER 14 OVERHEAD ENVIRONMENTS

What is known in the diving community as an overhead environment (caves and caverns) draws many people who hunt, explore, or merely inadvertently enter such an environment and get into trouble. These can include, in addition to SCUBA divers, swimmers, snorkelers, kayakers, and boaters. Occasionally people get into trouble in the cave systems on the islands of Anacapa and San Nicholas, which are located within the jurisdictional boundaries of Ventura County. Our SAR team will additionally respond to Santa Cruz Island at the request of the Santa Barbara County Sheriff's Department.

Diving in an overhead environment poses potential hazards and problems not encountered in open water. Many people, both divers and non-divers, loose their lives each year in aquatic overhead environments. The entry of any overhead environment requires specific planning, specialized equipment, and appropriate training,

In addition to natural overhead environments as described above, pipelines, sunken vessels, automobiles, busses, and aircraft pose similar problems with some additional complications.

The following procedures should be followed when diving an overhead environment:

- Whenever practicable, a continuous guideline will be run into the cave or cavern. This requirement also applies to sizeable vessels. A braided nylon line of small diameter is recommended (e.g., #24). The line must be secured at the entrance and regularly secured along the route to keep it taut.
- The guideline should be affixed at one side of the cave in as much as the water flow through a cave tends to be strongest in the center and slack along the walls. (Similar to the laminar / helical flow of water in a river.) The guideline should be placed in order that divers swim above, and to one side of it. It is not necessary for divers to maintain direct physical contact with the line; in fact, in most instances this is inadvisable. However, divers must remain within arm's reach of the guideline in order that the line can be quickly obtained should a light failure or silt-out occur.

- A guideline should never be run along the ceiling of any overhead environment in as much as doing so not only promotes entanglements of diver's equipment, but also is difficult to follow. Polypropylene line is not recommended for use in overhead environments due to its buoyant qualities.
- It must be recognized, that in conditions of heavy surge, the handling and placement of a guideline may expose divers to excessive danger of entanglement due to slack line. In such instances, use of a guideline is not recommended.
- Consideration must be given in the planning stage of a dive into any overhead environment of the distance to be covered and the breathing gas demands of diver(s). Redundant breathing systems must be "staged" throughout the environment upon the entry and movement through the environment as appropriate.
- When diving a sizeable overhead environment, divers will observe the "rule of thirds" with regard to breathing gas supply: 1/3 of the gas supply will be utilized to penetrate the overhead system; 2/3 will be utilized to exit the system (1/3 for return to the entrance, and an additional 1/3 for unanticipated contingency and return to the surface).
- Needless to say, there is a loss of ambient light in any overhead environment, Divers will carry at minimum, two lights (one primary / one back-up) – three lights are recommended (one primary / two back-ups).
- Divers should carry a spare mask when diving an overhead environment.
- Overhead environments may present a danger of entanglement not encountered in open water. Divers will have at minimum, two sharp cutting instruments (IE: sharp knife, line cutter, EMT shears, etc.).
- All equipment (gauges, consoles, octopus regulators, etc.) must be streamlined with the body in order to avoid snags and entanglements. Spare lights, tools, etc. must not be allowed to dangle, fin and mask straps should be taped down; snorkels removed and stowed. Inflator / exhaust hoses must not be allowed to float above the diver's head, nor dangle beneath their torso.
- Obviously, once an overhead environment is penetrated, direct surface access is eliminated. Divers should strongly consider carrying a redundant air source (pony bottle and regulator).

There are significant dangers raised by diving in an overhead environment that are not concerns in open water:

- In caves, disturbed silt and fine sediment can significantly reduce visibility and even result in a total blackout causing confusion and disorientation.
- Divers must move efficiently utilizing proper fining and buoyancy control techniques in order to minimize "silt-out".
- Bubbles from regulators can disturb silt and debris on the ceilings of caves reducing visibility to a matter of inches.
- Heavy surge causes significant danger in caves and caverns. In addition to unwanted movement of the diver caused by surge, should a diver surface in an air pocket and stick their head out of the water, the pressure created by the surge of water movement through the cave could potentially burst their eardrums.
- Gas pockets that form in the air pockets of some caves may be toxic. There may not be enough oxygen in an air pocket to sustain life. It is impossible to detect this condition. Should a diver surface into such an air pocket, remove the regulator from their mouth and inhale the ambient air, they would pass out, settle to the bottom and drown.
- In case of submerged automobiles, aircraft or vessels, jagged metal and broken glass present a potential for injury to divers and damage to equipment; loose wiring presents an entanglement hazard.
- On sizeable submerged structures, divers should consider carrying a glass-breaking tool (e.g., sledge or salvage hammer, etc.) along with a pry tool (e.g., crowbar, large knife, etc.). It is possible that a heavy-duty Abalone Iron, or a crow bar will serve both purposes.
- On aircraft, pneumatic, or electric and explosive devices can pose hazards to divers (e.g., ejection seats on military aircraft).
- In the case of any mechanical device constituting an overhead environment, biohazards such as fuels may be present.
- Penetrations into pipelines pose potential hazards such as chemical or bacterial contamination, rusty metal, broken concrete, etc. Rate of flow through the pipe must be considered as well as the potential for increased flow due to rain, opening floodgates, etc. If possible, flow is to be cut-off and "tagged out" prior to SAR divers entering the water.

Body recoveries in overhead environments can pose a difficult task:

- Scuba divers who have ditched their weights may be found against the ceiling of a cave, etc.
- Decomposing bodies will be positively buoyant and likewise found against the ceiling.

- In either case, it will be necessary to weight the victim to counteract positive buoyancy in order to affect the recovery.

When diving overhead environments, divers should endeavor to:

- Kick as little as possible. In extremely silted areas it may be more efficient to swim with the hands, pulling oneself through the water, as opposed to kicking.
- Maintain a level or slightly inverted (head down / feet up) swimming position. Keeping the feet higher than the rest of the body reduces fin turbulence at the bottom to reduce silting.
- Maintain proper buoyancy and trim.
- Keep the guideline in sight and remain within an arm's length of the line. If necessary to stray from the guideline, a gap reel (small search reel) or finger spool) must be utilized as a safety.

SAR operations in overhead environments can pose significant risks, however these are manageable if adequate planning takes place, proper equipment is utilized, proper safety procedures are followed, and good judgment is utilized.

# CHAPTER 15 DIVER ENTRAPMENT

Underwater entrapment is unquestionably the most dangerous and frightening condition presented to the SAR diver. Entrapment can result from entanglement as a result of being caught up in a myriad of underwater hazards (e.g., fishing line, wire, tree branches, search line(s), etc.); from inability to reach the surface due to an overhead obstruction; as a result of being caught in a constriction; or from being held in position by current against a siphon or drain pipe, etc. The problems associated with underwater entrapment are intensified by loss of visibility due to silt-out within the diving environment.

Regardless of the circumstances that cause the entrapment, unless the diver is able to either escape of their own accord, or be assisted by another diver, the result is invariably the same: either panic by the entrapped diver resulting in their spitting out their regulator, swallowing water and drowning, or an eventual depletion of air supply followed by drowning.

Fortunately, most of our entrapment situations amount to entanglements (sometimes referred to as line entrapments). Entanglements can be dangerous, although more often than not are merely annoying. It is not out of the realm of possibility for an entanglement to distract a diver, and in their effort to free himself lead to other, more serious problems. For this reason, it is critical that a diver snap their search line to a D-ring on their BCD or harness, lest they lose a handhold and become separated from their search line resulting in an extremely difficult, if not impossible, rescue effort.

In an effort to prevent injury / death of dive personnel encountering an entrapment situation, the following procedures are to be followed:

## PREPARING FOR AN ENTANGLED DIVER SEARCH

Each diver going on a search for an entangled diver should bring the following equipment:

- A search line and reel (tether) attached to the chain of the diver's ascending / descending line (or alternatively to a tender) at one end; and clipped to the diver's BCD or harness at the other.

    - On searches performed without a search line (e.g., a compass pattern) depending on visibility encountered, divers will use a buddy-line(s) as necessary to maintain contact.
- Sharp knife (at least one) for cutting line; and side cutters for cutting wire.
- Full Face Mask with underwater communication device. (Except where deemed inappropriate to the mission).
- Pony Bottle (minimum 13 cu. ft.) as a temporary emergency air supply. (Except where deemed inappropriate to the mission).
- SMB consisting of a small yellow colored personal floatation device and a "finger spool" carried on the diver's person to be deployed in the event that assistance is needed from topside and voice communications are inoperable or not being utilized.

## WHAT TO DO WITH AN ENTAGLEMENT

Upon encountering an entanglement, a diver should:

- Stop and ensure slow, controlled, breathing in order to slow the heart rate, assist in a clear thought process, and conserve breathing gas.
- Think about where they are likely "hung up", what might be causing the entanglement, and what will likely free the entanglement.
- Endeavor to determine (by feel) the location and cause of the entanglement.
- Endeavor to free himself and/or their equipment from the entanglement.

Divers are to avoid:

- Turning or twisting in position in order to see or feel the cause of the entanglement as this can result in the occurrence of a more severe entanglement situation.
- Cutting any line that cannot be seen or felt or is not known to be the source of the entanglement, lest the diver's own search line be cut, creating a location problem for the safety diver(s) and frustrating rescue efforts; or conversely cutting a regulator hose and depleting the air supply.

Should an entangled diver be unable to free an entanglement, they will:

1. Advise the topside communications operator that they have an entanglement emergency necessitating assistance.
2. Verbally advise the communications operator.

3. Should the diver have reason to believe that their verbal communication to topside has not been received or understood, they will DEPLOY A DSMB as a secondary signal (except in an overhead environment).
4. Depending on water conditions, the DSMB can be released with the line affixed to the diver, or alternatively released with the line intact. Conditions that might affect this decision are such factors as depth, strong current, nature of the underwater environment, nature of the entanglement, etc.
5. Remain as still as possible in order to conserve air and facilitate the best possible visibility for responding safety diver(s).
6. If the primary air source is depleted, the diver should advise the topside comm. operator that they are switching to emergency air, activate the valve on the pony bottle, and breathe from the redundant air supply.

## PREPARING FOR AN ENTRAPPED DIVER SEARCH

Each diver going on a search for an entrapped diver should bring the following equipment:

- A "Safety Clip" to be affixed to the entangled diver's search line by the safety diver affecting the rescue in order to assist in hands-free location and disentanglement of the entrapped diver
  - The safety clip should consist of two carabiners (or one carabineer and a gate snap) fastened together by a length of 1-inch nylon webbing or cord, approximately 8-12 inches long containing at least one quick release device to allow the safety diver to immediately free himself from the tether line should it become necessary or desirable to do so
  - One of the carabineers (or the gate snap) on the safety clip is attached to a D-ring on the safety diver's harness or BCD; the other to the entrapped diver's search line (tether)
- Sharp knife and side cutters
- Buddy Line
- Safety Cylinder: minimum 30 cu. ft. with a redundant regulator and stage bottle strap attached
- Additional air cylinders / regulators of varying capacities can be shuttled to the safety diver(s) by supplementary dive personnel as necessary

## THE ROLE OF SAFETY DIVERS

Prior to a diver entering the water on a search operation, or training problem, if entrapment is a possibility, at least one safety diver shall be suited up and standing by, prepared to enter the water should it become necessary to do so.

### PRIMARY SAFETY DIVER

- Shall be fully suited, placed at the water's edge, and ready to respond except that the FFM or face mask can be held (as opposed to worn) and the hood can be pulled off the head.
- Shall be in possession of a sharp knife (at least one), side cutters, buddy line, and safety clip.
- Upon being deployed to assist an entrapped diver, the primary safety diver will descend on the entrapped diver's ascending / descending line, and upon locating the diver's search line shall attach one end of the safety clip to this tether, the other to a D-ring on their harness or BCD.
- In the event that the entrapped diver is very near to the ascending / descending line and anchor, the safety diver can alternatively clip the safety clip onto the ascending / descending line.
- The primary safety diver is responsible for locating the entrapped diver, determining the cause and location of the entanglement, and freeing the diver.
- The primary safety diver should leave their safety clip affixed to the entrapped diver's tether line, if possible, and endeavor to work to free the entanglement while affixed to the line in order to avoid losing contact with either the entrapped diver or the ascent line to the surface.
- In the event that it is necessary / desirable for the primary safety diver to disconnect from the tether in order to free an entanglement, they may do so by either removing the carabiner attached to the tether line, or disconnecting the quick release on the safety clip. However, the primary safety diver must maintain physical contact with the entrapped diver until the entanglement is removed and the entangled diver successfully rescued.
- Upon freeing a diver from an entanglement, the primary safety diver must systematically check the diver's person and equipment for additional entanglement points prior to causing any movement toward recovery.

- In the event that the primary safety diver is unable to free the entangled diver, they will await the arrival of the secondary safety diver. Upon the arrival of the secondary safety diver, the primary safety diver will ensure that the entangled diver has a continuous air supply available and will then remove the entangled diver's equipment as necessary in order to facilitate escape from the entanglement.
- Prior to recovering the entangled diver, the primary safety diver will be responsible for unclipping the diver from their search line and "planting" the search reel in the sand or silt.
- Depending upon water conditions, the nature of the entrapment, visibility, etc., the primary safety diver may decide to attach a buddy line to the entangled diver to ensure that the divers do not become separated during the rescue process. The primary safety diver shall maintain constant contact (visual or tactile) and control of the ascent of the rescued diver.
- The primary safety diver will guide the rescued diver on an ascent to the surface. In so far as is possible, the rescued diver's search line and ascending / descending line should be followed, and required safety stop(s) made.
- In the event that the freeing of an entangled diver should become a lengthy endeavor, the primary safety diver must be cognizant of both the rescued diver's bottom time, as well as their own and ensure that decompression procedures are followed according to the both diver's computers or the dive tables.

## SECONDARY SAFETY DIVER

- Depending upon the complexity of the entanglement and rescue of an entrapped diver, it may be necessary to assign a secondary safety diver to the problem.
- A secondary safety diver will be designated and deployed in conjunction with the primary safety diver's response when:
- Requested by the primary safety diver, or
- Assigned by the divemaster.
- The secondary safety diver will be responsible for transporting an additional air cylinder to the entrapped diver in order to assure a continuous air supply during the process of freeing the entanglement and recovery of the diver.

- The safety cylinder should be affixed to the secondary diver by means of a "side mounted" stage bottle strap affixed to D-rings located at the shoulder area and waist of the diver.
- The safety cylinder can be released from the safety diver, if desirable, and attached to similarly located D-rings on the rescued diver.
- The secondary safety diver shall also possess a safety clip to be affixed to the entangled diver's tether line. Upon reaching the entangled diver, and/or the primary safety diver underwater, the secondary diver may disconnect their safety clip from the tether line, but must maintain constant physical contact with the entrapped diver.
- The secondary safety diver should take a position near the head of, and facing the entrapped diver in order to ensure that the primary safety diver does not confuse the equipment of the secondary diver with that of the entrapped diver.
- In the event that the primary safety diver is unable to free the entanglement, the secondary safety diver will assure a continuous air supply to the entangled diver until such time as the primary safety diver can remove the entangled diver's equipment and an ascent be initiated.
- It is the secondary safety diver's responsibility to call for additional air cylinders as needed to be shuttled from the surface, or alternatively to shuttle air cylinders himself.

## SUPPORTING SAFETY DIVERS

### Staged Air

Depending upon the bottom times of the divers involved in an entrapment rescue, the divemaster may cause additional air cylinder(s) to be staged on the ascending / descending line at appropriate depth intervals.

### Searching Divers

Upon hearing a distress message from another diver, all divers involved in a search will "plant" their search reels and return to the surface for the purpose of roll call and redeployment in conjunction with the emergency situation.

**Tending of Safety Divers**

Safety divers in "stand-by" mode on the surface are in extreme danger of dehydration and possible heat stroke. Provisions must be made to attend to the comfort of these divers during the pre-deployment phase. In so far as is possible and reasonable, the safety diver(s) should be seated in the shade, near the water, with cooling provisions (e.g., water bucket) and drinking water available.

# CHAPTER 16 FITNESS TO DIVE

SAR diving is a demanding endeavor, both physically and psychologically. Some operations are physically demanding and strenuous (e.g., surf operations, cliff operations, diving against a current, etc.) other operations are emotionally demanding (e.g., the search for a drowned child). Still other operations can be both physically and emotionally demanding. It is critical that divers be physically fit and mentally prepared to meet the demands placed upon them by the very nature of a SAR operation.

In all cases, the decision with respect to a given diver's physical and/or mental condition and the suitability thereof for participation in a given operation rests with the individual diver. It is the diver's right and responsibility to decline to make a dive if, in their own judgment, conditions are unsafe for him or their teammates due to their present physical / mental condition or beyond the scope of their training, experience, and capabilities. This does not mean, however, that a diver cannot be prohibited from participating in certain aspects of a given operation or an entire operation, should the divemaster, team captain, team physician, or other SAR official determine that it is in the best interests of the individual and/or the team to stand him down.

## CONDITIONS THAT PREVENT DIVING

Dive team personnel are on-call on a 24-hour basis. Due to a variety of factors, a given diver may not be physically qualified to participate in an underwater search effort. It makes absolutely no sense to send an additional potential victim to a Search and Rescue operation. The following should be considered as prohibitive for diving:

- Illness (e.g., Influenza, head/chest cold, allergic reaction, etc.)
- Significant injury
- Alcohol consumption
- Drug influence
- Fatigue

That is not to say however, that such a team member cannot be of value to the team by performing topside duties and contribute to the effort in other ways (e.g., assist in readying team equipment, assist divers in gearing up or in transport of their equipment, operation of watercraft, etc.).

Upon reporting for any dive operation, and likewise at the start of any dive team training exercise, the diver will report any existing physical problems to the divemaster and/or team physician. Following a dive or series of dives, should a diver suffer any injury or adverse physical effects, such shall be immediately reported to the divemaster and/or team physician.

SAR diving in and of itself is stressful and if emotionally upset or distracted by unrelated events (e.g., family problems, work problems, etc.) a diver is well advised to decline to make a dive. Divers must analyze their own motivations concerning an operation as well as those of their teammates. It is imperative that each diver be able to accurately assess their own capabilities and limitations.

*As the saying goes: "There are old divers, and there are bold divers, but there are no old, bold divers."*

A diver must possess enough self-confidence to decline to make a dive or even abort a dive if they feel uncomfortable concerning their ability to perform as needed on an operation. they must then possess the fortitude to advise the divemaster of this fact in order that their area of search responsibility can be re-assigned to another diver and the search efficiently completed.

## STRESS

There are a variety of circumstances that can cause stress to a diver on any given operation:

- Physical Stress – The equipment carried by a SAR diver (e.g., cylinder(s), weights, BCD, Mini-Mother and anchor, search reels, tools, etc.) accounts for a considerable amount of physical energy expended in just getting to the water. Additionally, this equipment will cause hydrodynamic drag, which must be overcome by propulsion. This equates to considerable exertion, which may lead to varying stages of fatigue.
- The Effects of Cold – The human body loses heat much more rapidly in water than in air due to the high thermal conductivity of water. As the body loses heat, the narrowing of peripheral blood vessels intensifies (peripheral vasoconstriction). This results in a greater amount of blood being sent to the heart which in turn, causes the heart to pump more blood. Constriction of the small arteries of the body increases the resistance of blood flowing through the periphery of the body which raises

the blood pressure. Thus, the heart must exert itself more to maintain an adequate flow of blood throughout the body.

- The Effects of Pressure – Breathing gas under pressure affects the heart and circulatory system. Increased levels of oxygen ($O_2$) cause vasoconstriction, increases blood pressure and reduces both heart rate and heart output. Increased levels of carbon dioxide ($CO_2$) which may accumulate in the body of a working diver, can increase blood flow to the brain which can speed up oxygen toxicity if breathing a gas mix with an elevated level of $O_2$ (e.g., Nitrox, Trimix, etc.).
- Task Loading – There are a significant number of both physical and mental tasks that must be performed by a diver involved in an underwater search (e.g., maintaining/adjusting buoyancy, maintaining proper trim, tracking depth and air consumption, searching for an object, expanding the search pattern, handling a light, tools, etc.) The more functions that must be performed by a diver, the greater the stress. Excessive task loading increases stress and thus promotes inefficiency.
- Absence of Vision – Human beings rely upon their eyesight for the vast majority of environmental information that they mentally process. Eyesight is supplemented by the senses of hearing, smell, taste and touch. Underwater, hearing (except for electronic voice communications), and smell and taste are for all practical purposes non-functional. In low / no visibility water, touch is the only sense left to reliably serve the diver, and even this sense is hampered by cold water and the wearing of protective gloves. In those prone to claustrophobia, this can be stressful to the point that it renders an individual either paralyzed and helpless, or prone to panic.
- Emotional Stress – The nature of a SAR diving operation may cause a great deal of mental stress for a diver (e.g., the search for a drowned child).

Virtually all personnel involved in an operation of this nature will experience some degree of mental anguish, which may be more noticeably pronounced in some.

Stress is a two-edged sword. While it serves to provide stimulation to keep one aware and appropriately responsive to the environment, it can also overpower an individual resulting in disaster. Stress does not present itself as a sudden phenomenon, but rather as a continuous variable that increases gradually.

## SYMPTOMS OF STRESS

There are many indicators of stress in a diver. SAR divers must learn to recognize these signs both in themselves and in others. While any one, or even a few of the below signs are not conclusive for the presence of stress, more than a few should raise a "red flag":

- Apprehension (e.g., a feeling of insecurity concerning an operation or some aspect thereof)
- Rapid breathing (rapid, shallow breathing results in poor oxygenation of the body tissues as well as carbon dioxide build-up)
- Increased pulse rate
- Irritability, unreasonableness
- "Wild-eyed" appearance
- Inability to concentrate (e.g., talking when they should be listening).
- Inappropriate comments (e.g., "dark humor", inappropriate jokes, or comments that seem not to apply to the operation at hand)
- A "white knuckle" grip
- Fixation. Intense concentration on one object to the exclusion of others (e.g., closely monitoring gauges)
- Repetitive behavior (e.g., checking the status of the air supply several times)
- A feeling of being rushed (the more "hurrieder" you go – the more "behinder" you get)
- Stalling (e.g., tinkering with equipment, taking excessive time to set up equipment, lagging in preparing to enter the water)
- Clumsiness (e.g., dropping gear, tripping over objects, etc.)
- Rapid, jerky, disjointed movements
- Frustration with some aspect of the operation, or piece of equipment (e.g., "fiddling around with a piece of equipment, appearance of irritation or annoyance concerning some aspect of the operation or equipment)
- Imaginary problems (e.g., gear issues, ear clearing problems, etc.)
- Contact maintenance (e.g., clinging to some piece of equipment or apparatus such as boarding ladder, anchor line, etc.)
- High treading in an effort to keep the head above water
- Escape behavior (e.g., swimming rapidly toward the surface, toward the boat, or the exit of a cave, etc.)
- The feeling of being cold

## IMPACTS OF STRESS ON THE BODY

Divers subjected to high stress levels will likely think and perform differently than what might normally be anticipated or expected. Man is adapted to deal with stress as a land animal – they are ill prepared to deal with stresses underwater. Higher levels of stress result in the following manifestations, which are uncontrollable and of critical concern to the SAR diver:

- **Diminished fine and complex motor skills**
  - Manual dexterity becomes adversely affected as does the thought process involved in being able to perform tasks requiring fine manipulations of the fingers (e.g., the removal of tangled fishing line from equipment, the ability to open a folding knife, etc.). The fingers may actually tremble. This is due to an increase in arterial blood pressure and pulse rate which results in increased blood flow to the large muscles of the body, and diminished blood flow to the small muscles. As an example, people involved in automobile accidents are many times unable to perform the simple act of unlatching a seat belt to extricate themselves from the vehicle – they have not forgotten how to unlatch the belt – their fingers and hands simply won't cooperate with their brains in performing this simple manipulation.
- **Dilation of the pupils of the eye resulting in an inability to focus on near objects**
  - This means that in an effort to untangle fishing line with uncooperative fingers, a diver may not be able to see the line – even when visibility allows it and they is looking right at it.
- **Loss of eye-hand coordination**
  - An inability to perform what previously was a simple task (e.g., the tying or untying of a knot).
- **Degraded mental ability**
  - Cognitive processing is extremely efficient in non-stress situations. However, under stress, higher brain function in the cerebral cortex deteriorates resulting in an extremely slow response to danger. Normal intellectual processes become unattainable. Thinking is impaired and decisions are likely to be faulty. The mind defaults to its most primitive response. This explains diver panic. In many instances, out of air divers will bolt for the surface rather than endeavoring to obtain air from another source. Even divers who are

sharing air with a buddy or breathing air from their own cylinder have been known to suddenly drop the regulator from their mouth and bolt for the surface – primitive stress response.

- **Intrusive thoughts**
  - An occurrence of thoughts not immediately relevant to the current situation. Thoughts of one's family, some future event, or a past event that reminds one of the present events.
- **Dissociation**
  - A strange sense of detachment may occur. A life-threatening event may be viewed as a dream, as if watching an event unfold from outside one's body. This is commonly referred to as a "near death" experience.
- **Degradation of echoic memory**
  - An inability to control memory function with respect to the order of occurrence of stressful events. Memory is dependent upon the ability to focus upon a situation or event. Intense focus upon a particular aspect of an event can result in vivid memory of some details and diminished or even total loss of memory concerning others. The more intense the stressful encounter, the greater the impact on memory. The mind has two memory systems:

## IMPACT OF STRESS ON MEMORY AND LEARNING

**Types of Memory**

- **Declarative Memory** has to do with the recall of facts and events. This is what is usually considered to be memory.
- **Non-Declarative Memory** has to do with skills, abilities, habits and reflex actions. This is knowledge that is performance based as opposed to recall based (e.g., riding a bike, clearing a regulator, etc.). Non-declarative memory is what the mind relies upon in extremely stressful situations. This is why emergency procedures (IE: weight ditching, regulator clearing, etc.) need to be practiced until they are reflexive. This is also why so many divers fail to ditch weights in emergency situations – the skill is not reflexive.

In high stress situations, progressive unlearning takes place. That is, those skills and techniques that were most recently learned, as well as those learned that were practiced least, will be the first to be forgotten. Under exposure to high stress, declarative memory becomes non-functional. This explains the phenomenon of divers being found drowned with their weight belts in place. Even though they were "taught" (translation: "told") early in their SCUBA training to ditch the weight belt in an emergency – they are unable to accomplish this simple act under stress. They have not repeatedly practiced this skill to the extent that it has become etched in their non-declarative memory and thus relied upon as a reflexive response.

It is critical that stress be managed in order to ensure the safety of all dive personnel involved in an operation. Most people are able to adequately manage low to moderate levels of stress in their daily lives in fact, some degree of stress in our lives is necessary to offset the tedious and mundane aspects of everyday life.

