Fresno Fire Department
WRT Dive Operations Guide

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PURPOSE

The purpose of this policy is to provide guidance to performing safe diving operations in the environments commonly encountered in the WRT response area.

APPLICATION

This policy is intended for Fresno Fire Dive Team members who have completed the course of training required to be a qualified diver. This manual assumes requisite knowledge obtained from the following completed courses or their equivalencies.

- PADI or NAUI Basic and Advanced Open Water Diver
- Swift water Rescue Technician Unit 1
- Swift water Rescue Technician Advanced
- Emergency Medical Technician Basic
- Basic Rope Rescue or Rescue Systems 1
- ICS 200,700,800

This policy also assumes a working knowledge of the following Fresno Fire Policies

- SOP 201.001 Incident Command
- SOP 201.014 Urban Search and Rescue
- SOP 202.014d Water Rescue
- SOP 203.001 General Safety Guideline
- Rapid Intervention Standard Operating Guideline

OPERATIONAL POLICY

Risk Management Overview

This manual recommends practices for experienced divers in order to safely conduct self-contained underwater breathing apparatus (known as scuba) diving operations in currents in excess of 1 knot and surface supplied diving (SSD) in excess of 2.5 knots. Supervisors and Incident Commanders must emphasize that swift/fast water diving operations are inherently more dangerous and pose additional risks to the diver and support personnel beyond those encountered in normal diving operations. There are several controls that must be applied to provide barriers to risk in dive rescue operations. The Dive Group Supervisor should consider the experience levels of the primary and safety diver. It is generally recommended that the more experienced diver should be assigned as safety in order to achieve the highest level of safety for the primary diver. In addition, personnel from the Rescue Alarm Assignment that may be utilized, who are not divers, may be incorporated into position that apply additional risk control measures including:

- Dive Tenders. (If properly trained and briefed, the supervisor may elect to use non-dive qualified personnel).
- Upstream Spotter.
- Downstream Safety (consider multiple based upon risk profile).
- Medic Standby.
- Safety Officer.
- Interagency Liaison.

In addition to personnel, the Dive Group Supervisor should also thoroughly assess the dive site for hazards that may be considered too dangerous for diving operations or hazards that may be dangerous but can be mitigated with control measures and control measures implemented prior to the dive. More detailed information regarding risk assessment is provided later in this manual. If the Dive Group Supervisor or Divers are uncomfortable with any dive based upon conditions or experience level the dive SHALL not be performed.

Risk Management Planning and Diver Operations Safety

a. Minimum Staffing

Minimum staffing for swift/fast water diving should be increased whenever tactically possible. Neither the techniques listed in this manual, nor the conditions encountered at the diving location, preclude the leadership, or diving supervisor, from ensuring that all diving operations are conducted in a safe manner. At a minimum, the following positions should be identified and filled.

SCUBA Diving

- One diving group supervisor (DGS)
- One dive recorder / tender supervisor
- One diver. Diving in buddy teams is not recommended
- One standby/safety diver
- Two tenders. If properly briefed, the supervisor may elect to use non-dive qualified personnel
- One upstream spotter
- One downstream safety (more may be utilized depending on DGS discretion)
- Ambulance standby ready for immediate use

Surface Supplied Diving

- One diving supervisor
- One