## THE FIVE STAGES OF STRESS

Higher levels of stress however tend to trigger a five-stage progressive reaction which must be interrupted if the diver is to survive a stressful underwater experience:

**Stage 1 – Fight or Flight:**

The human being is hardwired through thousands of years of evolution to respond in one of two modes to the presence of a threatening stimulus.

- **Fight** involves the direction of challenging behavior toward the stressor. The fight response, if logical, is the best approach to an underwater stressor. As the mind becomes acutely aware of the problem and adrenaline and noradrenaline are released into the bloodstream, the heart rate increases and thusly results in an increase in breathing rate. This is an obvious problem for a diver in that they has a finite air supply. By limiting the effects of this stage of stress, progression into the later stages can be short-circuited. This is accomplished by stopping and consciously slowing the breathing rate. Slow deep breathing has a relaxing effect and will assist in identifying the problem and arriving at a resolution.
- **Flight** involves moving rapidly away from the threatening stimulus in a direction of safety. There are appropriate circumstances in the underwater environment for controlled flight (e.g., free-swimming ascent, emergency buoyant ascent, etc.). It must be realized however that flight in the underwater environment must be consciously controlled in order for the diver to avoid injury or possibly even death.

**Stage 2 – Perceptual Narrowing (Tunnel Vision):**

- Intense concentration on the stressor to the exclusion of other stimuli. The higher the stress, the more pronounced tunnel vision will become and the narrower the field of vision. This is dangerous in that other hazards or stimulus may not be recognized (e.g., additional entanglement points, a safety diver coming to assist, etc.) The deeper the dive, the more pronounced perceptual narrowing is likely to be.

**Stage 3 – Cognitive Incompetence:**

- An inability to correctly identify, analyze, and solve the problem. The brain races to identify the solution to the situation, but the solution is not forthcoming.

**Stage 4 – Response Inadequacy:**

- An inability to focus acquired skills and knowledge to resolve the problem.

**Stage 5 – Panic:**

- An overwhelming reaction of the mind and body to the fright that is brought on by what the mind interprets to be an extreme stressor. Fright must be avoided in that it invariably leads to panic, which in turn results in poor decisions, poor response, and a high likelihood of death. **Panic is the culprit in most diving deaths.** Panic can occur when a diver is presented with a situation with which they is mentally and physically unprepared to cope. Irrespective of the stress that a diver is subjected to, panic must be avoided – panic is a killer.

Panic can manifest in one of two ways:

- <u>Desperate Flight:</u> An uncoordinated all-out effort to separate from the stressor.
- <u>Hypervigilance:</u> Freezing in place and the inability to respond to the stressor as the brain "races" and "slips gears" in a frantic effort to identify a solution that cannot be determined.

Panic will cause an individual to act instinctively, as opposed to logically and intelligently. In panic, a diver may swim rapidly toward the surface to get to air - even though they have an ample supply of breathing gas in their cylinder. There have been witnessed occurrences of divers swimming frantically toward the surface and later found drowned with air remaining in their cylinders, empty BCDs, and weight belts in place.

There exists a basic primal instinctive reaction in man to open the mouth in order to facilitate breathing in high stress, panic inducing situations – in spite of the logic of keeping the lips and mouth closed around the regulator mouthpiece. When panic takes control, there is an overwhelming feeling of suffocation – one simply cannot get adequate air. This explains many drowned SCUBA divers being found with the regulator out of their mouths and air remaining in their cylinders.

Research conducted by Drs. David and Lynn Colvard in 2003 examined 12,000 diving accidents indicates that pre-existing anxiety or stress combines with an unanticipated, stressful event resulting in panic. Divers studied were of various experience levels, from relatively new to very experienced. Virtually all of the panicked divers studied were anxious prior to entering the water. Thus, anxiety combined with an unanticipated underwater event tends to result in panic irrespective of diver experience.

**Probably the most critical attributes of a SAR diver are intelligence, good judgment, and a "cool head".** These are closely followed by such factors as skill, knowledge, experience, and possession of proper equipment. Good judgment dictates that when stressed beyond their threshold, a diver decline to make a dive, or discontinue a dive. In some cases of high stress exposure, a leave of absence or modification of team duties may be in order.

## TECHNIQUES FOR MANAGING STRESS

Divers can be conditioned to cope with stress likely to be encountered on an underwater operation. Many instructors hold the belief that "You will perform like you train." This is true to the extent that training is realistic; that the training provides stress comparable to that which will be encountered in reality; that the skills taught are pertinent to those likely to be needed; and that those skills are frequently refreshed.

The human body responds both physically and psychologically to stress. While stress cannot be eliminated, and while it is impossible to totally control the body's response to stress; both the physical and psychological responses can be managed to some degree. It is crucial that a diver be able to quickly break the escalating stress cycle in order to avoid panic. The SAR diver must develop skills and abilities as well as a mindset to enable him to work through fear that can arise when they is out of their ‘comfort zone.”

Techniques for managing stress are as follows and all must be employed in order for the diver to adequately respond to a stressful underwater situation:

- Training must be realistic and on-going. Divers must be exposed to likely stressors during training. Techniques developed for dealing with anticipated stressful situations must be simple – complex techniques cannot be accomplished when operating under high levels of stress.
- Cardio-vascular conditioning will permit the body to operate efficiently at higher stress levels. Regular aerobic exercise (e.g., running, swimming, cycling, jogging, rapid walking, etc.) elevates the heart rate and will have a dramatic influence upon the body to survive and recover from high stress events.
- Breathing control by means of slow, inhalations and exhalations with pauses between each has a dramatic effect on the heart rate and can slow it considerably allowing for enhanced performance, logical thought, and better problem solving. This is a technique employed by combat warriors, professional athletes, martial artists, yoga practitioners, etc. Coincidentally, this is the breathing technique that is recommended for divers breathing on SCUBA.
- Confidence in diving abilities results in a mental state void of fear, anxiety, and self-doubt. Confidence is acquired through exposure to situations likely to be encountered. When unprepared to deal with a stressful situation, (Translation: when not being trained to respond to likely scenarios) divers are much more prone to experience high levels of stress, fear, and panic. However, confidence can be a two-edged sword. Unwarranted over-confidence in one’s abilities can lead to faulty decisions and expose a diver and their teammates to unnecessary danger.
- Dive skills must be practiced conscientiously and frequently. Divers who have not been in the water for an extended period of time will be stressed by the mere act of preparing for the dive and getting into the water. Were these
- divers to be overly task loaded, or stressed by some unforeseen occurrence they would likely be unable to cope and likely degenerate into a state of distress. One of the biggest factors in avoiding panic is a thorough understanding of one’s equipment and a high level of comfort

in the foreign (underwater) environment. Diving proficiency is a diminishing skill. It is not enough that the SAR diver participate in training once each month absent additional exposure to the underwater environment SAR divers are to actively participate in no less than twelve (12) diving days each year (in addition to training days) in order to maintain their personal skills at a high level. Ideally these twelve days should be experienced at a rate of once per month, but at any rate, twelve days of diving is the minimum requirement.

- Visualization or "mental practice" in the form of mental dress rehearsal enhances the neural connectors in the brain utilized during actual physical performance. There is an old saying that "the body cannot go where the mind has never been." Warriors preparing for battle have utilized visualization for centuries. Top athletes and stage performers utilize this technique – diving is an athletic / performance endeavor. Visualization is extremely applicable to diving.

## LEAVING AND RETURNING TO ACTIVE DIVE STATUS

Divers who are unable to dive for an extended period of time can be removed from active dive status by presenting to the team captain and/or team physician, written correspondence from a physician stating the nature of the medical or psychological condition and the length of anticipated disability. Prior to reinstatement to active dive status, a diver must present a written release from a physician.

# CHAPTER 17 KNOTS AND RIGGING

Knots are utilized extensively by Mountain Rescue teams in setting up rope systems for their operations. Likewise, knots are important in swift water operations. For underwater operations, however, knots are less functional. Rather than make underwater line attachments with knots, it is highly recommended that hardware in the form of clips, snaps, and carabineers be utilized. This is due to the fact that underwater, knots can be extremely difficult to work with:

- Low-to-no visibility situations will render it difficult, if not impossible to tie a proper knot, or even to untie a knot.
- In cold water and/or when wearing gloves, tying or untying a knot can be extremely difficult.
- The loading" of a wet knot can render it impossible to untie.
- Narcosis experienced by a diver at depth can make it extremely difficult to tie a proper knot.
- A diver under stress may not be capable of tying or untying a knot.

Conversely, clips and snaps are quick and simple to attach underwater under all conditions. However, a diver still must be capable of tying a few knots on occasion.

NOTE: Boat snaps and butterfly snaps (commonly called suicide snaps) must never be utilized as connecting hardware in that these snaps tend both to attach themselves to objects unintentionally as well as release if they are turned on themselves.

NOTE: There is an excellent internet website that gives step-by step illustrated knot tying instruction: **www.animatedknots.com** .

A good knot must:

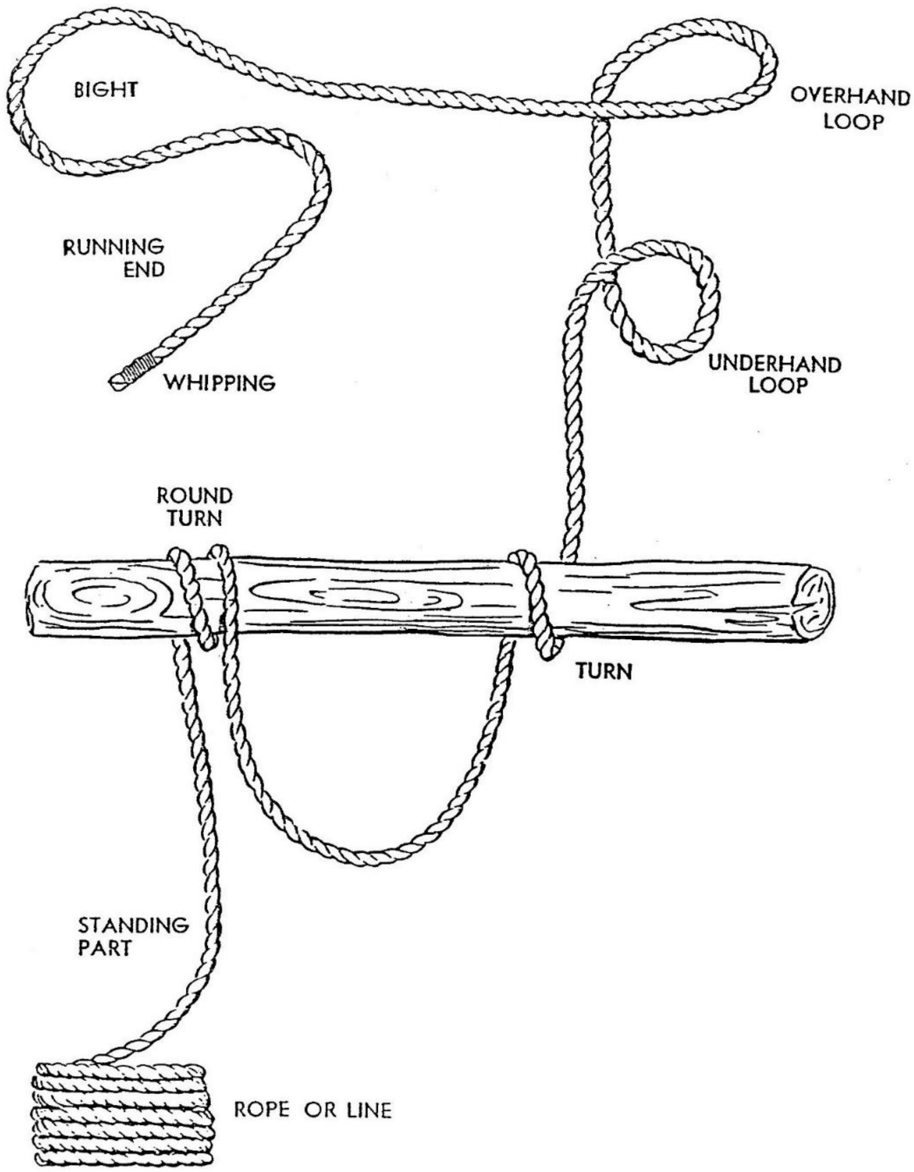
1. Be easy to tie
2. Hold without slipping
3. Be easy to untie

The choice of the best knot, bend, or hitch to use depends largely on the job it has to do. In general, knots can be classified into three groups: knots at the end of a rope, knots for joining two ropes, and knots for making loops. A study of the terminology pictured in figure 1 and the following definitions will aid in understanding the methods of knotting presented in this chapter.

## KNOTS & RIGGING TERMS

The fundamental terms associated with knots and rigging are as follows:

- **Rope** - A rope (often called a line) is a large, stout cord made of strands of fiber or wire twisted or braided together.
- **Line** - A line (sometimes called a rope) is a thread, string, cord, or rope, especially a comparatively slender and strong cord. In this class, we will use the terms rope and line interchangeably.
- **Running End** - The running end is the free or working end of a rope.
- **Standing Part** - The standing part is the rest of the rope, excluding the running end.
- **Bight** - A bight is a bend or U-shaped curve in a rope.
- **Loop** - A loop is formed by crossing the running end over or under the standing part forming a ring or circle in the rope.
- **Turn** - A turn is the placing of a loop around a specific object such as a post, rail, or ring with the running end continuing in a direction opposite to the standing part.
- **Round Turn** - A round turn is a modified turn, but with the running end leaving the circle in the same general direction as the standing part.
- **Overhand Turn or Loop** - An overhand turn or loop is made when the running end passes over the standing part.
- **Underhand Turn or Loop** - An underhand turn or loop is made when the running end passes under the standing part.
- **Knot** - A knot is an interlacement of the parts of one or more flexible bodies, as cordage rope, forming a lump known as a knot; any tie or fastening formed with a rope, including bends, hitches, and splices. It is often used as a stopper to prevent a rope from passing through an opening.
- **Bend** - A bend (in this class called a knot) is used to fasten two ropes together or to fasten a rope to a ring or loop.
- **Hitch** - A hitch is used to tie a rope around a timber, pipe, or post so that it will hold temporarily but can be readily undone.




**Elements of Knots, Bends, and Hitches**

Knots are used for different purposes and places:

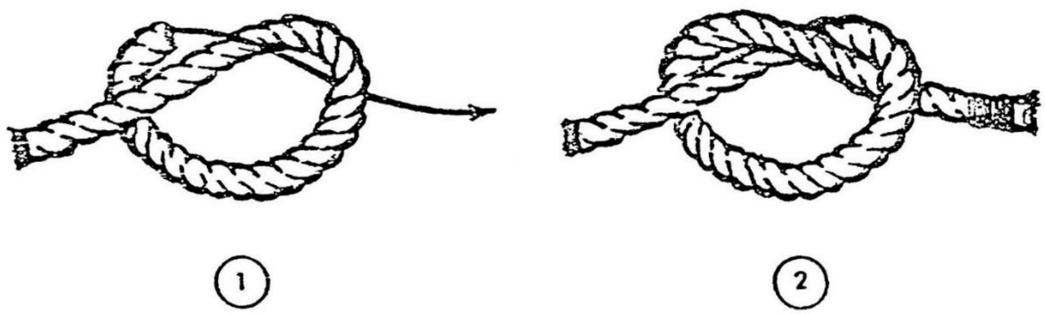
- Knots made at the end of a rope
- Knots used for joining two ropes
- Knots for making loops
- Hitches for fastening a rope to another rope or something else
- Splices for interweaving ropes or wires
- Whipping ends for of rope
- Other Knots

# KNOTS MADE AT THE END OF A ROPE

## OVERHAND KNOT

The overhand knot is the most commonly used and misused of all knots. In Search and Rescue the overhand knot is never used except as the start of other knots.

How-To Video of an Overhand Knot




**Overhand Knot**

## FIGURE 8 KNOT

The figure eight knot is one of the most useful of all knots. It can be used to form a larger knot at the end of a rope; to increase a person's grip on the rope; to prevent the end from slipping through a fastening or loop in another rope; and as a quick method to secure the end of a rope against untwisting. The figure eight knot is easy to untie even after a heavy strain has been placed on the knot.

How-To Video of a Figure 8 Knot

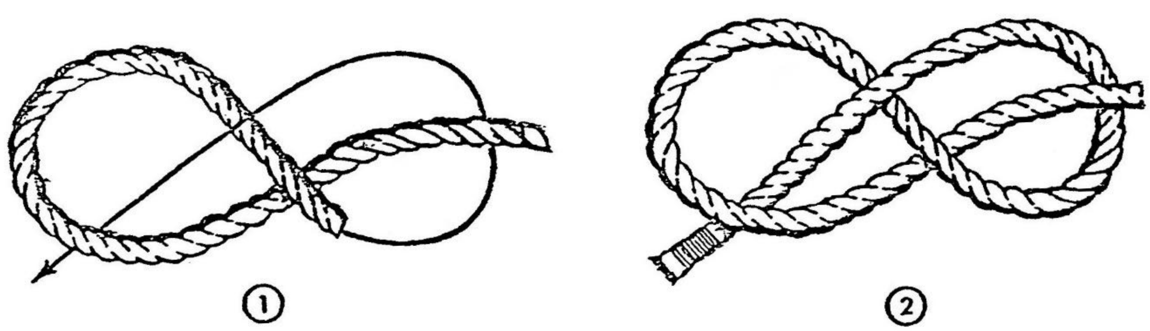


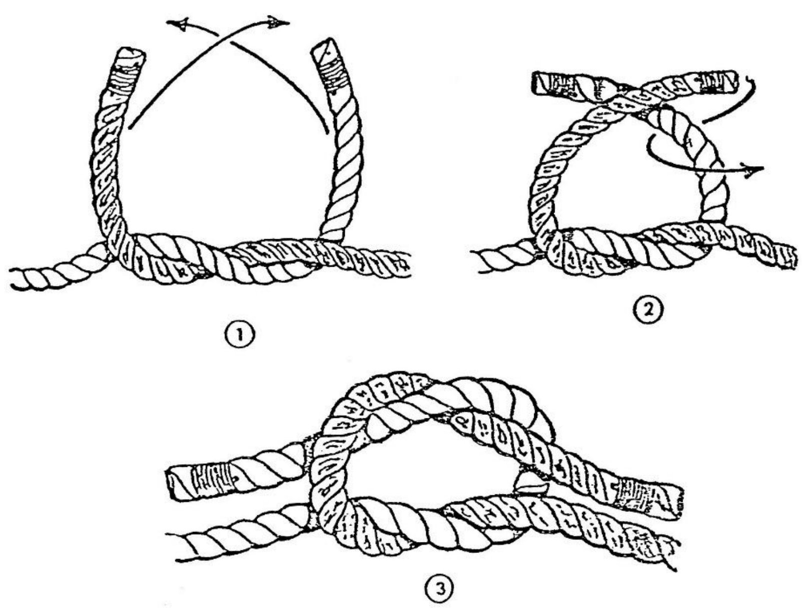

**Figure 8 Knot**

## KNOTS USED FOR JOINING TWO ROPES

### SQUARE KNOT (REEF KNOT)

The square knot is used for tying two ropes of equal size together so they will not slip. Note that in the square knot the end and standing part of one rope comes out on the same side of the bight formed by the other rope. The square knot will not hold if the ropes are wet or if they are of different sizes. It tightens under strain but can be untied by grasping the ends of the two bights and pulling the knot apart.

[How-To Video of a Square Knot]




**Square Knot**

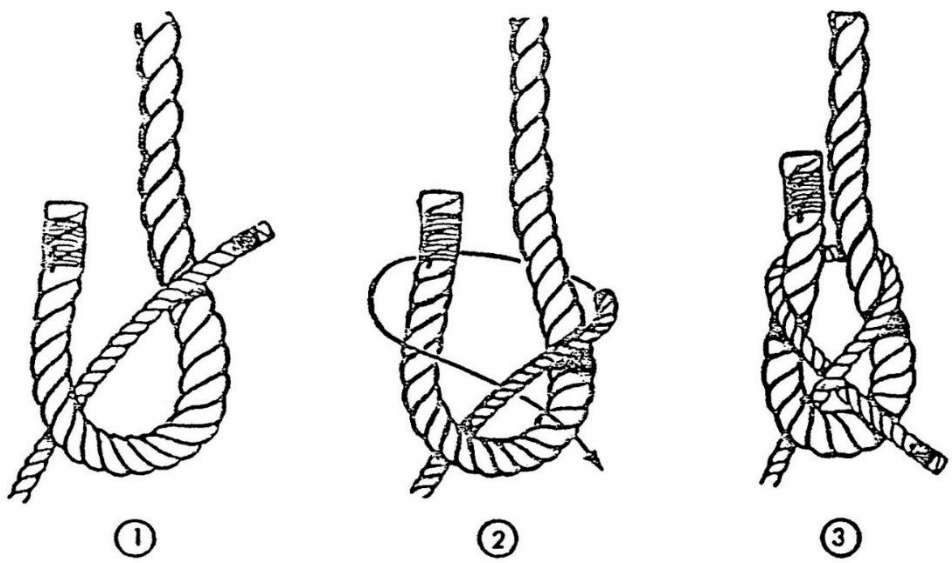
### SINGLE SHEET BEND KNOT

The use of a single sheet bend, sometimes called a weaver's knot, has two major uses:

1. Tying together two ropes of unequal size
2. Tying a rope to an eye.

This knot will draw tight but will loosen or slip when the lines are slackened. The single sheet bend is stronger and more easily untied than the square knot.

[How-To Video of a Single Sheet Bend]

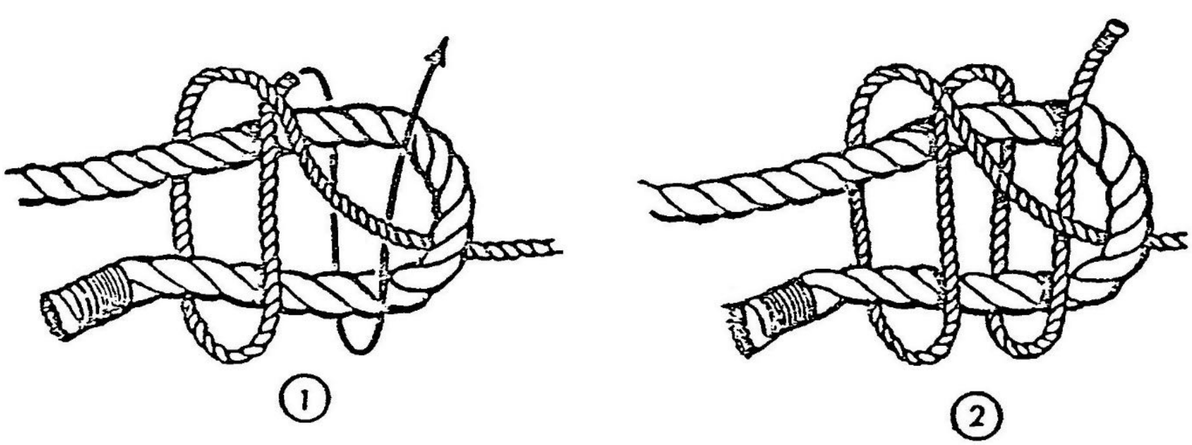



**Single Sheet Bend Knot**

## DOUBLE SHEET BEND KNOT

The double sheet bend has greater holding power than the single sheet bend for joining ropes of equal or unequal diameter, joining wet ropes, or tying a rope to an eye. It will not slip or draw tight under heavy loads.

[How-To Video of a Double Sheet Bend]

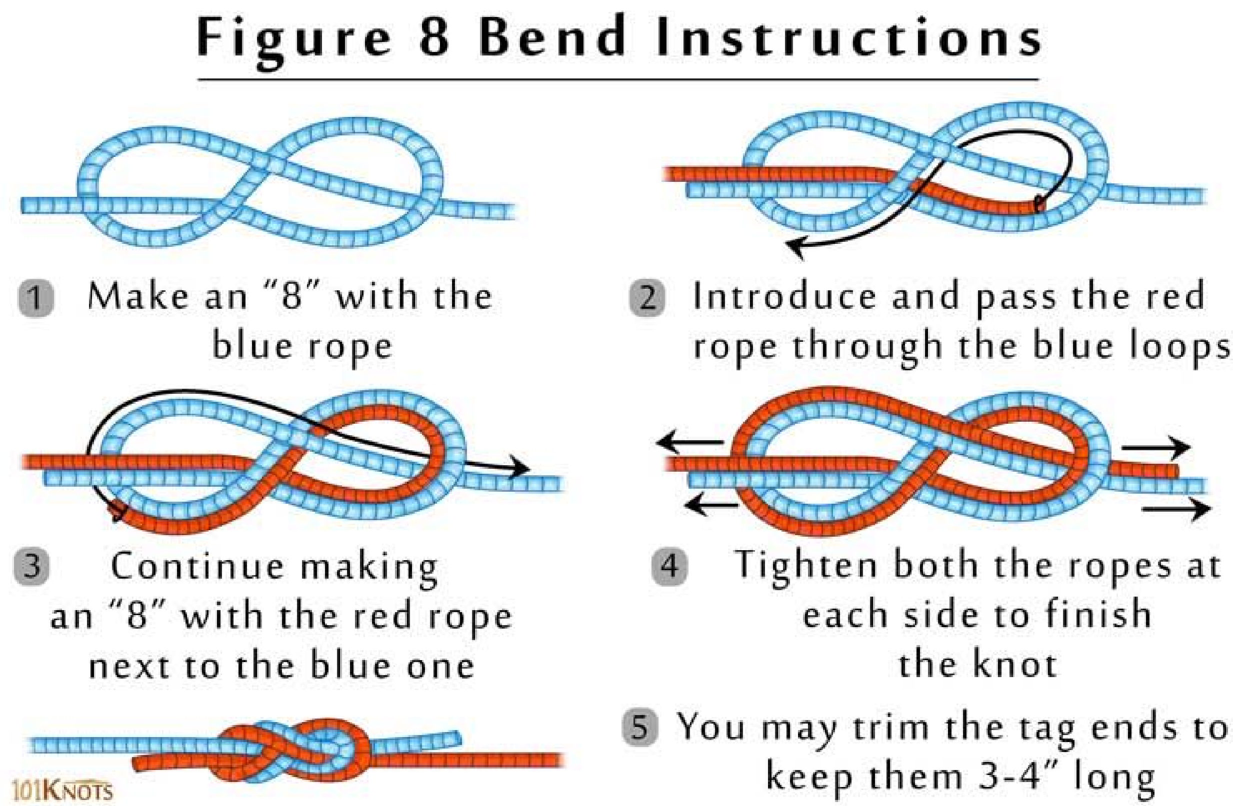



**Double Sheet Bend**

## FLEMISH BEND (FIGURE 8 BEND) KNOT

Tie a figure eight in one of the lines. Pass the end of the second line parallel to that of the first through the figure eight to create a double figure eight. The end of the second line must exit beside the first line's standing end. Secure each end with a stopper knot around its parallel standing end. The lines joined by a Flemish bend must be the same size, or nearly the same size.

How-To Video of a Flemish Bend Knot

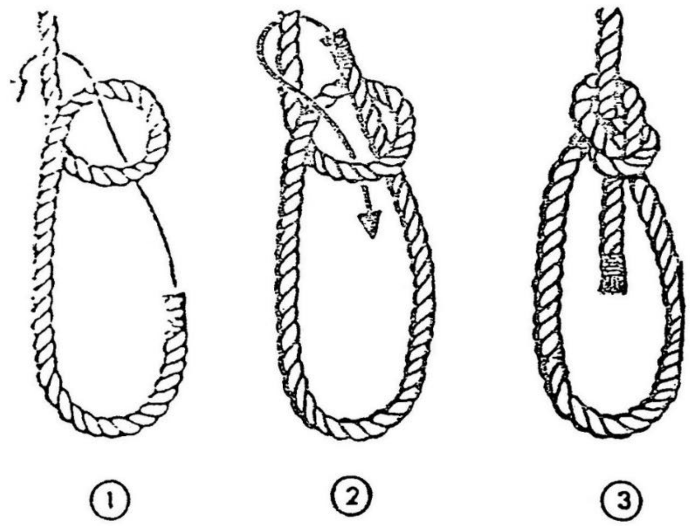



# KNOTS FOR MAKING LOOPS

## BOWLINE KNOT

The bowline is one of the most common knots and has a variety of uses, one of which is the lowering of people and/or materials. It is the best knot for forming a single loop that will not tighten or slip under strain, and is easily untied if each running end is seized to its own standing part.

How-To Video of a Bowline Knot

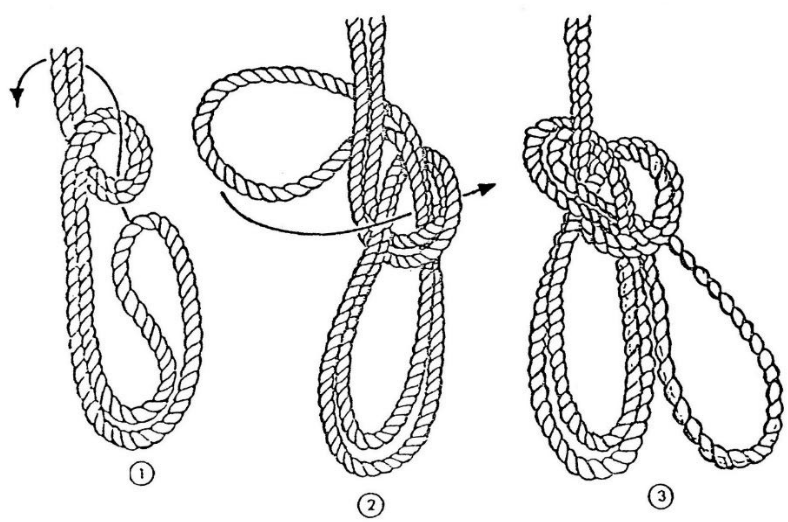


**Single Bowline**

## DOUBLE BOWLINE KNOT (SPANISH BOWLINE KNOT)

The double bowline forms 3 non-slipping loops. This knot can be used for lifting a conscience person. As they sit in the slings, one loop is used to support their back and the remaining two loops support their legs; a notched board passed through the two loops makes a comfortable seat known as a boatswain's chair.

[How-To Video of a Double Bowline Knot]

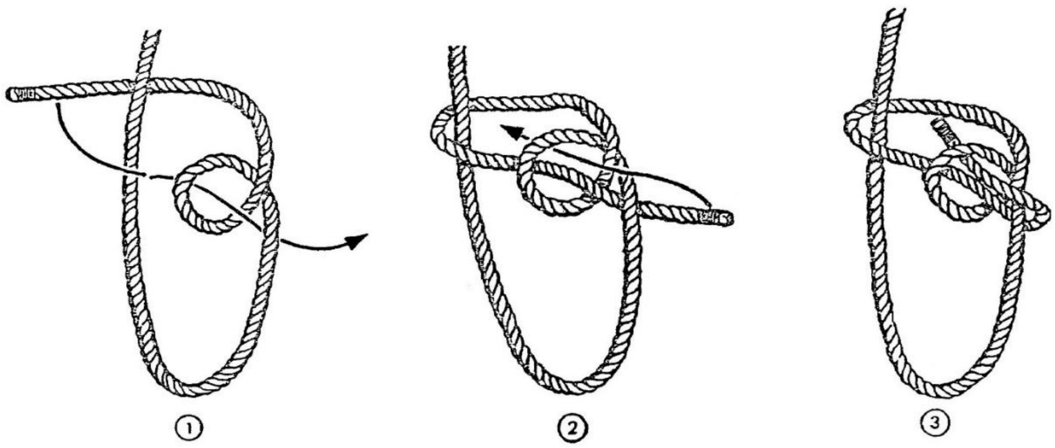


**Double Bowline**

## RUNNING BOWLINE KNOT

The running bowline forms a strong running loop. It is a convenient form of running an eye. The running bowline provides a sling of the choker type at the end of a single line. It is used when a hand line is to be tied around an object at a point that cannot be safely reached, such as the end of a limb

How-To Video of a Running Bowline Knot

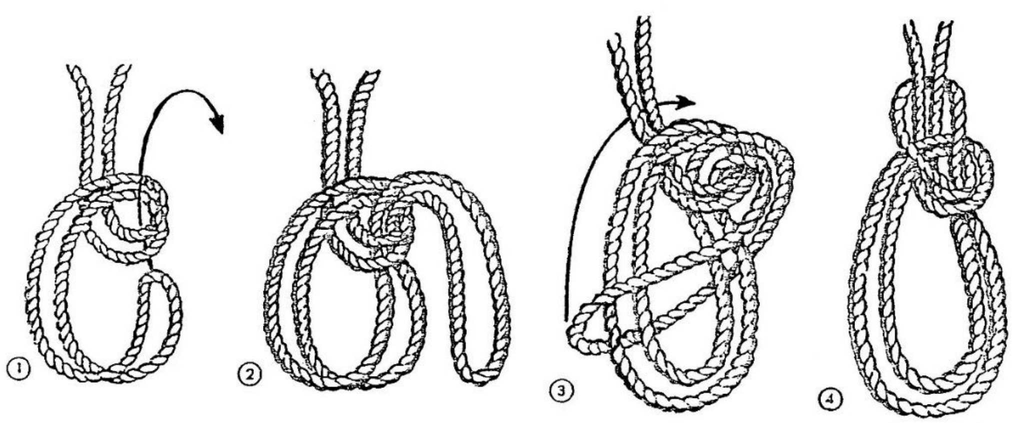



**Running Bowline**

## BOWLINE ON A BIGHT

This knot forms two non-slipping loops. It is used when a greater strength than that given by a single bowline is necessary, when it is desirable to form a loop at some point in a rope other than at the end or when the end of a rope is not accessible.

How-To Video of a Bowline on a Bight

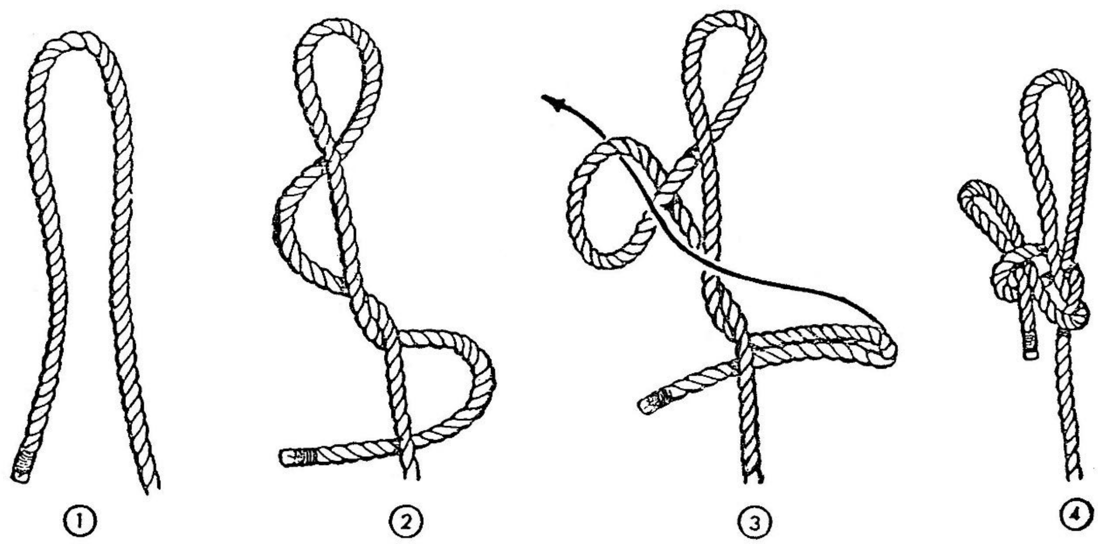



**Bowline on a Bight**

## SPEIR KNOT

A Speir knot is used when a fixed loop, a non-slip knot, and a quick release are required. It can be tied quickly and released by a pull on the running end.

How-To Video of a Speir Knot

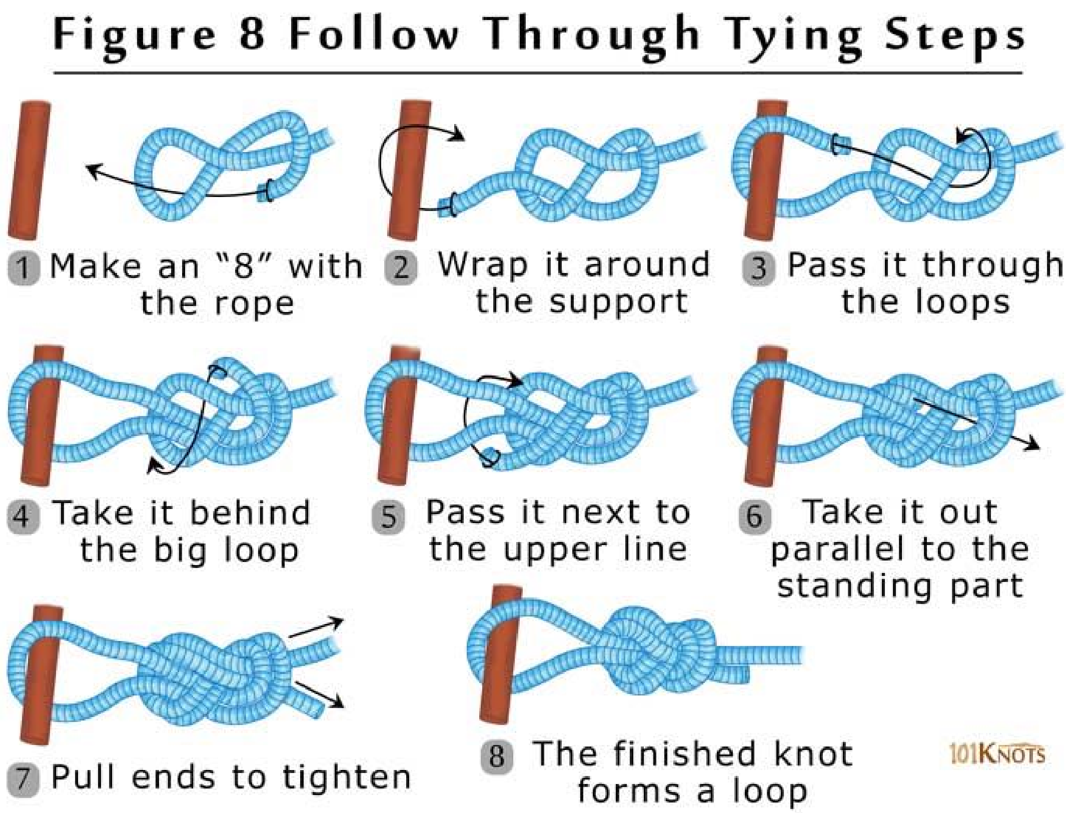



**Speir Knot**

## FIGURE 8 FOLLOW THROUGH

Tie a figure eight in a line.  Either create a loop, or pass the running end around an object to which the knot is to be secured.  Pass the running end back through the eight of the knot parallel to itself.  Follow the entire figure eight to create a two-strand figure eight knot.

How-To Video of a Figure 8 Follow Through Knot




## FIGURE 8 ON A BIGHT

Also called a figure eight directional knot. This type of knot is frequently used in rock climbing. Double a length of the line and tie a figure eight utilizing both strands of line in the construction of the knot. Utilized to construct a loop in a line for connecting to hardware or for a handhold.

How-To Video of a Figure 8 Knot on a Bight

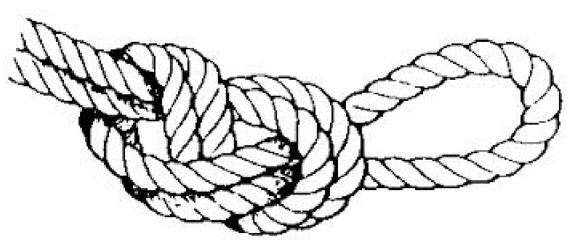


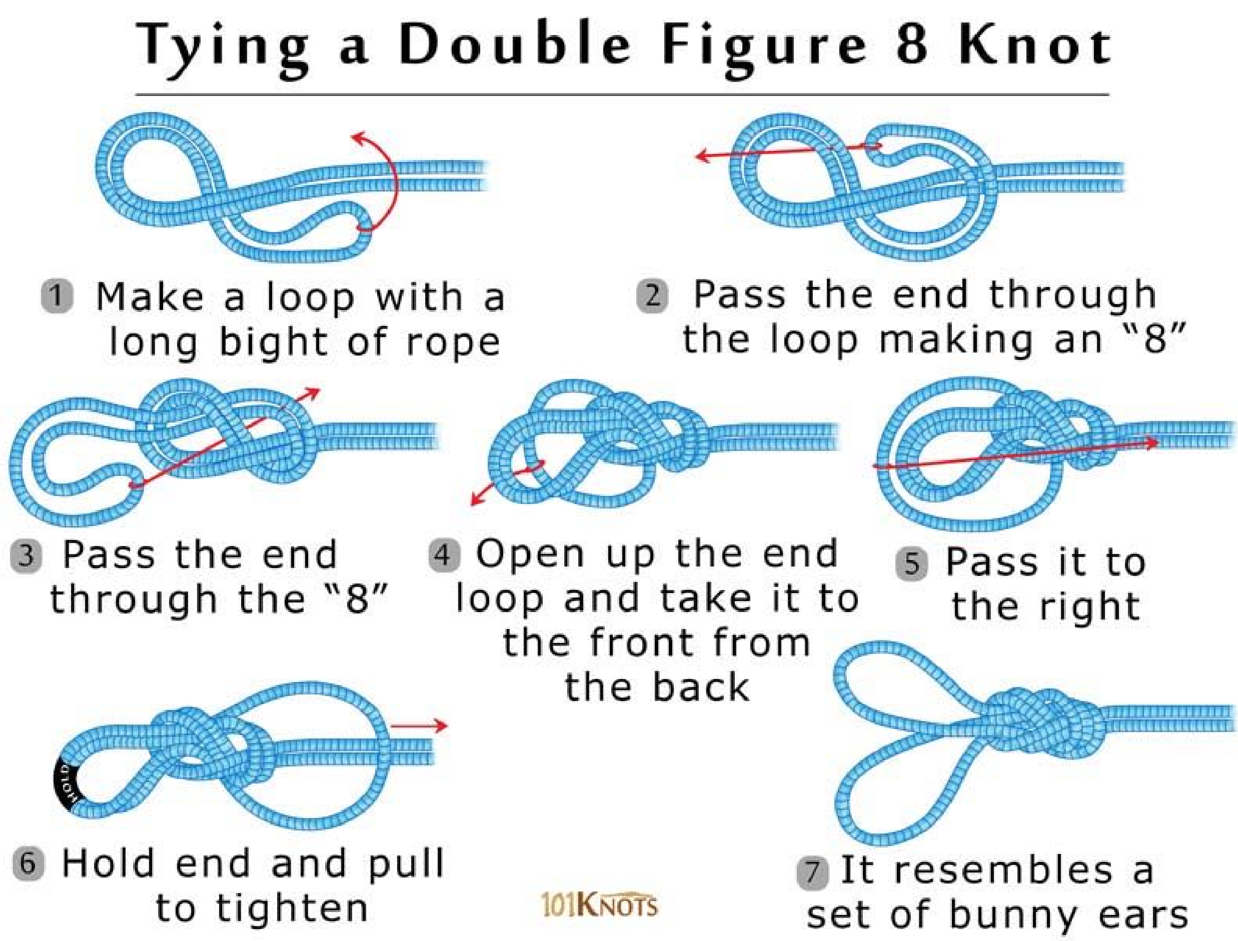
**Figure 8 on a Bight**

## DOUBLE FIGURE 8 (BUNNY EARS) KNOT

The two loops can be used as an improvised seat. The Double Figure 8 Loop has also been used to equalize the load in a top-roping technique using two anchors: with loops that are made very unequal, the much larger one is passed around both anchor points. The center of this loop is then secured with a carabiner to the small loop. During rappelling, this spreads the load between the two anchor points. Recently, however, this use of The Double Figure 8 Loop has been discouraged because if one anchor point fails, there is enough slack to create a large shock load on the remaining anchor point, possibly causing it to fail as well.

Make a long loop in a line and form a figure eight knot. Pass a bight of the loop through to form the figure eight, then pass the loop itself over the entire knot. Pull tight to lock the loops. Utilized for equalizing the load on two anchor points.

How-To Video of a Bunny Ears Knot

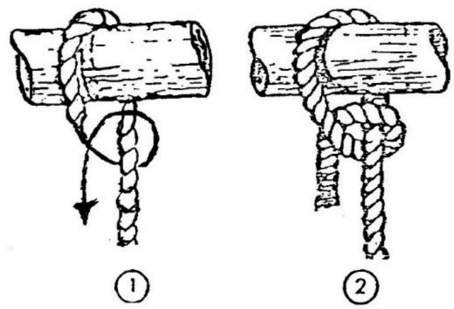


## HITCHES

### HALF HITCH

The half hitch is used to tie a rope to a timber or to a larger rope. It will hold against a steady pull on the standing part of the rope, but is not a secure hitch. It is frequently used for securing the free end of a rope, and is an aid and the foundation of many knots.

[How-To Video of a Half Hitch]

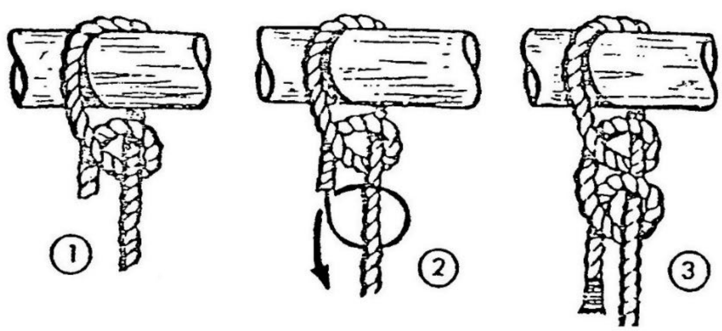



**Half Hitch**

### TWO HALF HITCHES

Two half hitches are especially useful for securing the running end of a rope to the standing part. If the two hitches are slid together along the standing part to form a single knot, the knot becomes a clove hitch.

[How-To Video of Two Half Hitches]

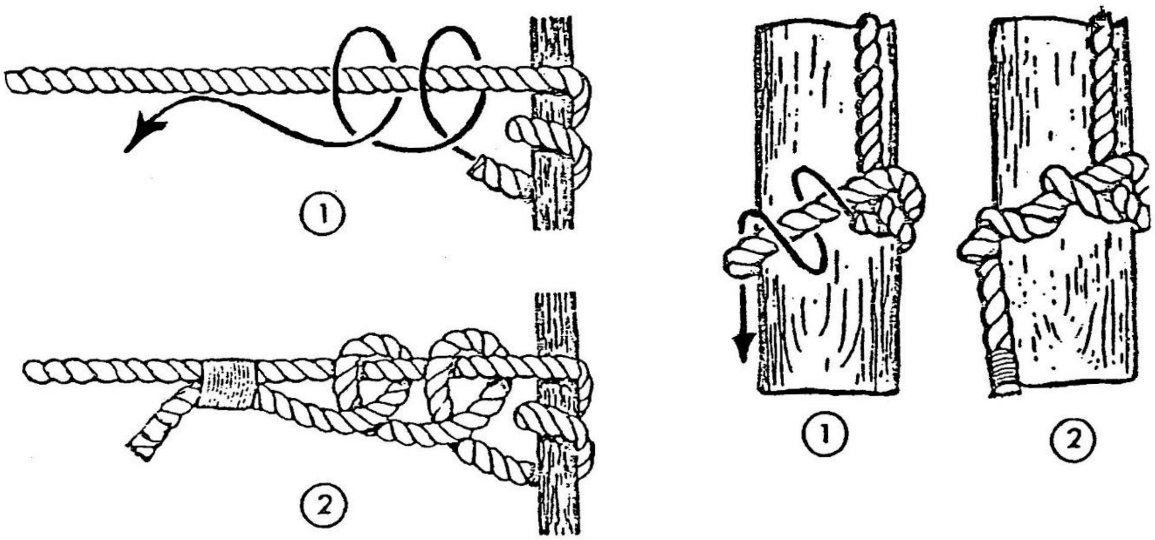



**Two Half Hitches**

## ROUND TURN AND TWO HALF HITCHES

Another hitch used for fastening a rope to a pole, timber, or spar is the round turn and two half hitches. For greater security, the running end of the rope should be seized to the standing part.

How-To Video of a Round Turn and Two Half Hitches

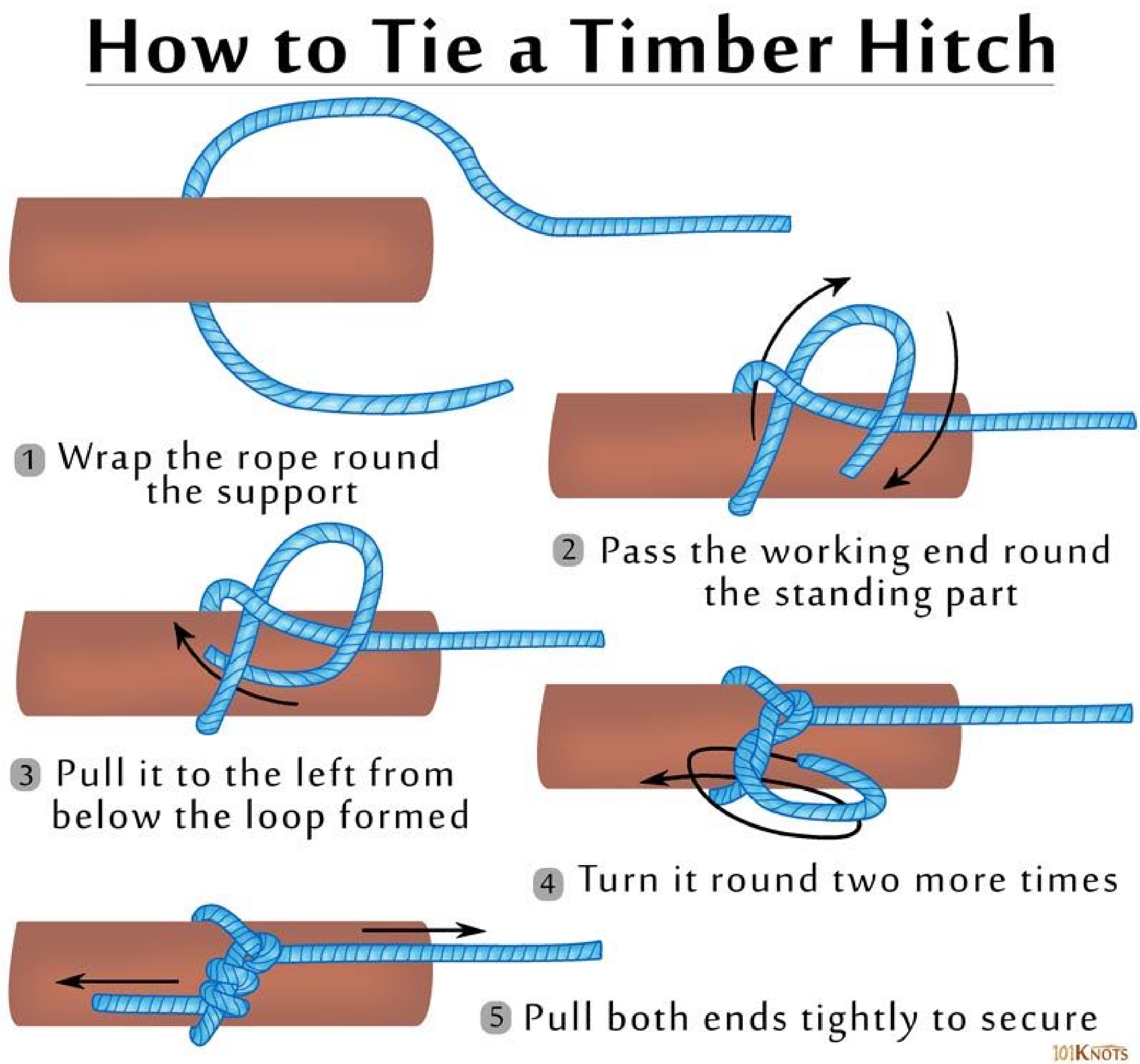



**Round Turn & Two Half Hitches**

## TIMBER HITCH AND HALF HITCH

A timber hitch and half hitch are combined to hold heavy timber or poles when they are being lifted or dragged. A timber hitch used alone may become untied when the rope is slack or a sudden strain is put on it.

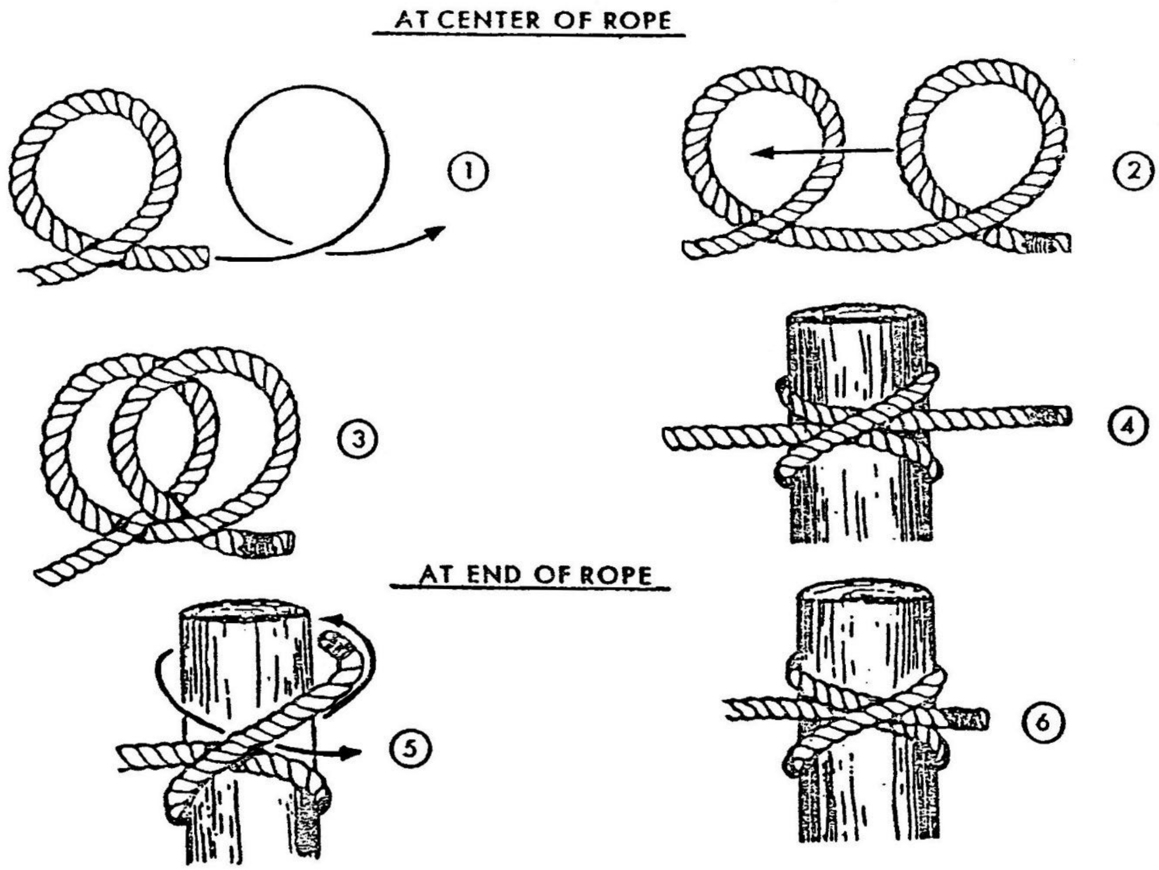
How-To Video of a Timber Hitch (Without Half Hitches)




## CLOVE HITCH

The clove hitch is one of the most widely used knots. It is used to fasten a rope to a timber, pipe, or post. It is also used for making other knots. This knot puts very little strain on the fibers when the rope is put around an object in one continuous direction. The clove hitch can be tied at any point in a rope. If there isn't constant tension on the rope, another loop (round of rope) around the object and under the center of the clove hitch will permit a tightening and slackening motion of the rope.

How-To Video of a Clove Hitch

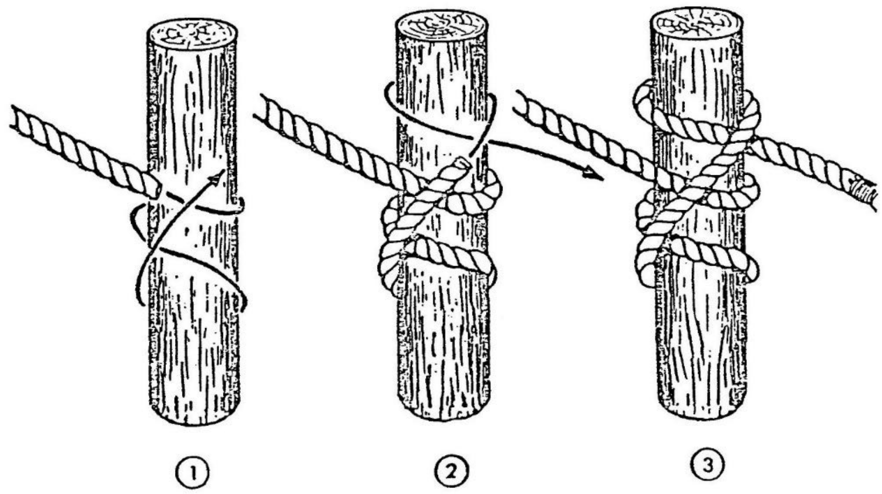



**Clove Hitch Variations**

## MOORING HITCH

The mooring hitch also called rolling or "magnus" hitch, is used to fasten a rope around a mooring post or to attach a rope at a right angle to a post. As an example, it can be used in short term use to fasten a kayak or small boat temporarily to a dock. This hitch grips tightly and is easily removed.

How-To Video of a Mooring Hitch

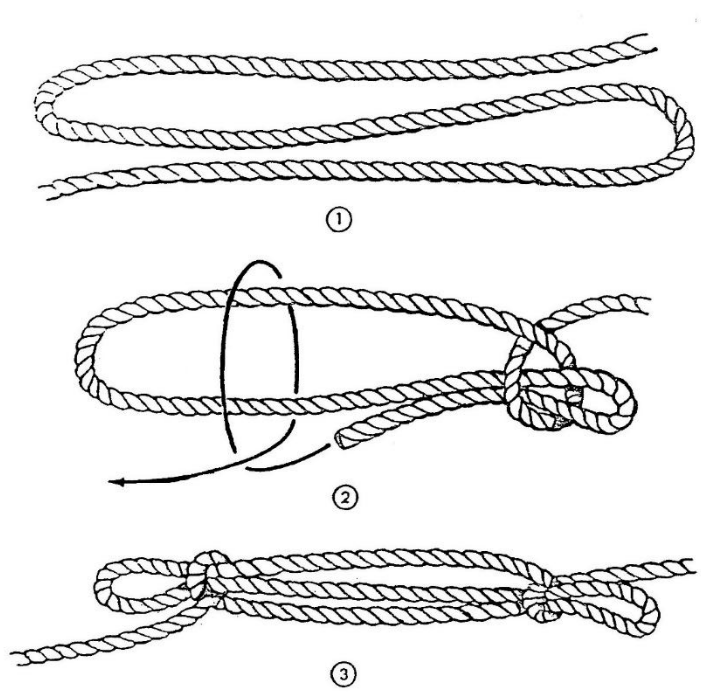


Mooring Hitch

## SHEEPSHANK

A sheepshank is a method of shortening a rope, but it is also used to take the load off a weak spot in the rope. It is only a temporary knot unless eyes are fastened to the standing part on each end.

How-To Video of a Sheepshank

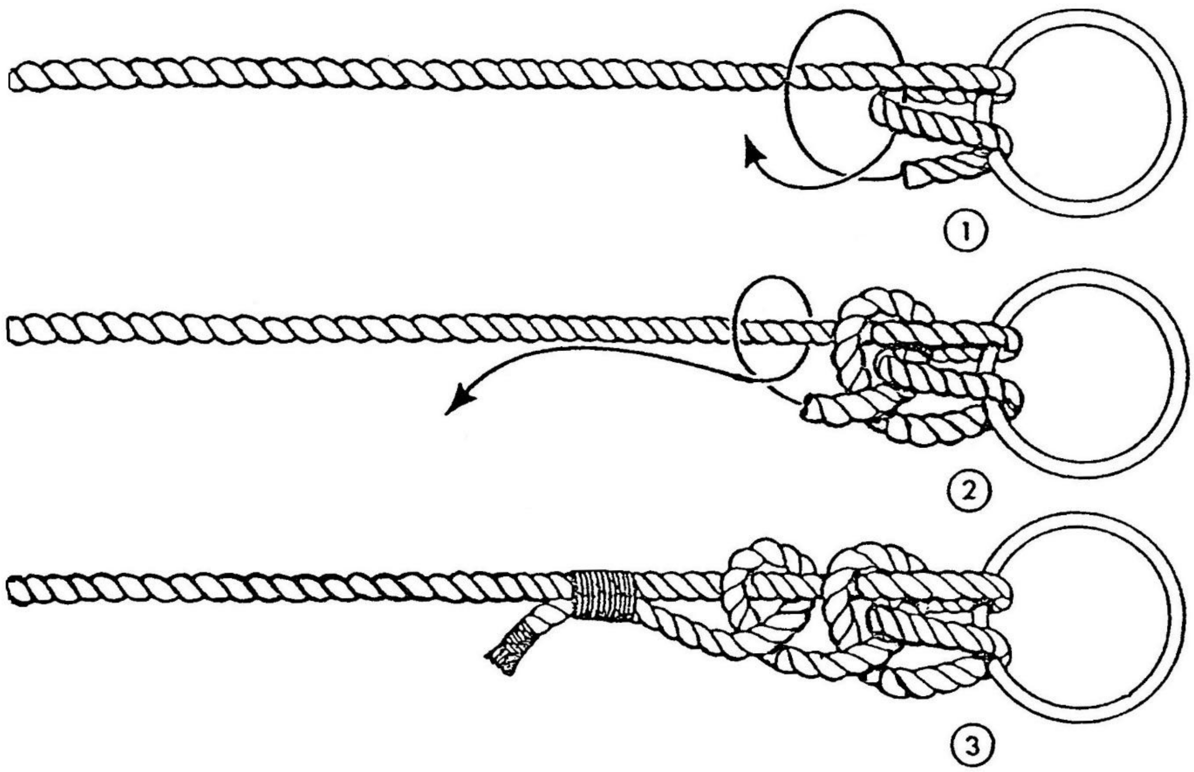


Sheepshank

## FISHERMAN'S BEND

The fisherman's bend is an excellent knot for attaching a rope to a light anchor, a ring, or a rectangular piece of stone. It can be used to fasten a rope or cable to a ring or post or where there will be slackening and tightening motion in the rope.

How-To Video of a Fisherman's Bend



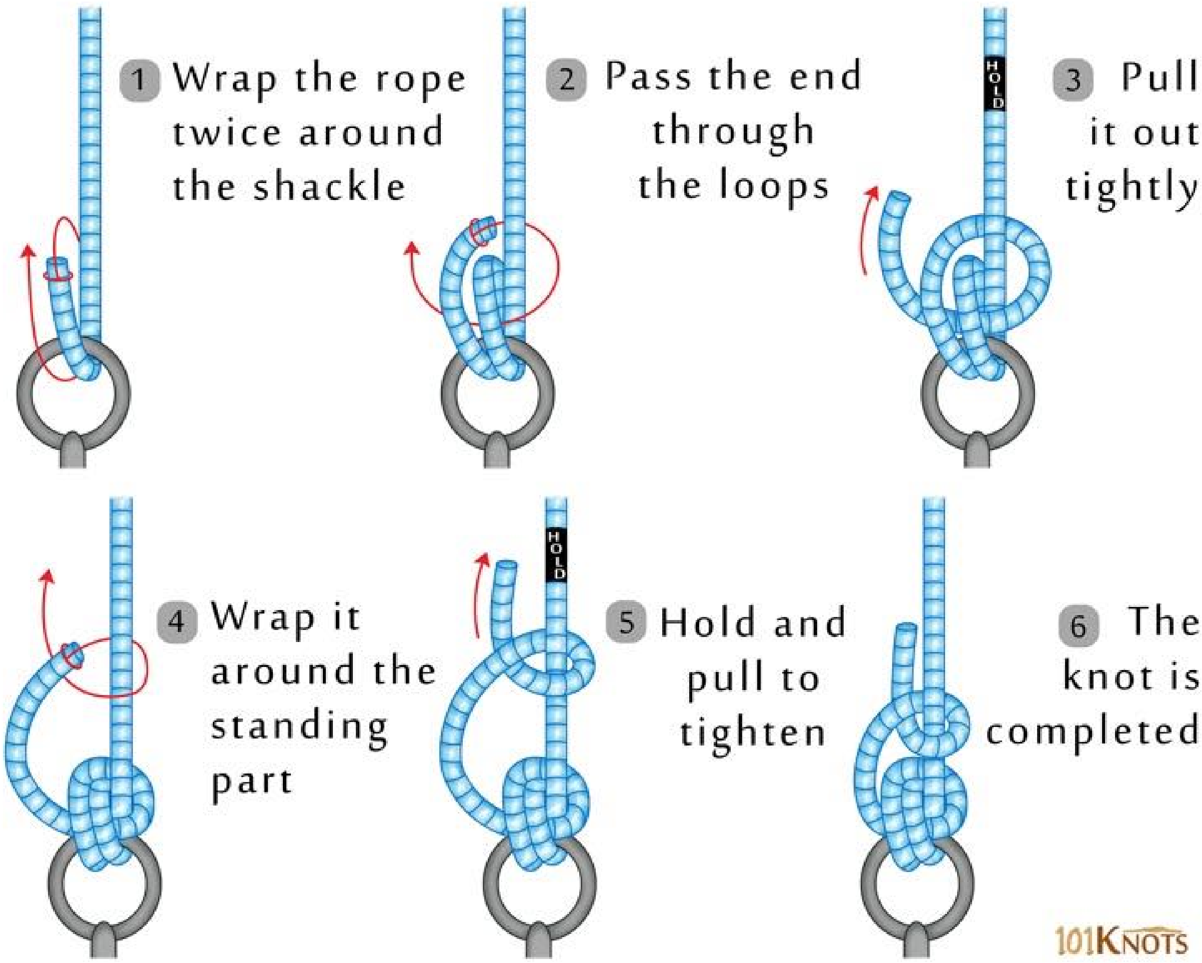

**Fisherman's Bend**

## ANCHOR BEND

It's actually a hitch, so "anchor hitch" would be more appropriate. The anchor bend is designed for securing boats to a dock or lines to an anchor.  It is secure and easy to tie.

How-To Video of an Anchor Bend

# Anchor Hitch Instructions



## SPLICES

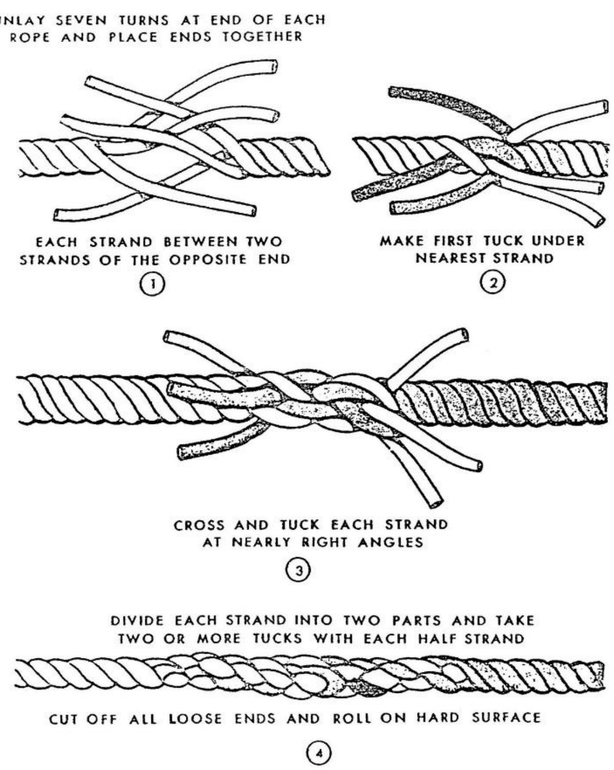
Splicing is a method of joining rope or wire by unlacing strands of both ends and interweaving these strands together.

There are four general types of splices:

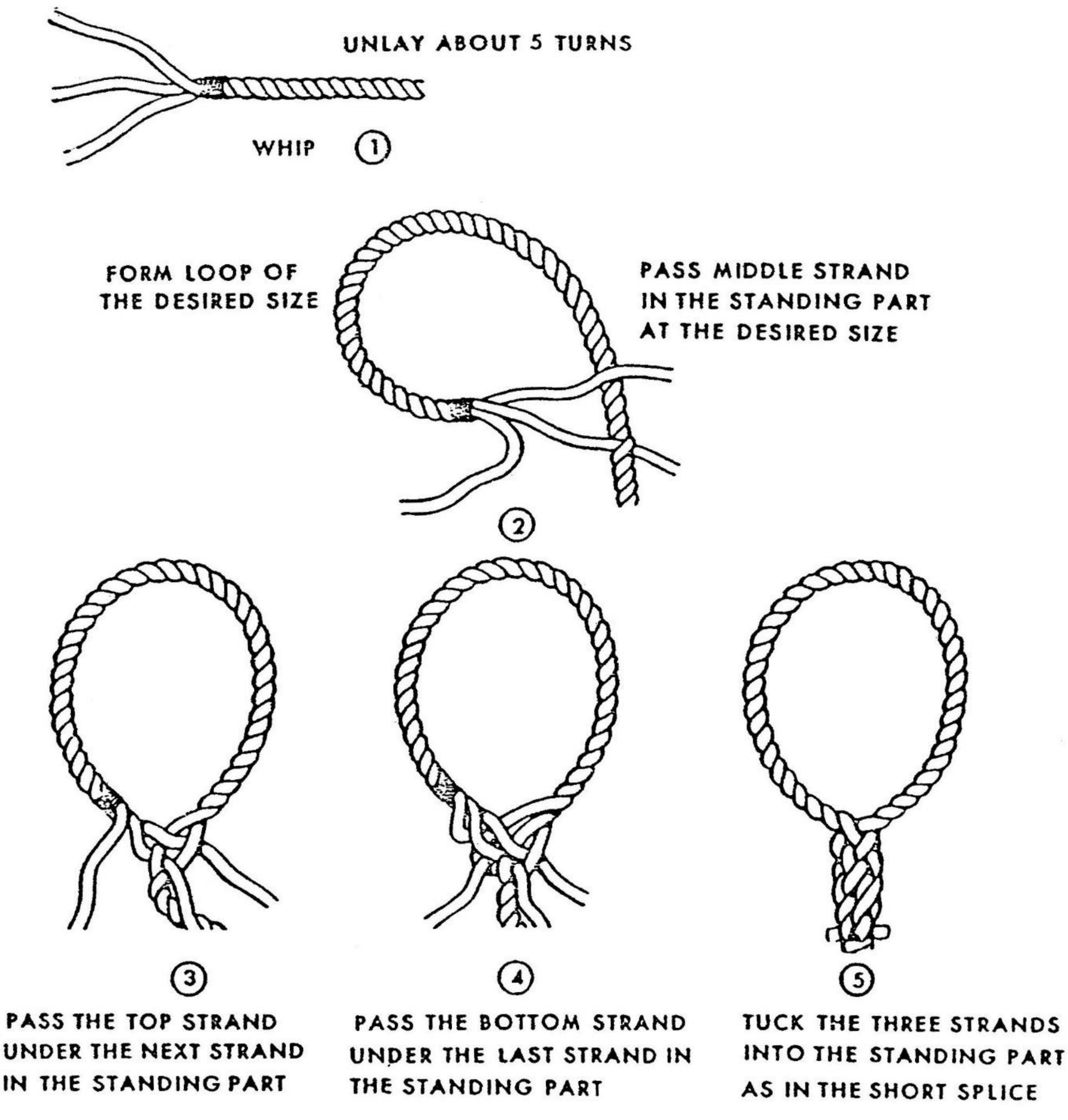
1. A short splice
2. An eye or side splice
3. A long splice
4. A crown or back splice

The methods of making all four types of splices are similar. They generally consist of three basic steps:

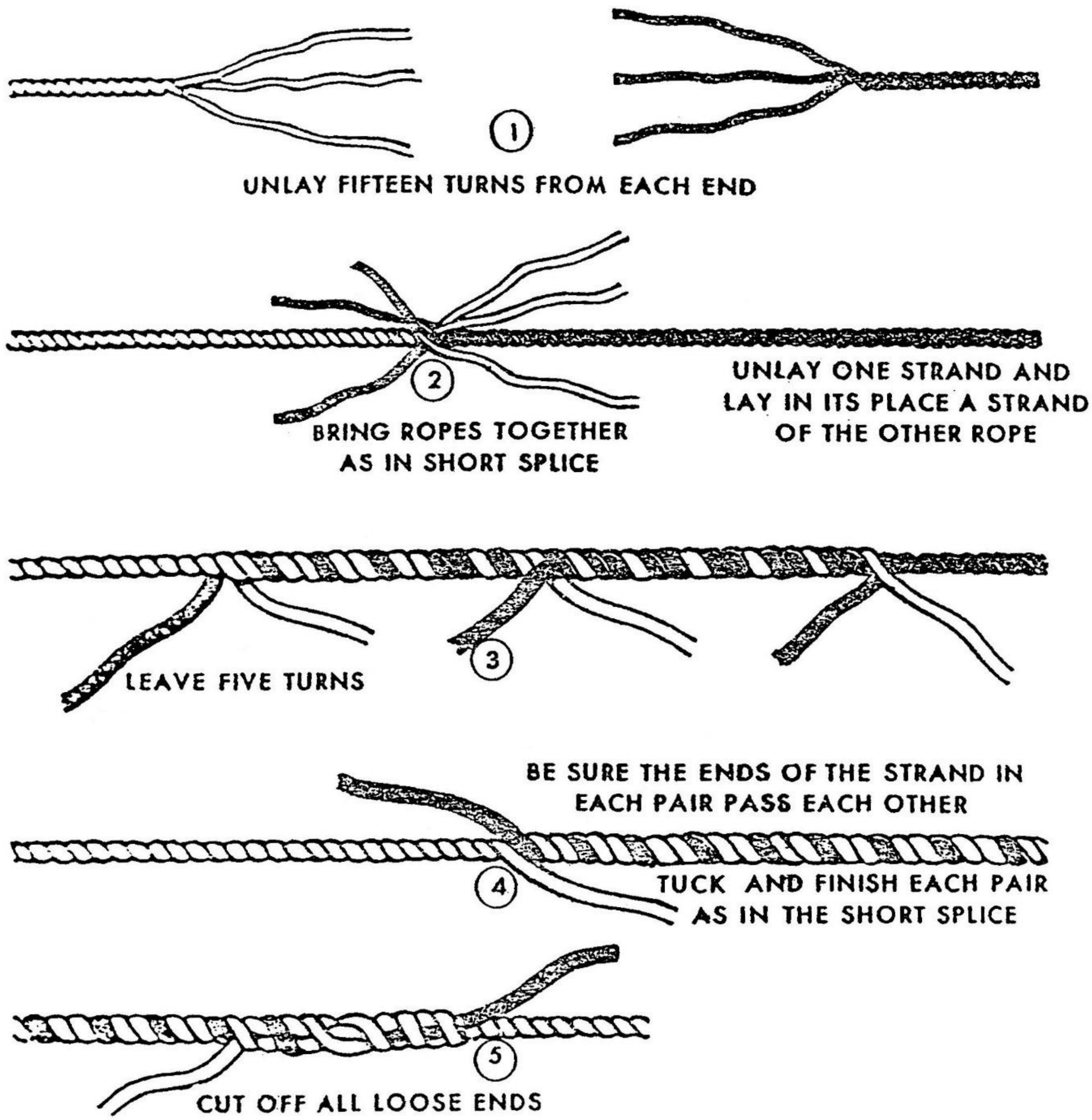
1. Unlacing the strands of the rope.
2. Placing the rope ends together.
3. Interweaving the strands and tucking them into the rope.




**Short Splice**




## Eye or Side Splice

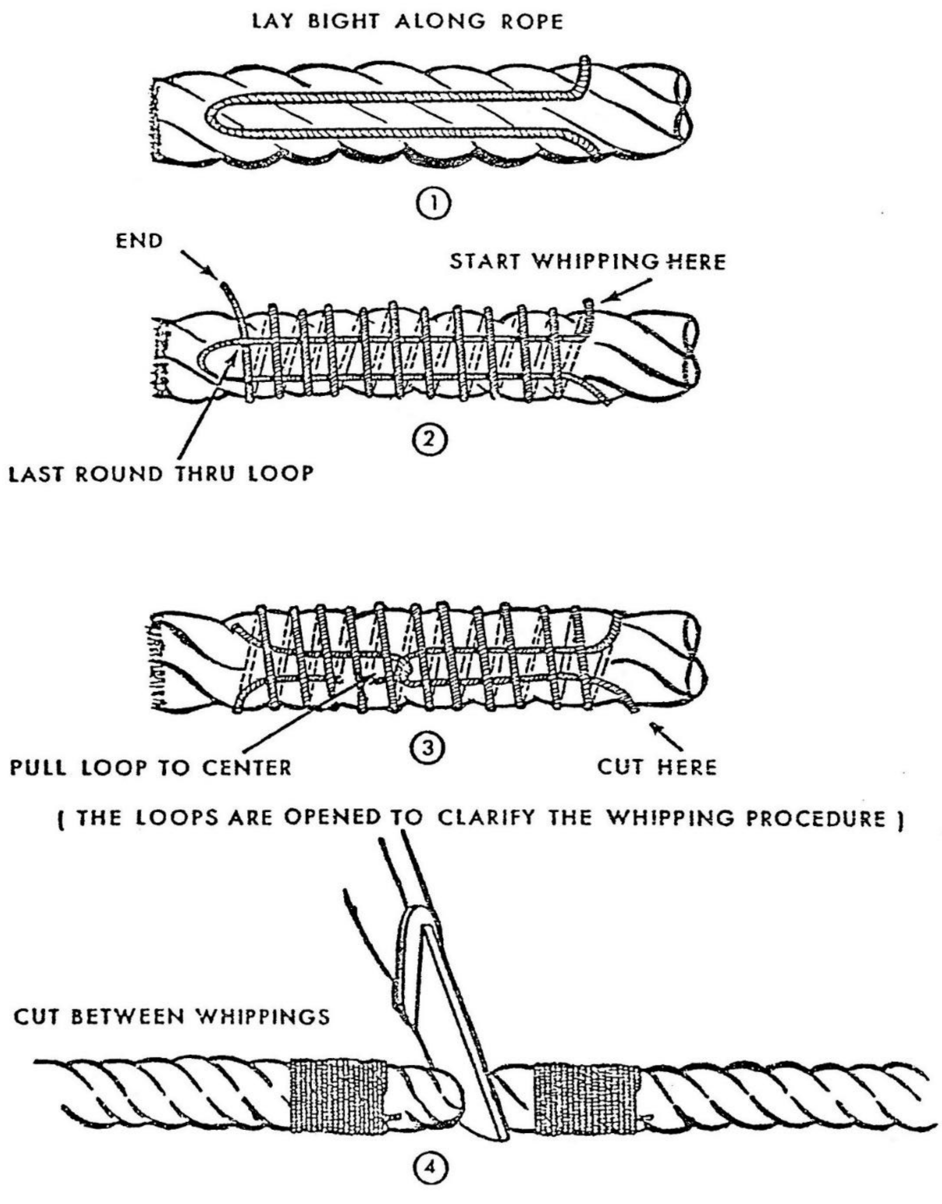

1
UNLAY FIFTEEN TURNS FROM EACH END
2
BRING ROPES TOGETHER AS IN SHORT SPLICE
UNLAY ONE STRAND AND LAY IN ITS PLACE A STRAND OF THE OTHER ROPE
3
LEAVE FIVE TURNS
BE SURE THE ENDS OF THE STRAND IN EACH PAIR PASS EACH OTHER
4
TUCK AND FINISH EACH PAIR AS IN THE SHORT SPLICE
5
CUT OFF ALL LOOSE ENDS

**Long Splice**


## Crown or Back Splice

## WHIPPING ENDS OF ROPE

The cut end of a rope has a tendency to untwist, and should always be knotted or fastened in some manner to prevent this untwisting. Whipping is one method of doing this. A rope is whipped by wrapping the end tightly with a small cord. Before cutting a rope, place two whippings on the rope 1 or 2 inches apart and make the cut between the whippings.




**Whipping Ends of Rope**

## OTHER KNOTS

In addition to the knots described above, knots utilized by climbers and cavers also have utility in search and rescue work. Knots such as the double fisherman, ring bend (water knot), girth hitch, and prussic knot all have application.

# CHAPTER 18 UNDERWATER EVIDENCE

The location, collection, and preservation of physical evidence are primary functions of any law enforcement organization. In an aquatic environment, it is invariably the SAR diver who must perform this task. Items of evidentiary value may be critical in either criminal matters or civil actions that arise from the occurrence of an incident involving either evidence that has been disposed of in the water or a death that occurs in or about the water.

It is important to recognize that due to the adverse environment that many times is encountered underwater that evidence overlooked or passed over may be impossible to re-locate later. It is additionally critical to recognize that evidence that has been mishandled will most likely be excluded from use in court. For these reasons the SAR diver needs a foundation in the proper recovery and handling of physical evidence.

The evidence collection process actually begins with the arrival of the first diver at the scene. In order to avoid the contamination of the scene and any evidentiary items therein, the scene must be protected from people and or vehicles, etc. either removing evidence from the scene or, conversely, bringing items into the scene that did not exist there at the time of the occurrence. The scene should be cleared of all non-essential and unauthorized personnel. The area should be roped or taped off in order to both protect the scene and to secure the equipment which must be brought in and utilized to conduct an underwater search.

SAR divers must understand that evidence and scene protection, etc. takes a back seat to performing a rescue when such is possible. Although generally not the case due to the time element involved in the notification process and travel considerations, there may be that rare instance where the Search and Rescue diver is either on-scene at the time of an occurrence, or arrives shortly thereafter.

## WITNESSES

Witnesses are of critical importance for the Dive Team in that they can be utilized to describe an event, give an approximate location, furnish a time frame for a missing subject, describe clothing and physical characteristics of a victim, and furnish information, which might bear upon the cause of the incident.

One of the most critical aspects of any underwater search (and the one that is most often neglected) is the holding of witness(es) at the scene for interview by Dive Team personnel. The questions asked of the witness(es) by on-scene fire fighters and law enforcement personnel tend to not be very helpful in determining where to begin an underwater search, aside from this, information tends to be most reliable when received first-hand, as opposed to second or third-hand information. Witnesses need to be located, identified and separately interviewed in order to establish a PLS (point last seen) or most likely location in order to establish a starting point for the search. At some point during their interview(s) witnesses must be taken to the exact location from where they witnessed the incident in order to assist in the establishment of the PLS.

Witnesses can be assisted in their identification of a PLS by such features as landmarks; the location of objects in the water such as boats, docks, buoys, etc., or a swimmer. If a swimmer is utilized, draw the attention of the witness away from the swimmer until the swimmer is in the approximate location preliminarily indicated by the witness. This is due to the fact that people tend to be affected by time estimates as much as they are by distance estimates and if the witness is allowed to view and track the movement of the swimmer, he may misjudge the PLS due to the fact that the swimmer is either swimming faster, or slower than did the victim. The fact that witnesses may differ in their placement of the PLS is not a problem, in fact it may be advantageous. People tend to see things differently – especially when they are under stress. The more identified locations that the Dive Team has as possible PLS sites, the faster the recovery is likely to be.

## SCENE SURVEY

Prior to actually initiating an underwater search, a Risk/Benefit Assessment must be conducted. That is to say, an analysis and evaluation of the objective of the search operation with consideration for the hazards and dangers involved must occur. Such factors as environmental conditions (darkness, weather, etc.) water conditions (current(s), surf, surge, depth, visibility, etc.) and underwater hazards (submerged obstacles, potential entanglements, etc.) must all be considered with a view toward initiating an underwater search, postponing the search, or even declining to perform the search.

In the scene survey, the entire area must be considered. The presence of unusual items or absence of items that would be expected to be present should be noted. (e.g., overturned rocks, broken vegetation, footprints, missing /

damaged road signs, tire tracks, floating or beached debris, fuel slicks, clothing, personal effects, etc.)  The shoreline should be searched for the victim, victim's property, and/or evidentiary items.

Based upon the terrain involved, water movement, the statements of the witness(es), etc., scene boundaries must be established.  Boundaries should be marked on land by barrier tape or lines.  This will ensure that the area is not further contaminated by the introduction of insignificant items carried in by members of the public or other unauthorized personnel.  It will also serve to assist in securing Dive Team equipment (both personal and team equipment) from damage and/or pilfering.  Water boundaries can be marked by watercraft (boats, PWCs, etc.) or by the placement of buoys supplemented by watercraft.  This will serve to both prevent the contamination of the aquatic environment and provide protection for the dive operation by excluding boaters and swimmers from the area.

It is helpful to have a pair of binoculars available for conducting the initial scene survey in that it is possible for the body of a drowning victim to be moved on the surface by wind/water a considerable distance from the PLS.  It is conceivable that the victim may be located along the shore or floating some distance from the identified PLS.

## EVIDENCE LOCATION

Upon locating evidence, either underwater or topside, it should be photographed, if possible, prior to being collected.  Photographs should depict the item's physical relationship to landmarks, its physical relationship to other evidentiary items (if any), and a close-up depicting the condition of the item.

A Sketch should be made depicting the location and position of the item and distances from fixed objects.  In the case of evidentiary items located underwater, the diver should determine:

- The distance from his fixed base of search (anchor, pier piling, etc.).  This can be accomplished by a measurement of the length of search line utilized by the diver from the base of the search to the object.
- The direction of the item from the search base, determined by compass heading.
- The depth of the water column at the site of the object.
- The water temperature (degrees F.) at the location of the body.

- By noting the distance from the fixed search base and a compass heading, a GPS coordinate can be established for both the search base as well as the object itself.

If at all possible, do not touch or disturb any evidentiary item until it has been photographed, measured, and sketched. In the case of an item located underwater it is important to mark the location with a surface buoy in order that it can be readily located for later photographing and collection.

## EVIDENCE COLLECTION

Items of evidentiary value inclusive of firearms, tools, jewelry, papers, etc. should be preserved in the same condition as when they were found. Items found underwater should be placed into an airtight / watertight container filled with the same liquid as well as a bottom sample (if the item was resting on the bottom). This will prevent the oxidation of metallic objects and degradation or disintegration of paper. DO NOT place any items of evidentiary value into a mesh or canvass collection bag in as much as trace evidence is likely to be lost, contaminated, or destroyed.

It is feasible that fingerprints can be lifted from objects even after a lengthy exposure to an aquatic environment. Water and mud can, in some instances, actually act as a preservative for fingerprint evidence. The eradication of fingerprint evidence from evidentiary objects is probably due more to mishandling by the finder(s) and exposure to the chemical additives in certain bodies of water (e.g., algaecide, herbicide, etc.) than from water exposure. Divers must avoid handling evidentiary items to the greatest extent possible.

## WEAPONS LOCATION AND RETRIEVAL

Search and Recovery Divers are many times called upon to attempt to locate and retrieve weapons (e.g., firearms, knives, tools, etc.) which have been used in crime(s) and disposed of in an aquatic environment. In many instances, criminals will mislead investigators into believing that a firearm or knife has been discarded into the water under the mistaken assumption that investigators will "write it off' and not continue to conduct any further efforts to find and recover the weapon. In this regard, it is as important to be able to say that an item is not located in a given area as it is to find the item in the area.

Firearms are undoubtedly the most dangerous of evidentiary items for the diver to recover. Firearms must be handled carefully in that they can discharge a cartridge even after being submerged for several months. Divers must not endeavor to render found firearms safe by unloading them or manipulating the safety, etc. as this can destroy evidence. All firearms must be packaged in an appropriately sized airtight / watertight container (large diameter PVC pipe with screw-on end caps work well) and if loaded, marked as such on the container exterior. An important consideration is the fact that not all firearms are negatively buoyant. The synthetic stocks on modern firearms may be filled with air and thus prevent them from sinking to the bottom. Knives and tools should be packaged similarly to firearms for delivery to the Crime Laboratory.

## ROPE, LINES, AND TAPE

Rope, line, and tape may all have evidentiary value. Anytime these items are suspected of having evidentiary value, their entire length should be recovered if possible. The ends of these materials can be matched to the ends from which they were cut. Any knot must be left as found – do not endeavor to untie or cut through a knot. If it becomes necessary to cut a length of rope or line that contains a knot, cut away from the knot and wrap the end(s) with tape to prevent fraying or unraveling. The sticky side of tape can be an excellent source of fingerprints. Handle any evidence from which fingerprints can be extracted very carefully and place into an airtight / watertight container.

## SUBMERGED AUTOMOBILES

Search and Recovery Divers are many times called upon to search for and recover automobiles that have been driven into or disposed of in an aquatic environment. Usually, these occurrences are a result of unintended accidents or efforts to conceal evidence (IE: stolen vehicles); however, there have been cases of people committing suicide or homicide by causing an automobile to submerge. Additionally, insurance fraud may motivate one to dispose of a vehicle in such a manner.

Upon contact with the surface of the water, an automobile can be expected to have a buoyant longevity of approximately 2-3 minutes. This time frame is affected by the status of the windows and the integrity of the window and door seals. During this time, the vehicle is subject to movement along the surface of the water due to current, surf, etc. Two to three minutes allows plenty of time for a conscious, thinking, non-panicked person to remove his seat belt, roll down a window and escape from the vehicle prior to submergence. Most people, however, will panic and due to ignorance, will roll up windows in an effort to exclude water rather than using a window to affect an escape. Once a vehicle becomes submerged, it may be difficult to open a door or roll down a window due to the pressure created by the water rushing in. Once the water pressure on the interior of the vehicle is equalized with that on the exterior it becomes much easier to open a door or window.

At the scene of a "vehicle in the water" incident, the roadway and adjacent area should be surveyed for tire tracks and skid marks. In addition, the area should be checked for damage to fences, guard rails, sign posts, shrubbery, etc. Debris from the vehicle itself may be present such as stripped off parts or fluids. There may be objects floating on the surface that are out of place. A fuel slick may emanate from the submerged vehicle, which provides a hazmat issue.

Prior to investigating or exploring any submerged automobile, divers must establish the stability of the vehicle. If in a current, vehicles should always be approached from the upstream side, if possible, unless the vehicle is known to be stable in the position in which it rests. Automobiles tend to sink nose first and descend in a vertical manner due to the weight of the engine. (An exception would be a rear engine vehicle such as the Volkswagen Beetle). Roofs of automobiles tend to indent slightly upon submergence due to the lower ambient pressure of the passenger compartment. In less than 15 feet of water, automobiles will tend to settle on their wheels; at greater depths, they tend to "turn turtle" and come to rest on their roofs. Vehicle electronics (headlights, tail lights, power windows, etc.) tend to remain operational for a period of approximately ten minutes following submersion.

With the advent of hybrid and electric vehicles, there has been a concern that a diver could possibly become electrocuted by working about such vehicles. A lot of myth and misinformation has accompanied these concerns. Due to the design features of hybrid vehicles, unless the HV battery receives a signal from the vehicle computer, its energy is contained within itself. Vehicle computers are not designed to function in a submerged environment. Once the vehicle computer is wet, it is incapable of sending a signal to the HV battery. Thus, the voltage contained in the HV battery of a hybrid vehicle poses no greater danger to a diver than does a standard 12—volt system battery.

It is a myth that a vehicle can retain a breathable air pocket when submerged. Water will seek to, and in fact will eventually fill every available air space within a vehicle. Upon impact, the rear seat of an automobile may very well dislodge giving access to the trunk from the passenger area. Small children and other buoyant objects within the vehicle may be floated into the trunk. Older persons may migrate into the trunk since it will be the last place within the automobile to hold air.

## SUBMERGED BUSES

When driven into water at extremely low speed (less than 8 mph), buses will tend to float for as long as 3.5 minutes. When driven into water at speeds greater than 8 mph, buses tend to sink in less than 20 seconds. As opposed to the 2–3-minute escape leeway offered by automobiles entering the water; buses afford little chance of escape. This is due to the fact that the front windows and accordion doors of buses are designed to give way upon impact in order to provide escape routes for dry-land passengers. A bus driven into water has its windshield and doors immediately compromised allowing water to rush in.

Small buses tend to sink in less than nine seconds. In water deeper than the length of any bus they all tend to “turn turtle” and land upside down.

## VEHICLE SEARCHES

A safety line running from the vehicle to a surface float should be established prior to initiating the search of the vehicle. Divers should first survey the area around the vehicle for evidence or property, which may have liberated itself from the vehicle. The vehicle must be examined for exterior damage in as much as the recovery process will undoubtedly cause additional damage.

The interior of submerged vehicles should be partially searched prior to their recovery. Doors must be opened slowly and carefully in order to prevent floating objects inside the vehicle from being lost. Any closed and secured containers (e.g., glove box, console cabinet, trunk, etc.) should not be examined underwater as doing so may allow for the escape and loss of evidence or property. Divers should work in pairs with one searching the vehicle while the other serves as a “safety”. A diver should not enter a vehicle completely, but instead reach into and examine the vehicle with his head, hands, arms and torso while keeping his legs and feet outside the vehicle. Items found floating at the headliner as well as loose items on the seat and floorboards should be collected so as not to be lost during the process of vehicle recovery. A check for possible victims should be made under the dash, on the floorboards, and if the rear seat has dislodged, in the trunk of the vehicle.

Divers should take particular note of any obvious absence of any personal items / effects inside the vehicle.

Significant items that should be noted prior to the recovery of a submerged vehicle include the following:

- Damage to the vehicle exterior?
- Resting position of vehicle (IE: upright, on side, on roof)?
- Direction the vehicle is headed (N / S / E / W)?
- Depth?
- License Number?
- Open doors / windows?
- Windows intact?
- Doors locked?
- Keys in ignition? If so, in what position?
- Vehicle in gear?
- Parking brake on?
- Light switch on or off?
- Condition of tires?
- Location of unusual objects inside vehicle.
- Absence of valuables or personal items in vehicle.
- Location of victim(s) within or in proximity to vehicle.
- If inside, is seatbelt(s) fastened?

## SUNKEN WATERCRAFT

Sunken vessels confront the diver with many of the same issues as do submerged vehicles. Additionally, when checking the interior of small boats, divers must be aware that exhaled bubbles may create enough buoyancy for a boat to rise to the surface.

The procedure for the search and recovery of sunken vessels is generally similar to those for vehicles. Significant items that should be noted prior to the recovery of a sunken vessel include the following:

- CF Number?
- Determine the vessel's heading.
- Determine the position of the vessel relative to other watercraft or markers (e.g., buoys, reefs, rocks, etc.)
- Depth?

- Hull damage?
- Position of vessel?
- Position of ignition and light switches?
- Presence / absence of Marine safety equipment (e.g. radio, PFD's, flares. etc.).
- Anchor deployed / set?
- Evidence of fire / explosion?

## SUBMERGED AIRCRAFT

Aircraft which crash into the water will most likely not resemble anything similar to their former configuration. For the most part they tend to be a heap of twisted, jagged metal with exposed wires and cables. The wreckage may not resemble an aircraft at all. Many times, aircraft will break into several large pieces upon contacting the water. Divers must be extremely careful when operating around submerged aircraft in that jagged metal can cut exposure suits and BCD's and loose cable and wiring constitutes an entanglement hazard.

Any downed aircraft, whether on land or submerged, falls under the jurisdiction of the Federal Aviation Administration and the National Transportation Safety Board. Aircraft cannot be recovered unless authorized by the FAA or NTSB (Federal Law CFR 14, NTSB 830).

Significant items that should be noted concerning a submerged aircraft include the following:

- Tail number (N number) of the aircraft?
- Depth?
- Damage? As noted above this will generally be extensive, however note should be made of same due to the fact that the recovery process will alter the wreckage from its bottom configuration.
- Position of landing gear? (e.g., extended, retracted, or separated)

There are hazards attendant to any downed aircraft of which divers must be aware:

- Aircraft cables and wiring are extremely resilient and difficult to cut
- Sharp jagged metal will cut BCD's and exposure suits
- Aircraft fuel in the water is hazardous
- Hydraulic fluid is caustic

Commercial aircraft carry an in-flight recorder commonly called the “black box” which is critical in determining the cause of the aircraft failure and is important to recover. Commercial aircraft present the following hazards:

- High-pressure pneumatic tires
- High-pressure hydraulic lines
- High-pressure oxygen cylinders

Military aircraft present even more hazards by way of the munitions that they may carry as well as the crew’s ejection system, which is operated by explosive charges.

Penetration of any sizeable submerged craft (IE: bus, airliner, large vessel, etc.) requires overhead environment procedures and safeguards.

## BODY RECOVERY

Drowning can be accidental, suicidal or homicidal. The vast majority of bodies recovered by SAR divers are the victims of accidental drowning. However, it is important to consider that even when what is described by witnesses present as an accident, there may be physical evidence present to dispute what a witness says occurred.

In any underwater body recovery, wherein suspicious circumstances or foul-play are involved, divers must be extremely careful not to stir up the underwater scene prior to its being photographed and diagrammed. The victim’s body must be marked either by the diver’s search reel, or alternatively by a line and surface marker. The area around the body must be checked for evidentiary items. Note should be taken of any peculiar characteristics concerning the body and/or its surroundings. Prior to recovering the body divers must determine the depth, water temperature, direction from the anchor point, and the distance from the anchor point. Upon being lifted to the surface, the time that the body is removed from the water must be noted. It is generally the best practice to have the Coroner and Major Crimes Investigators present on-scene at the time the body is removed from the water. Upon removing a body from its underwater resting place, divers should search the immediate area in order to locate and recover any evidence or personal effects of the victim that might exist there.

## PHYSIOLOGICAL MANIFESTATIONS RELATING TO DEATH

There are a variety of physiological manifestations, which surround death that should be observed:

### RIGOR MORTIS

Rigor mortis or post mortem rigidity is a chemical reaction within a deceased body that results in muscle stiffening. Rigor begins immediately after death in the small muscles of the body, progresses to the larger muscles, and is totally developed within about 12 hours. Colder temperatures tend to retard the process; while warmer temperatures accelerate the process. Rigor leaves the body in the same order as which it appears: smallest muscles first. The intensity of rigor in a body is dependent upon muscle mass. Rigor may not appear to be present at all in infants or in elderly persons. In some cases, rigor may have to be "broken" in order to get a body into a body bag. This involves forcing a limb or limbs into a desired position in order to facilitate the bagging process. Although termed "breaking rigor", nothing is in fact broken. If this is done to facilitate handling the body, the Coroner just needs to be informed of such.

### LIVER MORTIS

Liver mortis or post mortem lividity is a discoloration of the lower areas of the body due to the gravitational pull on the blood within the body causing it to settle. Lividity appears as a purplish discoloration and is usually visible within 30 minutes following death. Lividity is fully developed within eight hours of death and is "set" within twelve hours.

Lividity does not usually develop in drowning victims due to the fact that the blood, a liquid within the body, does not settle when surrounded by a liquid environment. A body found in water, which displays pronounced post mortem lividity was likely placed into the water sometime after death. There are two exceptions, which occur in moving water:

### CURRENT LIVIDITY

Blood pooling on the downstream side of a body caused by the current pressure exerted on the upstream side.

### COMPRESSION LIVIDITY

The absence of lividity caused by pressure exerted on the body by some object which forces blood away from the area of the body affected. Compression lividity appears as a pale or white area due to blood being forced out of the tissues against which pressure is exerted.

## TRAVEL ABRASIONS

Travel abrasions can occur when moving water transports a drowning victim, and while in the process of moving, parts of the body are dragged over gravel, rocks, tree branches, etc. Keeping in mind that a drowning victim will usually assume a supine fetal position in the water, as the current moves a body along, injuries can occur to those areas exposed to objects on the bottom (e.g. forehead, nose, elbows, forearms, back of hands, knuckles, knees, top of feet, toes).

## OCULAR CLOUDING

Ocular clouding is indicated by the presence of a horizontal line across the eye following death. Ocular clouding is caused by the exposure of a portion of the open eye to air and the resultant drying following death. A grayish lateral line will appear over the portion of the eye that was open and exposed to air at the time of death. This can be contrasted with the portion of the eye that was covered by the eyelid and thus kept moist. Ocular clouding will not occur in a drowning victim since the entirety of the eye will be kept moist by the submergence in water. A drowning victim who displays ocular clouding should raise red flags with respect to the road that the investigation must follow.

## WHITE FOAM

Many times, a recovered drowning victim will emit white foam from the mouth and/or nose. The presence of white foam is an indication of the presence of water in the lungs. It does not necessarily indicate that death has occurred. Personnel should be guided by the time of the occurrence of the incident with respect to rendering medical aid to a drowning victim who is emitting white foam from the oral / nasal cavities.

# HOW TO RECOVER A BODY

Body retrieval from an underwater environment can be accomplished in several ways:

1. Bagging
2. Trap Lift
3. Grab and Go

4. Body Bag

Upon locating such a body, the diver should place his search reel in close proximity to the body and follow his search line back to the anchor at the ascending/descending line. It may be desirable to further mark the location of the body with a separate surface buoy in order to facilitate photographs and GPS readings at the surface. Once there the diver should communicate the discovery to the topside communications operator and await instruction. The diver may be told to return to the surface to obtain body retrieval equipment, or alternatively told to wait and equipment will be brought to him.

## BODY BAGGING

A body that has been submerged for several days indicates a definite preference for bagging. Should the body display signs of decomposition, the head and hands should be bagged separately in order to best preserve evidence that may be necessary for identification.

There is a body bagging system that was specifically designed for use by dive teams in underwater body recovery. This a system is known as the "x7ix Victim Recovery System". It consists of a collapsible metal ring to which a large mesh bag which is sealed on one end is attached. When deployed, this device resembles a diver's "catch bag" – on steroids. The bag is placed over and around the body, the ring which closes the bag serves as a handle to which a closed-circuit lift bag can be attached. The body can then be sent to the surface. Alternatively, a diver can swim the bag to the surface. This entire process can be accomplished by one diver.

Should this victim recovery system be unavailable, a standard body bag will have to be deployed. In the bagging process utilizing a standard body bag, the bag should be staged prior to being submerged, that is the bag should be unfolded, unzipped, and re-folded. The bag should be placed over and around the victim (as opposed to moving the victim to the bag) and the zipper closed as much as possible in order to afford the least possibility of evidence and / or property being lost. The bag and victim can then be turned in the water and the bag completely zipped. Once the victim is secured in the bag, the surface communications operator should be notified to remove all watercraft from the immediate area. The body should then be lifted via closed-cell lifting device in order to eliminate the possibility of air spillage at the surface and having to conduct a repeat search for the body and body bag. This bagging process requires the coordinated r efforts of two divers.  Divers should NEVER ride nor accompany a body and lift device to the surface, as a slow, controlled ascent is virtually impossible, and doing so subjects the diver to decompression injury.

The weight of an adult in water is approximately 8-16 pounds, thus a single closed-cell (85#) lifting device will provide more than adequate lift to buoy a body to the surface.  Once the lifting has been accomplished, the victim can be lifted onto a watercraft through the efforts of both surface and in-water personnel.

After being partially lifted aboard the watercraft, the zipper of the body bag should be relieved so as to drain water from the bag and reduce its weight. Divers in the water should keep their Full-Face Masks in place on their faces, or alternatively keep their dive masks on and second stage regulator in their mouths.  As water is drained from the bag and the weight decreased, personnel aboard the watercraft can lift the bag containing the victim aboard.

## STRAP LIFT

In cases where a victim has been in the water for a relatively short time, where a body bag is not available, where trace evidence recovery is not a concern, or in those cases where the physical size of the victim does not lend itself to body bagging, a strap lift can be employed.  One of two strap methods can be utilized:

1. A Hanson Harness
2. A Pick-Off Strap

In either case, the strap is secured about the victim and a closed-cell lift bag attached to buoy the body to the surface.

## GRAB ‘N GO

The grab ‘n go method of body retrieval is either the most desirable method or the least desirable method to employ:

In cases where a rescue may be possible, the grab ‘n go is definitely the method to be utilized.  In any case where there is a chance that a victim can be resuscitated, he should be returned to the surface as quickly as possible (keeping in mind of course a safe ascent rate for the diver).  The diver should raise the victim in a head down position (grabbing the victim by an ankle is suggested).  If practicable, the diver should either follow his ascending/descending line to the surface, or alternatively deploy a separate marker buoy and line for the ascent.  By so doing, topside personnel can position watercraft so as to immediately receive the victim on board in order to initiate CPR.  By ascending the line, should a mid-water stop be mandatory for the recovery diver, another diver can meet him on the line and take over the transport of the victim to the surface.

In those cases where victim rescue is not feasible, the grab ‘n go becomes the least desirable recovery method due to the possibility of evidence or personal property and effects becoming lost during the recovery process.

***NOTE:***

*In those instances, wherein the body of a recovered drowning victim has not been bagged in the water, it should be bagged at the water’s surface or aboard a watercraft, but never within the view of the victim’s friends and/or family members nor the media.*

# CHAPTER 19 UNDERWATER NAVIGATION

Navigation underwater can be uniquely challenging. Swimming a straight course underwater without navigational aids, is akin to rowing a boat in the fog. Without either a compass or underwater landmarks to assist him, a diver might believe that he is swimming a true course, however in reality, is likely to be swimming an extremely inefficient pattern.

Underwater navigation must begin prior to the dive with proper dive planning. Once below the surface of the water, the diver (unless using submerged geographical features to determine his course) can only follow the compass bearing that he has taken at the surface prior to beginning the dive, or conversely follow verbal direction provided from topside via electronic communication.

## FACTORS THAT INTERFERE WITH UNDERWATER NAVIGATION

There are numerous phenomena that will serve to interfere with any underwater navigational effort:

- **Current** – Pre-dive planning should include an observation of the current running at the dive site. A running current will indicate a necessity for a course correction by a diver in order to arrive at the desired destination. (Unless of course, the diver is swimming with the current). The amount of correction necessary is dependent upon the strength of the current. Current has an advantage for a navigating diver in that if it remains constant as to its intensity and direction, it provides a directional reference. In other words, a slight current might be beneficial in keeping a diver oriented in the water.
- **Swimming Technique** – It is important that the navigating diver maintain a consistent output of effort. The tendency is to sometimes put fourth too much effort at the beginning of a swim and to tire prior to completing the swim, thus adversely impacting efficiency. Additionally, a diver who favors his dominant kicking leg will not swim a straight course.
- **Compass Error** – There are a variety of phenomena that will induce error into a compass reading and thus adversely affect a navigational effort:
    - **Declination** – is the difference between where the compass needle points (Magnetic North) and the direction to the true North Pole

(True North). Declination is caused by a shift in the position of Magnetic North over a period of time due to the westerly drift of the Magnetic North Pole. The rotation of the earth, the liquid core of the earth, sunspots, diurnal change (solar winds), and other anomalies cause this shift of Magnetic North. Compass declination is constantly changing, albeit slightly. For example, for the year 2022, compass declination of local areas is as follows:

- Thousand Oaks (Zip Code 91360) = 11 degrees, 48 minutes East
- Camarillo (Zip 93010) = 11 degrees, 51 minutes East
- Ventura (Zip 93001) = 11 degrees, 55 minutes East

- This means that for the Ventura County area, there is presently a variation of approximately 12 degrees East between Magnetic North and Polar North, or True North. Or in other words, Magnetic North lies to the East of True North by approximately 11-12 degrees. Declination for this area changes by 5 minutes (approximately 300 yards) West each year. In order to adjust the compass needle so as to indicate True North, the bezel must be rotated 12 degrees to the West. (Since most compasses used for underwater navigation utilize ten-degree correction, this correction is at best, an estimation, but a very close one). In reality, declination has a negligible effect upon underwater navigation due to the relatively short distances that a diver will navigate. However, a diver should realize that a failure to set declination on his compass, if given direction from topside via corrected compass, will lead to a navigational error of as much as 25% of the total distance covered. For this reason, it is suggested that the underwater compass and topside compass, when utilized in a coordinated search effort, both be set with Magnetic North as 0-degrees.

- **Deviation** – the difference between the course shown on the compass and the actual magnetic course being followed due to interference from a magnetic field. Since the compass is a magnet, it will be attracted to ferrous metals and repelled by other magnets. Ferromagnetic objects (e.g., iron. steel, nickel, cobalt, copper, etc.) cause deviation. Geographical landmark features such as faults, lava beds, ridges, seamounts, mountains, and ground that has been struck by lightning can likewise cause compass deviation. Magnetic fields created by boat engines operating on the surface can affect the compass needle, as can large submerged metal objects such as the steel hull of a sunken ship. Indeed, items of a diver's equipment (e.g. steel cylinders, knives and tools, flashlights and/or batteries, DPV's, watch, dive computer, comm. unit, search reel, metal BCD and weight belt buckles, D-rings, split-rings, etc.) can all affect the performance of the compass if positioned too closely thereto. The difference between declination and deviation is that the compass bezel can be corrected for declination; whereas deviation must be corrected by means of "Kentucky windage."

The navigation of an underwater course of direction can be accomplished via three methods, or combinations thereof:

1. Natural Navigation
2. Compass Navigation
3. Direction via Electronic Underwater Communications

## NATURAL NAVIGATION

Natural navigation is possible when water clarity gives enough visibility for the diver to positively identify certain underwater topographical features such as: rock formations, vegetation beds, sand ripples, water movement, etc. Additionally, any man-made objects that have been placed or discarded into the water (IE: pipelines, cables, trash, plumbing fixtures, etc.) can serve the same purpose.

## COMPASS NAVIGATION

Compass navigation must be utilized when water clarity does not allow for the use of landmarks, or when such are not present. The underwater compass must have a rotating bezel as well as a clearly visible lubber line and needle. Numerical bearings on the compass must be large enough and clear enough to be easily read. It is also helpful if the compass dial is phosphorescent.

The diver can carry a compass in one of several ways:

- The **wrist-mounted compass** is traditional, but is probably the most difficult to utilize due to the fact that in order to swim an accurate heading, the compass must be constantly held level and in line with the centerline of the body. This is nearly impossible to accomplish with a wrist-mounted compass. Additionally, the wrist-mounted compass has a propensity for hanging up on objects when reaching into tight places, snagging line, and is closer to the diver so as to be more affected by compass deviation (see below).

- The **console-mounted compass** is probably the most popular and provides a more accurate method of navigation than does the wrist-mount.
- A **compass mounted to a retractor** attached to the diver's harness, or conversely mounted to a neck lanyard is easier yet to utilize accurately.
- Probably the easiest and most accurate method of underwater compass navigation involves the use of a **navigation board**.

In order to set a compass course, a bearing (the direction of an object from your position) must be obtained prior to submergence. If for example, the directional bearing is determined to be 270 degrees, the bezel of the compass is set with 270 appearing between the lubber lines. The diver then swims the 270-degree heading until he reaches his destination. Upon completing his mission, the diver takes a reciprocal heading (180 degrees) from the point where he arrived in order to return to his point of origin. In this instance the reciprocal heading is 90 degrees.

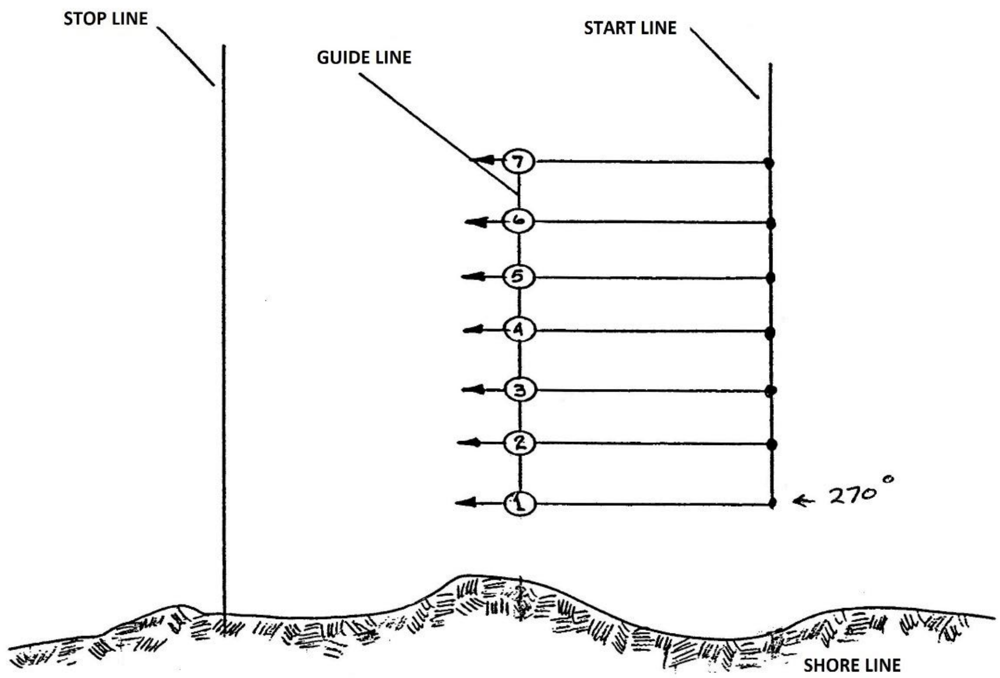
Navigation is a function of both direction and distance. As mentioned above, direction can be determined through a variety of means. Distance must be determined through kick cycles. A kick cycle is one kicking revolution. While every diver is different with respect to the length of his legs, his strength, the type of fins utilized, and the hydrodynamic drag created by his equipment, as a rule of thumb, one complete kick cycle will move a diver approximately three feet in the water column. Of course, this requires that the diver be and remain neutrally buoyant so as to not have to expend energy in defiance of gravity and that the diver be capable of sustaining the same strength of kick throughout the distance traveled. It is recommended that a dive team of two be utilized when employing compass navigation: one diver concentrates on the compass bearing; while the other counts kick cycles.

## COMPASS-BASED UNDERWATER SEARCH PATTERNS

Unless the object of the search is relatively large, the use of the compass in conjunction with the search pattern will interfere with the diver's visual search of the area covered. Various search patterns can be run with the assistance of the underwater compass.

## STRAIGHT SWEEP COMPASS PATTERN

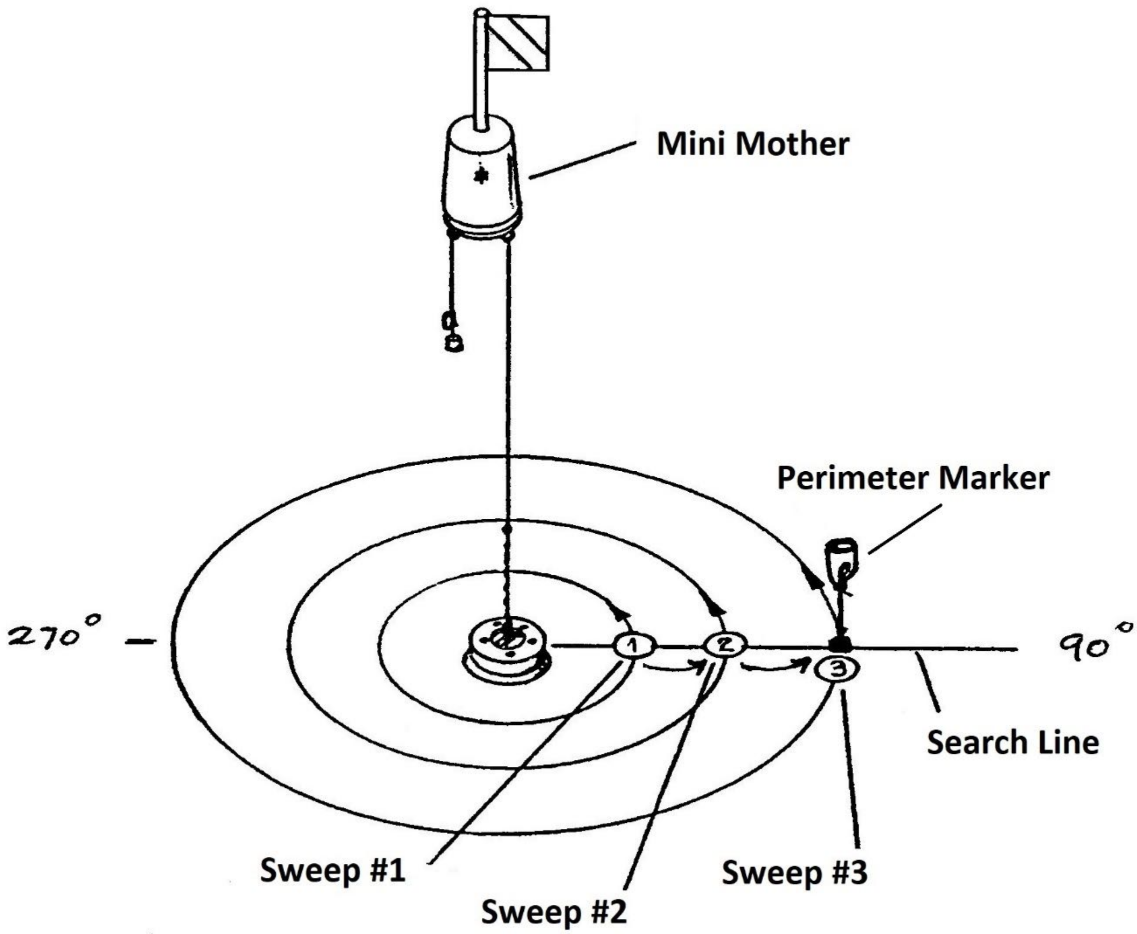
The **straight sweep** can be accomplished by having one diver on the line follow a compass bearing.




**Straight Sweep Compass Search Pattern**

## CIRCULAR SWEEP COMPASS PATTERN

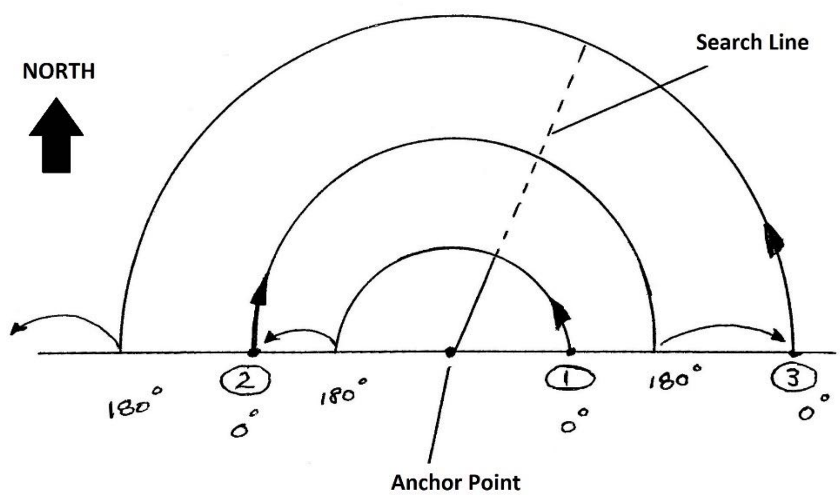
The **circular pattern** can be conducted by utilizing a given compass heading to begin the sweep, and upon reaching that heading again, the diver will know that one complete revolution has been completed and that the pattern should be expanded.




**Circular Sweep Compass Search Pattern**

## SEMI-CIRCULAR COMPASS PATTERN

A **semi-circular pattern** can be accomplished by taking a compass heading and swimming until the reciprocal heading is reached (e.g. 0 / 180; 45 / 225; etc.) then turning around. Expanding the pattern and returning via the original heading, where the pattern is expanded again, etc.




**Semi-Circular Compass Search Pattern**

## DIRECTION VIA ELECTRONIC UNDERWATER COMMUNICATIONS

Direction via Electronic Underwater Communications can be accomplished by combining the features of the underwater scanning sonar with the electronic diver communication units. The sonar operator identifies underwater “targets” picked up by the sonar and directs divers to the suspected object via voice communications utilizing either compass headings, or more simply, directional turning instructions.

# CHAPTER 20 SURF OPERATIONS

Search and recovery efforts in surf environments can be uniquely challenging. The movement of water onshore must be dealt with either in getting the diver(s) and search equipment to the PLS, actually conducting the search, or returning the diver(s) and equipment to the beach. In some cases, all three scenarios must be accomplished during the course of the search. Initially, divers should survey the water and its movement with a view toward such features as wave height and length of periods between sets, rip currents which may assist in entry, and desirable entry / exit points.

## SURF ENTRY

In preparing to enter the surf zone, divers must ensure that all equipment issues (e.g., tightening of straps, buckle fastening, etc.) are resolved prior to approaching the water. The surf zone is no place to be fiddling with equipment adjustments. The diver's attention must be on the surf and its movement. The facemask should be on the face with either the snorkel or the regulator in the mouth. It is recommended that the facemask strap be worn under the hood in order to prevent the mask from being washed off the head and lost. The fins should either be worn on the feet or carried with the fin straps threaded over the forearms to prevent loss should the diver be knocked down by a wave. By threading the fin straps upon to the forearms and holding the base of the foot pocket of each fin in the hands, the diver is prepared to don the fins quickly should it become necessary. The BCD should be empty of air in order to allow the diver to dive beneath a wave if necessary. A functional low-pressure inflator is required on the BCD due to the fact that a SAR diver may be transporting equipment (extra weight) through the surf zone and once in deep water, may need to quickly increase buoyancy.

Entering the surf zone has been compared with crossing the freeway, and for a fully dressed-out scuba diver transporting search equipment, the hazards can be comparable. If one were to endeavor to cross a multi-lane freeway on foot, it would be important to assess the flow of traffic from the side of the freeway, near the flow of traffic, but far enough removed from the speeding vehicles to insure one's safety. Timing the waves that roll upon to the beach must be accomplished in much the same manner. A diver can get close to the breaking waves without actually exposing himself to their energy by standing in ankle-to-knee-deep water and timing the sets.  In any given set of waves, there will be larger waves and smaller waves.  The idea is to move through the surf zone during the period of the smaller waves.

If the surf is small enough, divers can simply walk out through the waves, donning their fins on the far side of the surf zone.  However, divers must be capable of making good judgments as to the size and intensity of surf.  A diver getting rolled by a wave in the surf zone as he endeavors to walk out through the surf carrying his fins will find himself "diving" without the benefit of any power to move himself in any direction, and is at the full mercy of the surf.

Larger surf will dictate that the fins be donned on shore (in ankle-to-knee-deep water) and that the diver shuffle his feet in a backward direction with his back to the surf and looking over his shoulder to watch the movement of incoming waves.  The facemask must be held in place by a free hand lest it be knocked off the diver's face by a wave and lost in the surf.  Wearing the hood on the outer side of the mask strap will assist in mask retention.

As a diver progresses through the surf zone, they will experience the flow of water both coming up from behind him as it travels to the beach; and the return flow from the beach back to the ocean.  The diver can pivot on one foot to change his direction momentarily to better cope with the forces of this opposing flow.  Once the diver makes the decision to enter the surf zone, it is important that they do not stop until he reaches the safety of deeper water on the far side of the surf zone.

If the surf is moderate to heavy, it is advisable that the diver enter and exit the surf with their regulator in their mouth.  The amount of air depleted from the tank is insignificant considering that beach dives tend to be relatively shallow and it will prevent sand and debris from clogging the regulator and causing a free-flow of air from the cylinder, or otherwise rendering the second stage regulator inoperable.

## RIP CURRENTS

Rip currents are powerful, channeled currents of water that flow away from shore.  They typically extend from the shoreline, through the surf zone, and past the line of breaking waves.  Sometimes a rip current will end just past the "breakers", but sometimes they continue to push hundreds of yards offshore.

Rip currents can be especially dangerous for weak swimmers or non-swimmers who get caught up in them. Over 80% of all beach rescues and beach drownings are attributed to rip currents. Conventional wisdom with respect to rip currents has taught that if caught in a rip current, one should swim perpendicular to the direction of the current (parallel to shore). However new research indicates that this may not always be the best course for escaping the rip. Some rip currents more closely resemble whirlpools as opposed to rivers and recirculate their water as opposed to merely dumping their energy in deeper water. A swimmer caught in a recirculating rip will not necessarily escape the current by swimming parallel to shore. The best way to escape this type of rip current is to relax and rely on eddies created by the recirculating water to sweep the swimmer back into shallow water.

Rip currents (commonly erroneously referred to as "undertow") are apt to be present on sandy beaches where waves from open water approach at right angles. They can, in fact, occur on any beach with breaking waves. Rip currents typically form at low spots or breaks in sandbars, and near structures such as groins, jetties and piers. They can also occur on sheltered beaches due to the diffraction of arriving waves caused by topographical features.

Rip Currents are often not readily or easily identifiable. However, they can sometimes be recognized by unusually calm water (e.g., an inviting path of calm water intersecting breakers); a channel of churning, choppy water; an area of noticeable difference in water color; or a line of foam, kelp or debris moving steadily seaward. Additionally, the water line is lower on shore in a rip current. Polarized sunglasses can assist in identifying rip currents.

Rip currents can assist in moving divers from the beach to open water. However, caution must be exercised. It is possible for a rip current to move an object as much as ½ mile from shore at speeds of up to 500 feet per minute (5.7 miles per hour). The speed and strength of a rip current is likely to increase as wave height and wave period increase. Rip currents are strongest when the surf is rough or when the tide is low. Rip currents should definitely be avoided when endeavoring to swim from open water back onto the beach.

## SURF EXITS

Upon endeavoring to exit the surf, the diver should face the incoming waves with their back to the beach. The diver should have a small amount of air in their BCD in order to make themselves slightly positively buoyant. The diver should kick with the flow of water allowing the waves to move him into the beach until such time as he can stand comfortably.  At this time, they should remove either one or both fins (depending upon surf conditions) in order to facilitate walking and standing as they back out of the surf.  The fins should again be held by threading the fin straps upon to the forearms and holding the base of the foot pocket of each fin in the hands, in order to be quickly donned again should the diver be tumbled by the surf.

Again, once in the surf zone it is important to keep moving in order to avoid being "clobbered" by incoming surf and rolled up onto the beach.  The only exception is when a diver determines that a large wave might take them off their feet, they should stop momentarily to dive under the wave and once the wave is past him, continue to move toward the beach.

Should a diver get tumbled in the surf either upon entry or exit, it is important that he not try to regain his footing as this endeavor will most likely be unsuccessful causing the diver to be tumbled again and again by relentless incoming waves until he is fatigued to the point that he can't move.  Rather, a tumbled diver should relax and let the water do the work by either washing them out through the surf or in to the beach.  On an entry, the diver fins toward deeper water and begins the dive; on an exit, the diver crawls up onto the beach.

## ROCKY ENTRIES & EXITS

Entry from rocks into the ocean is very much like sandy beach entries except that instead of walking or shuffling into the water, the diver actually "slides" into the water headfirst. The diver should scout the area from shore for a large flat rock free of barnacles, jagged rock outcroppings, or other material that might be injurious should the force of water overcome and roll him.  The diver takes a position on the rocks near the water line.  The timing of sets of waves is essentially the same.  The diver takes a squatting position much like that of a baseball catcher and with the regulator or snorkel in the mouth, fins on, and holding the face mask in place on their face, waits for the incoming water to get high around him then slides forward into the water and kicks out with the returning water.

In exiting the water onto the rocks, while kicking toward shore the diver allows the water to move and lift him and in essence, deposit them at the desired exit point.  Thereafter they should crawl out of the water and up onto the rocks until they reach a point where it is safe to remove their fins and facemask, then stand and walk.  Wetsuit kneepads are recommended for rocky surf operations.

## SEARCHING THE SURF ZONE

At times searches must be conducted within the surf zone.  In these instances, the type of search conducted and the nature of dive equipment utilized are dependent upon the size and nature of the surf.  Drowning victims who succumb off the beach are many times located in underwater trenches adjacent to sandbars which run parallel to shore and are caused by wave action.  These types of searches are extremely challenging for the diver in that the surge of water is continually moving them to and from and additionally crashing down on top of them.  It is important in these searches for the diver to relax and take their time, allowing the water to move them from and return them to the area they desire to search.  Care must be taken with respect to the size of the surf: a diver searching in the surf zone can suffer an embolism by taking a breath of air with a large wave overhead and neglecting to exhale as the wave passes.

It is most advantageous to run surf operations from a boat or other suitable platform outside the surf zone.  Deploying divers from a surface craft gives divers the best communication with the dive master, allows for a more rapid spotting and placement of mini-mothers, permits a more rapid recovery of divers, and exposes dive personnel to a lesser danger of injury.  Alternatively, a PWC and sled can be utilized to transport divers and mini-mothers through the surf zone.

Equipment utilized in surf operations should be pared down as much as possible. Divers should carry only that equipment that is needed or likely to be needed. Surf operations do not lend themselves to the use of such equipment as full-facemasks, pony bottles, etc.

# CHAPTER 21 MEDIA CONTACTS

Depending upon the nature of the SAR dive operation, representatives of the media (newspaper / television reporters and/or photographers) may be present or arrive at the scene. While it is the obligation of the Sheriff's Office to cooperate with the media in providing public information, any and all information released to the media must be appropriate and sensitive to the family of any drowning victim or missing person presumed to be drowned.

## SECTION 409.5 OF THE CALIFORNIA PENAL CODE

Section 409.5 of the California Penal Code gives Peace Officers (e.g., sworn Sheriff's Office personnel, park rangers, etc.) the authority to close an area at the scene of an accident, disaster, or crime and to deny access to the area to unauthorized persons except members of the news media [PC409.5(d)].

Although media representatives have access to a scene, they are not permitted to enter an area where their presence endangers the life or safety of another or might destroy or contaminate physical evidence. Nor are they permitted to interfere with, or impede rescue or recovery operations. [PC148(a)(1)].

It is important to recognize that media representatives are, in most cases, merely trying to "do their job" and quick cooperation with media requests will generally result in their timely departure from the area.

## SPEAKING DURING OFFICIAL INTERVIEWS

The on-scene Sheriff's Office Incident Commander and/or Public Information Officer (PIO) will be responsible for liaison with, and the release of information to the media. On occasion, media representatives may request to speak with someone involved in the actual search process. Should this occur, the following are guidelines for statements to the media:

- Do not mention the name of any victim. Family members should be personally notified by friends / family of the victim, or by a representative of the Medical Examiner or Sheriff's Office – not by the media.
- Do not mention the names of any witness(es) to the event, or any family member(s) of the victim(s).

- Explain what efforts are being made to locate the missing individual(s) but do not speculate as to the cause of the drowning accident.
- Do not speculate on body re-float time should underwater search efforts be unsuccessful. There is a myriad of factors that can influence the amount of time that may be involved in the re-float of a submerged body:
    - Water temperature at the location of the body. Colder water will retard decomposition; warmer water will hasten it.
    - Depth of the body. If deep enough, the body may never produce enough gas to overcome ambient water pressure and rise to the surface.
    - Clothing worn by the victim. Heavy clothing will tend to weight a body. Clothing articles made of Gore-Tex. etc. may trap air within the garment and hasten resurfacing. Tight fitting clothing may retard gas production and bloating.
    - Victim's body type. Body mass, bone mass, amount of fat tissue, etc. all have an effect.
    - Type of water involved. Seawater supports more bacteria than does freshwater. Murky water is more conducive to bacterial action than is clear water.
    - Time and type of food last ingested by the victim. Meals high in sugars and carbohydrates will hasten the production of gases in the digestive tract.
    - Marine life present. Certain types of marine organisms will attack and feed from the body.
    - Mode / cause of death. Traumatic injury may accelerate decomposition; however, a large torso injury may vent gasses from the body.
- Do not make "off the record" comments to members of the media – nothing is off the record.
- Be careful and sensitive concerning any comments made to other SAR team members, Sheriff's Office officials, etc. as the media has very sophisticated listening / filming equipment.

## CHAPTER 22 SWIFTWATER RESCUE OPERATIONS

Swiftwater operations are among the most dangerous of all aquatic operations. It is crucial to life and safety that all personnel deployed on an incident involving swift moving water possess the knowledge of the dynamics of such water and the techniques for safely operating in same.

SAR Dive Team members are trained in swiftwater operations. Actual participation in swifter events is discretionary with individual team members. Swiftwater teams may be comprised solely of Dive Team personnel, or may be comprised of a combination of personnel from various County SAR teams trained in swiftwater rescue techniques.

Personnel participating in any swiftwater operations must possess the following equipment:

- Helmet suitable for water operations
- (Personal Floatation Device (PFD) rated by the U.S. Coast Guard as either "Type III" or "Type V"
- Wetsuit (3-4 mm recommended, gloves and booties or tennis shoes
- Swim fins – short stiff fins for quick bursts of power in shallow water
    - NOTE: dive fins are generally not appropriate due to excessive length
- Knife – sharp, attached to PFD
- Whistle – loud, attached to PFD
- Personal throw bag
- Waterproof flashlight

On those swiftwater operations that involve a sizeable body of rapidly flowing water, all personnel within ten (10) feet of the water's edge **must wear a helmet** and PFD.

The SAR dive equipment truck carries a swiftwater systems bag with line, carabineers, ascenders, figure eights, anchor straps, prussic lines, etc. for setting up a rope system or zip line.

Swiftwater certification is conducted by Sheriff's Office SAR personnel certified as swiftwater instructors. Personnel must re-certify in swiiftwater procedures every two years in order to remain current.

# CHAPTER 23 DIVING AT ALTITUDE

High altitude presents some interesting challenges for human beings. At altitude there are a variety of maladies that can affect everyone, although some people seem to be more susceptible than others. There are additionally other concerns at altitude, which divers must heed.

## ALTITUDE SICKNESS

At altitudes greater than 7000 feet, the decreased partial pressure of oxygen, commonly referred to as “thin air” can cause arterial hypoxemia due to low inspired fractional concentration of oxygen. This malady is commonly referred to as **acute mountain sickness**. Those newly exposed to high altitude may, within 3-4 hours, experience shortness of breath, rapid heart rate, headache, vomiting, insomnia, swelling of hands and feet, and malaise. These symptoms generally disappear with rest and acclimatization. Prevention of altitude sickness lies in adequate hydration and allowing a 24-hour period of acclimatization to the altitude, if possible, prior to initiating physical activity.

Those who travel to elevations near the 8,000-foot level and neglect to allow for acclimatization may experience **high altitude pulmonary edema (HAPE)**, an accumulation of fluid in the lungs. Symptoms will generally appear within 18 hours of arrival at altitude and can be inclusive of: shortness of breath, (especially upon exertion), rasping cough producing a pink, frothy sputum, bluish colored lips, elevated pulse, elevated body temperature, and chest pain. Treatment requires an immediate removal to lower altitude and hospitalization. Prevention consists of adequate acclimatization and reduced exertion.

Upon spending 2-3 days at altitudes near or above 10,000 feet, **high altitude cerebral edema (HACE)** can develop. HACE is caused by the swelling of brain tissue from fluid leakage. Symptoms can include: headache, loss of coordination, weakness, confusion, decreasing levels of consciousness, disorientation, memory loss, hallucinations, irrational behavior, and coma. HACE is frequently fatal. Immediate descent and hospitalization are mandatory.

Both pulmonary edema (HAPE) and cerebral edema (HACE) are serious, potentially fatal afflictions. Acute mountain sickness, while not in and of itself fatal, can progress into HAPE or HACE. At high altitude, any diver displaying any symptoms of altitude sickness must not be permitted to dive and should be immediately removed to lower altitude, administered oxygen (if available), and medically evaluated.

## DIVE OPERATIONS AT ALTITUDE

Special precautions must be taken for altitude dives due to the fact that atmospheric pressure is lower at altitude than at sea level. Surfacing at the end of an altitude dive results in a greater reduction in pressure than occurs following dives at sea level, and thus an increased risk of decompression illness occurring.

Generally, altitude becomes a concern for divers at 1000 ft. or greater above sea level. All of the bodies of fresh water in Ventura County require that slight altitude adjustments be made in order to dive safely. However, divers must be mindful that Dive Team mutual aid responses to other jurisdictions may involve significantly greater altitudes than encountered locally and required altitude adjustments may be substantial.

The altitudes of local fresh water bodies are as follows:

- Casitas Lake: 600 ft.
- Matilija Lake: 1,100 ft.
- Piru Lake: 1,000 ft.
- Rose Valley Lake: 3,400 ft.
- Sherwood Lake: 1,000 ft.
- Westlake: 900 ft.

Upon arriving at high altitude, it is recommended that a 24-hour period of time be allowed for acclimation, however this is not always possible due to the nature of, and time constraints involved in the diving operation. Divers who intend to make a dive(s) shortly after arrival at altitude must penalize themselves by utilizing a more restrictive repetitive group designator. The following table should be utilized in this event:

**PENALTY GROUP TO BE UTILIZED UPON ARRIVAL AT ALTITUDE**

| Sea Level | 1000 | 2000 | 3000 | 4000 | 5000 | 6000 | 7000 | 8000 | 9000 | 10000 |
|---|---|---|---|---|---|---|---|---|---|---|
| N/A | A | B | B | C | D | E | E | F | G | H |

## GAUGE READINGS AT ALTITUDE

Depth gauges are calibrated for use in salt water at sea level. A depth gauge is accurate only when used in the environment for which it has been calibrated. Depth gauges measure water pressure – not depth. In salt water, each foot of depth is equal to .445 psi; each foot of depth in fresh water is equal to .432 psi. Thus, a depth gauge utilized in fresh water at sea level will register a small error (approximately 3%). However, as altitude increases, depth gauges will register increasing error. Oil-filled gauges will read less than zero at altitude unless there is a pin that stops the needle at zero. At altitude, diaphragm and oil-filled gauges will indicate depths that are too shallow; capillary gauges will indicate depths that are too deep. To correct sea level gauges for fresh water at altitude:

- Diaphragm and oil-filled gauges: add 1 fsw for each 1000 feet of altitude plus add an additional 3% of the gauge reading.
- Capillary gauges: subtract 3.5% of the gauge reading for every 1000 foot of elevation.

The following table can be utilized in determining no decompression times for dives at altitude when using a diaphragm or oil-filled depth gauge:

**GAUGE**

**READING THEORETICAL DECOMPRESSION LIABILITY AT ALTITUDE**

| **Sea Level** | **1000** | **2000** | **3000** | **4000** | **5000** | **6000** | **7000** | **8000** | **9000** | **10000** |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **10** | 10 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 14 | 15 |
| **20** | 21 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| **30** | 31 | 32 | 33 | 35 | 36 | 37 | 39 | 40 | 42 | 44 |
| **40** | 41 | 43 | 45 | 46 | 48 | 50 | 52 | 54 | 56 | 58 |
| **50** | 52 | 54 | 56 | 58 | 60 | 62 | 65 | 67 | 70 | 73 |
| **60** | 62 | 64 | 67 | 69 | 72 | 75 | 78 | 81 | 84 | 87 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **70** | 72 | 75 | 78 | 81 | 84 | 97 | 91 | 94 | 98 | 102 |
| **80** | 83 | 86 | 89 | 92 | 96 | 100 | 103 | 108 | 112 | 116 |
| **90** | 93 | 97 | 100 | 104 | 108 | 112 | 116 | 121 | 126 | 131 |
| **100** | 103 | 107 | 111 | 116 | 120 | 124 | 129 | 134 | 140 | 145 |
| **110** | 114 | 118 | 122 | 127 | 132 | 137 | 142 | 148 | 153 | 160 |
| **120** | 124 | 129 | 134 | 139 | 144 | 149 | 155 | 161 | 167 | 174 |
| **130** | 135 | 140 | 145 | 150 | 156 | 162 | 168 | 175 | 181 | 189 |
| **140** | 145 | 150 | 156 | 162 | 168 | 174 | 181 | 188 | 195 | 203 |
| **150** | 155 | 161 | 167 | 173 | 180 | 187 | 194 | 202 | 209 | 218 |
| **160** | 166 | 172 | 178 | 185 | 192 | 199 | 207 | 215 | 223 | 232 |
| **170** | 176 | 182 | 185 | 196 | 204 | 212 | 220 | 228 | 237 | 247 |
| **180** | 186 | 193 | 200 | 208 | 216 | 224 | 233 | 242 | 251 | 261 |

NOTE: Theoretical depths of dives listed above in light gray colored font will be made only those situations requiring a quick recovery of a located object. Those depths indicated by red colored font are out of policy and such dives will not be conducted under any circumstances.

The following table can be utilized in determining no decompression times for dives at altitude when using a capillary gauge:

**ACTUAL DEPTH, *fsw*** **GAUGE READING AT ALTITUDE**

| **Sea Level** | **1000** | **2000** | **3000** | **4000** | **5000** | **6000** | **7000** | **8000** | **9000** | **10000** |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **10** | 10 | 9 | 9 | 9 | 8 | 8 | 8 | 7 | 7 | 6 |
| **20** | 19 | 19 | 18 | 17 | 16 | 16 | 15 | 14 | 14 | 13 |
| **30** | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 20 | 19 |
| **40** | 39 | 37 | 36 | 34 | 33 | 32 | 30 | 29 | 27 | 26 |
| **50** | 48 | 46 | 45 | 43 | 41 | 39 | 38 | 36 | 34 | 32 |
| **60** | 58 | 56 | 54 | 52 | 49 | 47 | 45 | 43 | 41 | 39 |
| **70** | 67 | 65 | 63 | 60 | 58 | 55 | 53 | 50 | 48 | 45 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **80** | 77 | 74 | 72 | 69 | 64 | 63 | 60 | 58 | 55 | 52 |
| **90** | 87 | 84 | 80 | 77 | 74 | 70 | 68 | 65 | 62 | 56 |
| **100** | 96 | 93 | 89 | 86 | 82 | 79 | 75 | 72 | 68 | 65 |
| **110** | 106 | 102 | 98 | 95 | 91 | 87 | 83 | 79 | 75 | 71 |
| **120** | 116 | 112 | 107 | 103 | 99 | 95 | 91 | 86 | 82 | 78 |
| **130** | 125 | 121 | 116 | 112 | 107 | 103 | 100 | 94 | 89 | 84 |
| **140** | 135 | 131 | 125 | 120 | 115 | 111 | 106 | 101 | 96 | 91 |
| **150** | 145 | 139 | 134 | 129 | 124 | 118 | 113 | 108 | 103 | 97 |
| **160** | 153 | 149 | 143 | 138 | 134 | 126 | 121 | 115 | 110 | 104 |
| **170** | 164 | 158 | 152 | 146 | 140 | 134 | 128 | 122 | 116 | 110 |
| **180** | 174 | 167 | 161 | 155 | 148 | 142 | 136 | 130 | 123 | 117 |

Note: Dives made to depths indicated in light gray font are to be made only for short time durations for the purpose of quickly recovering a located object.

It should be obvious to the diver (from both of the above charts) that regardless of the type of depth gauge utilized, as altitude and/or depth increase, so also does the margin of error in the depth gauge reading.

It is obviously necessary for a diver to know which type of depth gauge he is using in order to determine which of the above tables to employ for the accurate compensation of gauge error. In order to determine the type of depth gauge being utilized (if unknown) a weighted line can be utilized at a given known depth. If the gauge reading is greater than the measured depth, the gauge utilized is a diaphragm or oil-filled depth gauge. If the gauge reading is less than the measured depth, the diver is using a capillary gauge. The best solution to the problem of erroneous depth gauge readings in fresh water is to utilize an altitude compensating dive computer. Computers measure depth of water electronically. Normally, dive computers will either detect and adjust for altitude changes automatically, or incorporate the ability to be programmed for altitude changes by the user and will adjust their decompression calculations to insure a theoretically safe dive at a given altitude. However, not all dive computers are created equal. Consult the manual for the computer concerning diving at altitude. If an altitude-compensating computer is not utilized, a depth gauge and the appropriate high altitude decompression conversion table must be utilized to determine theoretical depths of dives made at various altitudes.

## ASCENT RATE

At altitude, the actual amount of water column that constitutes one atmosphere is less than the 33 fsw that defines one atmosphere of seawater. Thus, an ascent in the water column at altitude must be slower than an ascent from the corresponding depth at sea level to maintain the same rate of pressure change over a given time. The ascent rate for all dives at altitude must be maintained at 30 ft. / min. in order to avoid both decompression problems and lung over expansion injuries.

## SAFETY STOPS

Safety stops are mandatory on all altitude dives. Safety stop depths vary from that indicated for dives at sea level according to the altitude of the dive. Ascent rates and safety stops are part of decompression calculations. Slow ascent rates and shallow safety stops at altitude have a beneficial impact on reducing dissolved gas in the faster tissues.

**SAFETY STOP DEPTH AT ALTITUDE**

| Sea Level | 1000 | 2000 | 3000 | 4000 | 5000 | 6000 | 7000 | 8000 | 9000 | 10000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 14 | 14 | 13 | 13 | 12 | 12 | 12 | 11 | 11 | 10 |

## DECOMPRESSION STOPS

The depths and durations of decompression stops utilized for altitude dives also differ from those utilized for identical dive profiles at sea level. Needed decompression calculations are based on pressure ratios – not actual measured in-water depths. Dive tables designed for diving in seawater are invalid at altitude.

The following table can be utilized for determining the depth of decompression stops at various altitudes:

**STOP**

**DEPTH** **THEORETICAL DECOMPRESSION STOP AT ALTITUDE**

| **Sea Level** | **1000** | **2000** | **3000** | **4000** | **5000** | **6000** | **7000** | **8000** | **9000** | **10000** |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **10** | 10 | 9 | 9 | 9 | 8 | 8 | 8 | 7 | 7 | 7 |
| **20** | 19 | 19 | 18 | 17 | 16 | 15 | 15 | 15 | 14 | 14 |
| **30** | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 22 | 21 |
| **40** | 39 | 37 | 36 | 35 | 33 | 32 | 31 | 30 | 29 | 28 |

It is recommended that altitude dives be limited to no more than two dives per day. Dives at or above the 10,000-foot level should be limited to one per day.

## INCREASING ALTITUDE FOLLOWING DIVING

Increased altitude exposure that occurs subsequent to diving can lead to an increased risk of decompression sickness (DCS). A decrease in ambient pressure at an increased altitude causes nitrogen to escape from solution and "bubble". Increased altitude exposure includes flying or ascending a high mountain after diving. Many otherwise undeserved "bends hits" have occurred as a result of increased altitude exposure following diving.

Divers should abide by the following table prior to ascending to a higher altitude following a dive:

**PERMISSIBLE RGD FOR ASSENTION**

| Sea Level | **1000** | **2000** | **3000** | **4000** | **5000** | **6000** | **7000** | **8000** | **9000** | **10000** |
|---|---|---|---|---|---|---|---|---|---|---|
| N/A | L | K | J | I | H | G | F | E | D | C |

Note: Repetitive Group Designators must be determined from dive tables following a dive.

A diver departing from a dive at the majority of lakes in Ventura County via helicopter must have a repetitive group designator of "K" or lower. This is due to the fact that virtually all Ventura County lakes sit at or near the 1000-foot level of altitude. The exception is Rose Valley Lake, which requires a RGD of "H". While, if necessary, a helicopter could likely fly from these areas at approximately 500 feet above that of the of altitude of a given lake, figuring the flight on the basis of allowing a 1000-foot increase builds in somewhat of a safety factor. Any elevation increase following diving requires that the highest elevation of ascent be utilized and the corresponding repetitive group designator selected as the RGD following the dive.

Divers who have a short surface interval between diving and ascending to higher altitude or who have been diving deeper than 60 fsw appear be at increased risk for DCS. Divers displaying any symptoms of DCS following diving must not ascend to any higher altitude. Following any diving, it is recommended that divers decrease their altitude, if possible, in order to facilitate off gassing of accumulated nitrogen.

Exposure to increased altitude should be delayed according to the following chart:

**RGD** **TIME DELAY FOR ACSENT TO ALTITUDE**

| | **1000** | **2000** | **3000** | **4000** | **5000** | **6000** | **7000** | **8000** | **9000** | **10000** |
|---|---|---|---|---|---|---|---|---|---|---|
| **D** | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 6:18 |
| **E** | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 4:50 | 10:37 |
| **F** | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 4:08 | 8:06 | 13:25 |
| **G** | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 3:41 | 6:50 | 10:48 | 15:56 |
| **H** | 0:00 | 0:00 | 0:00 | 0:00 | 0:00 | 3:20 | 6:02 | 9:11 | 12:58 | 18:05 |
| **I** | 0:00 | 0:00 | 0:00 | 0:00 | 3:04 | 5:24 | 8:06 | 11:04 | 14:51 | 20:10 |
| **J** | 0:00 | 0:00 | 0:00 | 2:53 | 4:57 | 7:12 | 9:43 | 12:41 | 16:39 | 21:18 |
| **K** | 0:00 | 0:00 | 2:37 | 4:30 | 6:29 | 8:38 | 11:10 | 14:19 | 18:11 | 23:24 |
| **L** | 0:00 | 2:26 | 4:08 | 5:51 | 7:44 | 9:54 | 12:36 | 15:40 | 23:09 | 24:50 |

Note the recommended delay time for an L-group diver to ascend to an altitude of 10,000 feet (24:50). This reflects the current recommended delay of 24-hours before flying in a commercial airliner after diving. The cabins of commercial airliners are pressurized to a maximum altitude of 8000 feet. Thus, a 24-hour delay incorporates a theoretical safety margin of 9+ hours. The time delays contained in the above chart are recommendations; there exists no fixed rule that guarantees the prevention of DCS caused by ascent to altitude following diving. Delay intervals specified on the chart should be extended for multiple dives occurring in one day, multi-day diving, or decompression dives.

## BUOYANCY AT ALTITUDE

Just as buoyancy changes occur when a diver moves between salt and fresh water, buoyancy additionally changes at different elevations. Since ambient pressure at altitude decreases from that at sea level, wetsuits expand at altitude thus increasing buoyancy. Wetsuit buoyancy increases approximately 0.2% of body weight for each 1000 feet of altitude. Thus a 200-pound diver making a dive at 1000 feet of elevation would need approximately ½ pound of additional ballast (added to his sea level freshwater weight system) in order to offset his increased buoyancy (200 x .002 x 1 = 0.4 pounds). The same diver making a dive at 5000 feet would need to increase his ballast weight by 2 pounds over his freshwater sea level weight requirement (200 x .002 x 5 = 2 pounds).

Additional weight required to offset wetsuit buoyancy at altitude can be determined from the following table:

**BODY WEIGHT BALLAST INCREASE AT ALTITUDE (POUNDS)**

| | **1000** | **2000** | **3000** | **4000** | **5000** | **6000** | **7000** | **8000** | **9000** | **10000** |
|---|---|---|---|---|---|---|---|---|---|---|
| **130** | .3 | .5 | .8 | 1 | 1.3 | 1.6 | 1.8 | 2.1 | 2.3 | 2.6 |
| **140** | .3 | .6 | .9 | 1.1 | 1.4 | 1.7 | 2 | 2.2 | 2.5 | 2.8 |
| **150** | .3 | .6 | .9 | 1.2 | 1.5 | 1.8 | 2.1 | 2.4 | 2.7 | 3 |
| **160** | .3 | .6 | 1 | 1.3 | 1.6 | 1.9 | 2.3 | 2.6 | 2.9 | 3.2 |
| **170** | .3 | .7 | 1 | 1.4 | 1.7 | 2 | 2.4 | 2.7 | 3 | 3.4 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **180** | .4 | .7 | 1 | 1.5 | 1.8 | 2.2 | 2.5 | 2.9 | 3.2 | 3.6 |
| **190** | .4 | .8 | 1.1 | 1.5 | 1.9 | 2.3 | 2.7 | 3 | 3.4 | 3.8 |
| **200** | .4 | .8 | 1.2 | 1.6 | 2 | 2.4 | 2.8 | 3.2 | 3.6 | 4 |
| **210** | .4 | .8 | 1.3 | 1.7 | 2.1 | 2.5 | 2.9 | 3.4 | 3.8 | 4.2 |
| **220** | .4 | .9 | 1.3 | 1.8 | 2.2 | 2.6 | 3 | 3.5 | 4 | 4.4 |
| **230** | .5 | .9 | 1.4 | 1.8 | 2.3 | 2.8 | 3.2 | 3.7 | 4.1 | 4.6 |
| **240** | .5 | 1 | 1.4 | 1.9 | 2.4 | 2.8 | 3.4 | 3.8 | 4.3 | 4.8 |
| **250** | .5 | 1 | 1.5 | 2 | 2.5 | 3 | 3.5 | 4 | 4.5 | 5 |

Note: It is obviously unrealistic for divers to make fractional adjustments to their weighting. Thus, the above numbers should be rounded to the nearest whole pound. In the case of diving the fresh water bodies of Ventura County, no weight adjustment is normally necessary beyond the adjustment necessary for fresh water at sea level. However, divers who are precisely weighted for freshwater at sea level (just enough weight to render the diver neutral on a 15-foot safety stop with an empty BCD and 500 psi remaining in the cylinder) will need to increase their ballast weight by one pound at 1000 feet of altitude.

## AIR CONSUMPTION AT ALTITUDE

Theoretically diver air consumption at altitude should improve from what it is at sea level. The decrease in ambient pressure at altitude results in lower air consumption than for a dive made to the same depth at sea level due to the fact that the density of the gas breathed through the regulator at altitude is less than it is at sea level, thus breathing resistance is lowered. Less resistance equates to less work, thus less air consumed. However colder water temperatures at altitude may cause a diver to chill faster, thus actually resulting in increased air consumption.

# CHAPTER 24 HELICOPTER OPERATIONS

Sheriff's Office SAR Divers are often deployed by helicopter in situations where expediency dictates that it is advantageous; or where remote search sites are not conducive to vehicle response. Certain safety considerations are of paramount importance in operations in or about helicopters.

## GENERAL HELICOPTER SAFETY CONSIDERATIONS

- Personnel are at all times to follow the instructions of the helicopter crew (pilot and/or crew chief).
- The passenger area of the helicopter is best approached at a 45-degree angle to the front of the helicopter where approaching personnel are in view of the crew; or as directed by the crew chief.
- Approaching personnel are not to approach a running helicopter except upon direction of the helicopter crew.
- **At no time should a helicopter be approached from the rear**, except when directed to do so by a helicopter crew member.
- Upon approaching / disembarking a running helicopter, all loose articles of clothing or equipment (e.g., baseball caps, etc.) are to be removed and held firmly in-hand.
- Upon entering the passenger area, personnel are to follow the directions of the crew chief with respect to seating, use of safety belts, stowage of equipment, etc.

## DRY-LAND DEPLOYMENT FROM A HELICOPTER

- On level terrain, personnel can move away from the helicopter at a 45-degree angle from the front of the helicopter, or as directed by a helicopter crew member.
- On uneven terrain, personnel exiting the helicopter should remove all necessary equipment from the helicopter and crouch close to the ground a short distance from the helicopter skid and await the departure of the air ship prior to further movement.
- Personnel should never approach a running helicopter from an uphill position nor depart uphill from a running helicopter.

## WATER DEPLOYMENT FROM A HELICOPTER

- Divers deploying into water from the helicopter will do so from the helicopter skid or step *as directed by the crew chief*.
- If feasible, two divers should deploy simultaneously from each side of the air ship in order to minimize load shift, or alternately, one diver at a time from the side of the helicopter as directed by the crew chief.
- When more than one diver is standing on a single skid for deployment into the water, *the diver toward the rear of the helicopter should deploy first* in order to avoid one diver landing upon another.
- Prior to deploying, divers should take care to check the water below them for obstructions, then depart by looking at the horizon and stepping off (not pushing away from) the skid or step while holding the facemask and regulator and continuing to focus the eyes on the horizon.
- Divers are to wear a hood on all helicopter deployments in as much as the hood will help to protect the diver's hearing from the noise generated by the helicopter's engines as well as assist in retaining the mask when worn over the mask strap.
- **Divers are to deploy with fins in place on the feet** in order to facilitate immediate mobility upon entering the water.
- **Divers are NOT to use a "giant stride" from a helicopter as serious injury will result.** Divers are admonished to perform either a "pier entry" where one foot is crossed over the other, or alternatively place both feet together and point the toes upward.
    - Exception – when deployed very close (e.g., 5 ft.) to the water.

## HELICOPTER RECOVERY OF A DIVER FROM THE WATER

- Divers can be recovered from the water via any of several methods: hoist into the air ship by means of strop, horse collar, etc., rescue basket hoist, billy-pugh and short-haul, etc.
    - The helicopter crew chief will brief and instruct divers prior to water deployment with respect to the method of recovery, dive equipment to be removed during the recovery phase, etc.
- Helicopter recovery from an "H-1" model helicopter requires that a diver wear a mask with snorkel affixed thereto – breathing at the surface of the water beneath a hovering helicopter is extremely difficult. Recovery by a "Black Hawk" (Fire Hawk) requires the diver to breathe from the regulator due to the excessive air displaced by the airship in hover.

- Any apparatus lowered into the water from a helicopter must be allowed to touch the water or a support platform (IE: boat. Pier, etc.) prior to being handled by personnel in order to allow the discharge of static electricity (assimilated from the rotor blades) into the water as opposed to upon personnel.

## CHAPTER 25 PHYSIOLOGY & DIVING MALADIES

Divers need to have a basic understanding of certain physiological problems that can be related to diving in general or breathing compressed air in particular. Knowledge of the causes, the signs and symptoms, their prevention, and their treatment can aid the diver in not only avoiding these anomalies, but in rendering assistance, as needed, should they occur.

The following are associated maladies that divers can experience before, during, and after diving.

### MALADIES THAT CAN CAUSE DISCOMFORT OR PAIN

| **Seasickness, Motion sickness (Mal de Mer)** | |
|---|---|
| Cause: | Excessive motion upsetting kinesthetic senses. |
| Symptoms: | Nausea, desire to vomit. |
| Prevention: | Avoid travel on sea or watching rolling pitching waves in a continuous motion. |
| Treatment: | Motion sickness medication such as Bonine, Marazene, Triptome, or Dramamine.<br>Natural remedies such as eating fresh ginger with lemon.<br>Sea Bands wrist bands when not in the water.<br><br>NOTE: Transderm pads are not recommended due to their delusion-causing effects. |

| **Sinus Squeeze** | |
|---|---|
| Cause: | Congestion in sinus cavities.<br>Failure to equalize during descent. |
| Symptoms: | Pain in one or several sinus cavities.<br>"Lightning bolt effect". |
| Prevention: | Do not dive when congested.<br>Equalize early and often. |
| Treatment: | Stop descent immediately and then slowly return to the surface.<br>Seek medical attention if pain is persistent. |

| **Aerodontalgia (Air in the tooth)** | |
|---|---|
| Cause: | Air in pocket of tooth filling or cavity. |
| Symptoms: | Pain in tooth with any pressure change. |
| Prevention: | See a dentist regularly for preventative care. |
| Treatment: | Stop diving.<br>See a dentist.<br>Sucking on ice cubes may relieve pain in tooth. |

| **Face Mask Squeeze** | |
|---|---|
| Cause: | Increased pressure across face mask due to absolute pressure forcing mask to compress against the diver's face. |
| Symptoms: | Mask pushes against the face and nose rupturing small capillaries around the orbits of the eyes. This causes redness and swelling of the face and eyes. |
| Prevention: | Avoid wearing goggles with air spaces that cannot be equalized. |
| Treatment: | Exhale through nose into mask during descent to equalize pressure. |

| **Suit Squeeze** | |
|---|---|
| Cause: | Usually occurs with older dry suits or improper fitting suits. Skin pinched when air spaces in the suit are not equalized. |
| Symptoms: | Welts on the skin.<br>A pinching sensation. |
| Prevention: | Make sure wet suit fit is proper without wrinkles in the elbows or Knee area. |
| Treatment: | Replace the wet suit, smooth out wrinkles, or adjust it to fit. |

| **Gas in the Gut** | |
|---|---|
| Cause: | Swallowed or trapped air in the stomach expands on ascent or gas formed in lower intestines. |
| Symptoms: | Sensation of "fullness" can be even pain or cramps.<br>Possibly excessive burping or venting of gas through anal canal. |
| Prevention: | Don't dive with bowel disorders.<br>Don't swallow air during dive. |
| Treatment: | Stop ascent and try to vent off gas. |

| Carotid Sinus Reflex | |
|---|---|
| Cause: | Excessive pressure on carotid arteries in the neck decreasing the flow of O2 in blood to the brain. Perhaps from a tight-fitting hood. |
| Symptoms: | Difficulty breathing, headache, dizziness and irregular breathing pattern. |
| Prevention: | Wear a properly fitting hood that is not too tight. |
| Treatment: | Avoid and/or loosen tight garments around the neck. |

## MALADIES THAT CAN CAUSE MORE SERIOUS INJURY OR DEATH

| Nitrogen Narcosis (Rapture of the deep) | |
|---|---|
| Cause: | The intoxicating effects of breathing the partial pressure of nitrogen at depth. Buildup of the partial pressure of Nitrogen is around 80' -100' (Martini's Law: For every 33' we dive down is like drinking one martini on an empty stomach). |
| Symptoms: | Similar to intoxication.<br>A breakdown in positive behavior patterns. |
| Prevention: | Avoid excessive depths. (Note: 60' and deeper is considered a deep dive.) |
| Treatment: | Return slowly to a shallower depth. |

| Vertigo (Twirly Bends) | |
|---|---|
| Cause: | Coldwater in middle ear or imbalance in pressures upsetting vestibular mechanism.<br>Also associated with ruptured eardrum |
| Symptoms: | Disorientation, loss of equilibrium, nausea. |
| Prevention: | Avoid diving while congested. |
| Treatment: | Seek buddy assistance, surface, and hold on to something to stabilize the body. |

| Reverse Block (Cannot equalize ears on ascent) | |
|---|---|
| Cause: | Inability to equalize ears on ascent perhaps to due congestion in the middle ear. |
| Symptoms: | Pain in the ear(s) or sinus' during an ascent. |
| Prevention: | Avoid diving when congested. |
| Treatment: | Slow ascent - possibly stop, descend and continue to equalize gently. Yawn, swallow, rub under the ears to relax neck muscles. If damage to eardrum occurred, discontinue diving and see a doctor. |

| Thoracic (Lung) Squeeze | |
|---|---|
| Cause: | Going too deep while holding breath. |
| Symptoms: | Chest compression and chest squeeze discomfort, difficulty breathing, some blood around mouth and nose. |
| Prevention: | Breathe normally on SCUBA.<br>Do not dive too deep while holding breath.<br>Know your limits...Remember that all squeezes (barotrauma) occur because closed air spaces in the body cannot be equalized to the outside ambient pressure. This in turn causes symptoms of pain, discomfort, shock, and tissue damage.<br>(Note: According to Boyle's Law, gas expands as pressure decreases. Failure to vent off increasing air pressure during ascent can cause certain problems. In the diver's case, if he/she holds their breath upon ascent, air in the lungs will expand. If not vented off by exhaling or breathing normally, the lungs rupture.) |
| Treatment: | Seek medical assistance. |

| Spontaneous Pneumothorax | |
|---|---|
| Cause: | Holding breath on ascent while using compressed air. Basically, air ruptures into the space between the pleural lining and the lung. |
| Symptoms: | Difficulty breathing, bluish tinge and cyanosis of the lips, nail beds and even skin pain. Distension of the neck veins. |
| Prevention: | Exhale or breathe normally upon ascent. |
| Treatment: | Immediate recompression is needed with 100% pure oxygen and medical aid. |

| Subcutaneous Emphysema (Air in Tissues Beneath the Skin) | |
|---|---|
| Cause: | Saturation of Nitrogen gas by exceeding maximum bottom time and/or no decompression limits without off gassing by way of decompression stops.<br>Diving too deep for too long and/or surfacing too fast.<br>Air bubbles that lodge in/or under the subcutaneous tissues of the body. |
| Symptoms: | Tingling sensation under the skin or anywhere on the body beneath the subcutaneous tissues. It is similar to the tingly sensation you feel when your foot falls asleep.<br>Blotchy rash which may give the sensation of mild sunburn. |
| Prevention: | Know your bottom time limits.<br>Use your dive computer<br>Stay within the No Decompression Limit.<br>Don't surface too fast. |
| Treatment: | Surface at the recommended rate of 30'/min then seek medical help. |

| Over-Exertion, Fatigue, and Heat Loss | |
|---|---|
| Cause: | Preforming hard work in cold water. |
| Symptoms: | Fatigue, weakness, and tendency toward panic. |
| Prevention: | Know your limitations. Rest between dives...Do not over expose yourself on any given dive. Maintain good physical condition. |
| Treatment: | Surface and rest. Re-hydrate. Slowly warm the skin up and prevent additional heat loss. |

| Hyperventilation | |
|---|---|
| Cause: | Rapid deep breathing lowering CO2 tension in lungs |
| Symptoms: | Blackout without warning (similar to anoxia)<br>Dizziness |
| Prevention: | Take slow, steady, breaths.<br>Inhale and exhale at consistent rates.<br>Work at a pace within your personal limits.<br>Avoid panic. |
| Treatment: | Blackout underwater can happen at any depth and is very common in the last 10 ft of water before the surface. It can lead to drowning or the intake of water in to the lungs. If a diver has blacked out or is suspected of having blacked out then surface and seek medical help at a hospital. Only a hospital will be able to determine if water has entered the lungs and treat it accordingly. |

| Mediastinal Emphysema | |
|---|---|
| Cause: | Air in tissues adjacent to heart and lungs in the medial cavity of the heart.<br>Holding breath during ascent while using compressed air.<br>Basically, air ruptures from lungs and travels to medial cavity or surrounding tissues. |
| Symptoms: | Symptoms may range from pain under the breastbone, shock, and shallow breathing to unconsciousness, respiratory failure, and cyanosis (blue coloring of the skin). |
| Prevention: | Exhale or breathe normally upon ascent |
| Treatment: | Immediate recompression. Render 100% pure oxygen and medical aid. |

| Air Gas Embolism (AGE) | |
|---|---|
| Cause: | Holding breath during ascent while using compressed air.<br>Basically, air pressure ruptures from the lungs and enters into the bloodstream. |
| Symptoms: | Usually immediate, general weakness and dizziness, even a paralysis, especially in the extremities. Can have visual disturbance and pain in the chest. Associated with bloody froth at the mouth and nose. Convulsions, loss of consciousness and cyanosis |
| Prevention: | Always exhale or breathe normally upon ascent.<br>Never hold your breath on ascent. |
| Treatment: | Requires immediate administering of 100% pure oxygen.<br>Treat for shock and render first aid as needed.<br>Recompression chamber treatment is required. |

| Carbon Dioxide (CO2) Poisoning | |
|---|---|
| Cause: | Skip-breathing. CO2 build-up in air supply...Closed circuit SCUBA |
| Symptoms: | Dizziness, perspiration and fatigue. Nausea and headache. Bluish tinge to lips and fingernail beds. |
| Prevention: | Restore adequate air supply. Do not skip-breathe. Obtain a new air supply. |
| Treatment: | Administer 100% pure oxygen and seek medical aid. |

| Carbon Monoxide (CO) Poisoning | |
|---|---|
| Cause: | Excessive CO in air supply. Usually due to improper compressor functioning or exhaust fumes from combustion engine near air intake. |
| Symptoms: | Dizziness, perspiration and fatigue. Nausea and headache. Cherry red lips and tongue. |
| Prevention: | Restore adequate air supply. Do not skip breathe. Obtain a new air supply. |
| Treatment: | Administer 100% pure oxygen and seek medical aid. |

| Decompression Sickness (The Bends / Caisson's Disease) | |
|---|---|
| Cause: | Saturation of Nitrogen gas by exceeding maximum bottom time and / or no decompression limits with insufficient off-gassing.<br><br>*Contributing Factors Include:*<br>o Time / Depth Violations (Too deep / too long)<br>o Ascent Rate (Too quickly)<br>o Dehydration<br>o Exertion (During and post dive)<br>o Thermal Stress (Cold water / inadequate thermal protection)<br>o Physical fitness (Lack thereof)<br>o Gas Mixture<br>o Elevated carbon dioxide ($CO_2$) in the system<br>o Post dive air travel<br>o Advancing age (none of us are getting any younger). |
| Symptoms: | A blotchy rash about stomach, chest, shoulders, or back. Pain in joints, swelling around joints, redness around joints / extremities. Difficulty walking, weakness, vision / hearing problems, numbness, nausea, paralysis, light headedness, difficulty breathing, unconsciousness. Symptoms may vary depending on the degree or severity classified as DCS1, DCSII, DCSIII, or DCSIV. |
| Prevention: | Know your bottom time limits, pay attention to your computer, and stay within No Decompression Limits. Don't push the dive tables, or your computer. Do not employ skip-breathing. |
| Treatment: | Slowly ascend. Administer Oxygen, treat for shock, send for recompression. |
| Other: | U.S. Navy Dive Tables assume a 5% incidence of DCS in 18- to 25-year-old divers in excellent health; most dive computers are designed around an algorithm that assumes a 1% incidence of DCS. |

| Anoxia, Lack of Oxygen, or Asphyxia | |
|---|---|
| Cause: | Tissues fail to receive enough Oxygen. |
| Symptoms: | Usually little warning of onset. Pulse and blood pressure increase. and Diver may have slowing responses. Blackout. Cyanosis evident. |
| Prevention: | N/A |
| Treatment: | Restore adequate air supply. Breath 100% pure Oxygen. Mouth to mouth if no O2 available and seek medical attention |

| Oxygen (O2) Toxicity | |
|---|---|
| Cause: | The intoxicating effects of breathing the partial pressure of oxygen at depth.<br>Build-up of the partial pressure of Oxygen around 230' - 250'. |
| Symptoms: | Muscle twitching, tunnel vision, convulsions, nausea, dizziness, unconsciousness, difficulty breathing. |
| Prevention: | Avoid using closed circuit O2 below 30'.<br>Adhere to modified operating depths when using Nitrox, and avoid using compressed air solutions below 230'. |
| Treatment: | Surface immediately and seek medical aid. |

# CHAPTER 26 ELECTRIFIED WATER

Electricity can be a lurking invisible danger in both open and confined water. When most people hear the term electrified water, they think of the movie scene where a villain introduces an electrical appliance to an unsuspecting person in a bath tub or swimming pool. While that is, in fact an example of electrified water, there is a much less obvious yet real electrical danger to anyone in a swimming pool or in the water around boat docks, launch ramps, and within marinas.

- **Swimming Pools:** faulty electrical wiring to lights, pumps, filters, vacuums, extension cords, outlets, switches, or other electrical receptacles can cause electrical current to flow through pool water.
- **Docks and Marinas:** Insulation on electrical conduits and cables leading to boat docks can be damaged by wear and tear, deterioration caused by age, destruction done by animals, etc. Faulty electrical wiring on boats, docks, or boat launches can release electricity into the water causing the water to be energized. Prior to the year 2000, very few boat docks were powered, however with lights, electric boat lifts, more comfortable and expensive boats, and shore-power connections becoming more common, the risk of electrified water increases each year. In 2017, the National Electrical Code required that all connections near water have working ground fault circuit interruption technology, GFCI. These devices break the electrical circuit if any stray current fails to return to the source connection. If GFCI devices are missing or faulty, it is possible for current to leak into the water. If a system is leaking current into the water, appliances will likely function as normal without any indication of a problem. Correctly functioning GFCI devices will instantaneously detect the problem and disconnect the power source.
- **Docked Boats:** Often the electrical fault occurs intermittently from a boat when a switch is flipped or an electrical device cycles on. The American Boat and Yacht Council estimates that nearly every boat in the water utilizing shore power has some degree of current leakage. An equipment leakage circuit interrupter (ELCI) on a boat's shore-cord inlet will prevent this issue. Deterioration of insulation on wires is common on boats. Many unwary boat owners will either perform electrical repairs themselves or contract a "land-based" electrician for the work. However, the wiring

configuration requirements on boats is considerably different from that of buildings. Electrical repairs on boats should only be performed by certified marine electricians.

The danger is that these aquatic areas can cause electric shock drowning (ESD) to a swimmer or diver. ESD is caused by alternating electrical current flowing through water and encountering a human body. The current will attempt to pass through the body causing temporary skeletal muscular paralysis, heart stoppage, and drowning. Electrical current lessens the further from the source it travels. In some cases, the shock itself is fatal, causing immediate heart stoppage or paralysis of the diaphragm, inability to breathe, and suffocation, while in others it incapacitates the swimmer or diver causing them to drown.

The risk of ESD is higher in fresh water than in sea water. Salt or brackish water has high conductivity and low resistance, thus leaking electrical current tends to avoid the human body and remain in the low resistant sea water.

Fresh water has low conductivity and high resistance and electrical current seeks a path of lower resistance – through the human body. Fresh water is nearly 70X more resistive than salt water. It only takes a minute amount of leaking electrical current to kill. As few as 10 milliamps (1/50th of the current drawn by a 60-watt light bulb) can cause paralysis and death.

## SIGNS OF POTENTIAL IN-WATER ELECTROCUTION:

- A "tingling" sensation while in the water.
- Muscle cramps.
- A sensation as though something is holding you in place.
- Unsettled or panicked behavior.

## PREVENTION AGAINST IN-WATER ELECTROCUTION

- DO NOT enter the water near a marina, boat dock, or boat launch while any boat is running.
- Inspect docked boats to determine the presence of electrical cables or cords leading from the dock to the boat. If present, disconnect and secure such cables prior to water entry.
- Take note of the location of power cut-offs.
- Prior to entering the water, check water surrounding adjacent docks with electrical current detection equipment (e.g., Shock Alert).

- In cases where electric current in water is detected, diving operations will be postponed / discontinued until such time as the source of the current is identified and secured.
- If appropriate, lock-out / tag-out any electrical boxes in the immediate area prior to any water entry.
- Diving operations around docks should involve only one diver, equipped with FFM for communications and tended on a line by a shore tender.
- NEVER reach out of the water for handholds on conduits, cables, or anything else that might be electrically powered.
- If feeling a tingling sensation in the water, either minor or severe, a diver is to swim back in the direction from where they came, report the experience to shore support personnel, and immediately exit the water.
- Exit the water by means of a non-metal ladder (a metal ladder increases risk of ESD).

## RESCUING A VICTIM OF IN-WATER ELECTROCUTION

- Immediately cut all electrical power to the area.
- Immediately call 911.
- If unable to reverse direction in the water, a diver experiencing ESD (tingling or paralysis) should become positively buoyant and surface keeping the regulator in the mouth and yelling for help through the regulator, if possible.
- Utilize a carbon fiber ladder to exit the water (as opposed to a metal ladder) on boats and around boat docks and marinas.
- DO NOT jump into the water to rescue someone experiencing ESD.
- Extend a carbon fiber pole for the victim to grab onto; if the victim is debilitated, using the pole, move the victim to safety (face up if possible).

## TREATING A VICTIM OF IN-WATER ELECTROCUTION

- Call 911 / Emergency Medical Services if you have not already.
- Remove the victim from the water and initiate CPR.

# CHAPTER 27 DIVE TEAM BY-LAWS (REVISED 01/14/2018)

## ARTICLE I

### Team Purpose

The Underwater Search and Rescue Team is formed to provide the Ventura County Sheriff's Office with a group of highly trained SCUBA divers who will provide search, rescue and recovery services in open bodies of water within the County of Ventura. The team will also provide assistance / support to other dive teams and to the SAR Mountain Teams as requested and approved by the Sheriff's Office.

## ARTICLE II

### Membership

**Section I: Requirements for Membership**

1. General:

    A. Applicants must be 21 years of age.
    B. Applicants must meet all background requirements of the Sheriff's Office.
    C. Applicants must hold a current open water dive certification.
    D. Applicants must possess and maintain a valid California Driver License.
    E. Applicants must hold and maintain current First Aid and CPR cards.
    F. Applicants must own their own personal dive gear as specified in the Dive Team Training Manual.
    G. Applicants must possess and carry a personal cellular telephone.
    H. Applicants must be a resident of Ventura County or the immediate vicinity.
    I. Applicants must submit a current Medical Statement form.
    J. Applicants must submit a signed Liability Release and Express Assumption of Risk form.
    K. Applicants must successfully complete the VCSO SAR Dive Academy.
    L. Applicants must be approved by a majority vote of current team members.

2. Probation

   A. All new members will serve a one-year probationary period. During this time, they will be subject to performance reviews by the team officers and training committee.

3. Membership Status:

   A. Trainee: Upon acceptance of the team an applicant becomes a trainee. To become an active member the following criteria must be met:
      1. Successfully complete the team Dive Academy.
      2. Acquire and maintain specialized search equipment as specified in the Dive Team Training Manual.
      3. Fulfill all requirements of regular team members.

   B. Active Membership Requirements:
      1. Must pay annual dues of $25.00 (due every January).
      2. Maintain an attendance record to team trainings of no more than 2 unexcused absences in a row or 3 in a year.
      3. Demonstrate proficiency in all core training material and techniques.
      4. Must maintain all required certifications / licenses.
      5. Must comply with all Search and Rescue SOP's.
      6. Must maintain all issued / personal equipment in serviceable condition.

   C. Inactive Membership Requirements;
      1. If for personal reasons a member will not be able to be active for a period of time (up to one year), the member may request a leave of absence in writing and be placed on the inactive list.
      2. Inactive membership is subject to approval by the team officers.
      3. Inactive members are not required to attend meetings / trainings but are responsible to maintain current "dues" at the current rate. First Aid / CPR certifications must be maintained.
      3. Inactive members are required to turn in any and all property and / or equipment issued by the Sheriff's Office or the Dive Team to the SAR Coordinator.
      4. If the member does not request re-activation to regular membership within one year, the member will automatically be removed from the team.

D. Re-Activation of Inactive Member:
   1. To become re-activated, an inactive member must inform the team captain of his intent to do so.
   2. The inactive member will be placed back on the active member list.
   3. If the member has been on inactive status for more than six months, upon re-activation of team membership status, the member must receive approval from the training committee prior
      to being assigned to an actual operation.
   4. The training committee may require the inactive member to participate in a refresher session or complete any mandatory training sessions that might have been missed.

E. Support Membership:
   1. This classification of membership is reserved for professionals who desire to donate or by other means offer a specific service to the team.
   2. An example of this might be a boat crew who may assist the team with operations and/or training on a regular basis.
   3. Support members will be issued a Sheriff's Office ID and must maintain a current OES Disaster Services Worker card.

F. Termination of Members:
   1. Members who do not meet their obligation to the team will be subject to termination as decided by team officers.
   2. Any member in danger of termination due to commitment / participation factors will be sent a letter containing the following:
      - The member must re-affirm commitment to the team.
      - The member must attend the next scheduled team training.
   3. Members who do not respond to the letter or who do not fulfill the above will be automatically removed from the team.
   4. Team officers maintain the right to terminate the membership of any member who fails to comply with any part of the Team By-Laws.
   5. The Sheriff's Office maintains the right to terminate membership of any member who fails to comply with any part of the Search and Rescue SOP's or other Department requirements.

**Section II: Membership Limit**

1. The Dive Team shall consist of the following configuration:

    A. Active members – 25
    B. Support members – 5
    C. In-active members – 2

**Section III: Dues**

1. All monies taken in will be utilized as necessary for team equipment and benefit.
2. The team officers may authorize payment by unanimous vote.
3. Payment of all outside expenses must be authorized by a majority vote of the team members.
4. Dues are established at $25.00 per year.
5. Dues are due and payable at the first team meeting / training in January of each year.
6. Members who have not paid their dues by April 1st of each year will be subject to removal from the team.

**Section IV: Participation:**

1. In order to maintain the reputation of the Dive Team as a professional and dedicated Search and Rescue unit, it is necessary to maintain a high level of attendance and participation at meetings, training sessions and operations.
2. Excessive unexcused absences will not be tolerated.
3. Excused absences are granted only for work, scheduled vacations, and family emergencies.
4. Team training sessions will be held at 0800 hours on the second Sunday of each month, unless otherwise scheduled.
5. Each team member shall attend 75% of all regularly scheduled team-training sessions.
6. Missed training sessions may be made up at the discretion of the training committee (if feasible).
7. Members are expected to notify the Team Captain if a training session will be missed.
8. Any member missing two consecutive monthly training sessions will be informed that missing a third consecutive training session may result in termination from the team.

## Section V:  Search and Rescue SOP's and Equipment Directives

1. All team members shall conform and comply with all pertinent Standard Operating Procedures for SAR personnel.

**ARTICLE III**
**Team Staffing**

**Section I: Election of Team Officers:**

1. Election of team officers will be held in conjunction with the team meeting
   / training session in the month of January of each year.
2. The team shall be governed by four (4) officer positions elected by a majority of the team members present at the January meeting.
3. Vacancies shall be filled with existing officers or by a special election for the remainder of the term of the vacated office.
4. The following positions will be filled:
   A. Captain.
   B. Training Officer
   C. Equipment Officer.
   D. Treasurer
   E. Research / Development Officer.
5. Team Officer responsibilities are as follows:
   A. Team Captain:
      1. Overall command and control of team activities and functions.
      2. Directly responsible to the Sheriff's Office through the SAR Coordinator or designee.
      3. Creating and/or disseminating any information designed for member knowledge (IE: events, schedule changes, department information, etc.)
      4. Notifying team officers and SAR coordinator of issues or concerns of importance to the existence or professionalism of the team.
      5. Oversee the functions of all team committees.
   B. Training Officer
      1. Assists the Team Captain with command and control of team activities and functions.
      2. Accepts operational / training responsibilities as assigned by the Team Captain.
      3. Accepts overall command and control over team activities and functions at the direction of, or in the absence of the Team Captain.

4. Chairs the training committee and reports training plans to the Captain.
5. Maintains records of team training activities.

C. Equipment Officer
1. Assists the Team Captain and Training Officer as required.
2. Accepts overall responsibility for team and Department equipment and service.
3. Maintains records of equipment maintenance and deficiencies and reports same to the Team captain.

D. Treasurer
1. Receives and deposits all team dues and any other monies received by the team.
2. Maintains team checking account and writes checks for payment of team financial obligations as necessary,
3. Prepares team financial report for presentation at team meeting each January.

E. Research and Development Officer
1. Examines new developments in the area of underwater search and recovery and any new equipment techniques for accomplishing the mission of the team.
2. Makes recommendations to the Team Captain, the team at large, and SAR administration concerning the acquisition and/or implementation of new equipment and/or techniques.

**Section II: Appointed Positions**

1. The team is authorized to appoint as many as five (5) positions for the accomplishment of team goals and purposes. Such positions may be inclusive of:

A. Administrative Officer
1. Maintains records of all team activities and functions.
2. Maintains team attendance records.
3. Maintains minutes of team meetings.
4. Collects and organizes functional data (IE: training reports, equipment inspection sheets, various activity reports, etc.)

B. Team Physician
1. Reviews and approves all medical statements submitted by prospective applicants.
2. Provides medical advice / support to the team on issues of dive medicine.

C. Team Watercraft Operator
    1. Operates County / Rental watercraft at training / callout functions
D. Team Webmaster
    1. Maintains and updates team website at the direction of. team officers.
F. Community Outreach Coordinator
    1. Schedules and staffs various public events with a view toward positive exposure for the Dive Team.
    2. Performs other duties as necessary.

## ARTICLE IV
## Committees

**Section I: Committees**

1. The team shall have the following committees to plan, oversee, and coordinate various functions.
2. Committee duties are as follows:
    A. Training Committee
        1. Develop an annual training schedule and implement the team training program.
        2. Report to the Training Officer any concerns regarding member training and skill levels.
        3. Assist members and probationary divers who need and/or desire additional training and/or practice.
    B. Equipment Committee
        1. Maintain inventory on all team equipment assigned to and/or owned by the team.
        2. Maintain records on and conduct inspection of personal equipment for completeness and serviceability.
        3. Ensure that equipment assigned or owned by the team is cleaned, serviced, and properly stored.
    C. Research and Development Committee
        1. Research, develop, evaluate, and implement new operational equipment and techniques in conjunction with the Training Committee.
        2. Make recommendations to team and SAR administration concerning the adoption of new equipment / techniques.

**ARTICLE V**
**Uniforms and Equipment**

**Section I: Member Supplied**

1. SAR Underwater Team Uniform
   A. Nylon Jacket, red in color with "diver down" patch and embroidered name on right breast of jacket (mandatory).
   B. Approved team t-shirt / sweatshirt (optional).
   C. Approved team headgear (optional).
2. SAR Underwater Equipment (mandatory).
   A. Full ocean dive gear (as prescribed in the training manual).
   B. Search gear (as prescribed in the training manual).

**Section II: Department Supplied**

Sheriff's Office identification, patches, and equipment are issued to team members for their use in carrying out their official duties with the Dive Team and the Department. All issued equipment, patches and identification remain the property of the County of Ventura Sheriff's Office and must be returned upon request or when a member leaves the team.

Care and maintenance of Department owned equipment is an individual responsibility and misuse, abuse, or carelessness in the handling of Department equipment is grounds for termination from the team.

1. Uniform Patches
   A. VCSO shoulder patch – 2 (right and left shoulder).
   B. VCSO "Search and Rescue" rocker – 2 (below shoulder patch, each arm).
   C. VCSO cloth star – left breast of jacket.
   D. VCSO "Sheriff Rescue" back patch – rear of jacket, across shoulder blades.

2. Rain Jacket
   A. As approved and issued by SAR administration.

3. Identification
   A. Sheriff's Office ID card.
   B. Disaster Services Worker card.
   C. Metal Search and Rescue badge.

4. Dive Equipment.
    A. OTS Full Face Mask.
    B. OTS Second stage regulator.
    C. OTS Buddy Phone underwater communicator.
    D. Storage bag.
    E. SMB and spool
    F. Call-out kit.
    G. Mini-Mother float
    H. Heavy duty reel for ascending / descending line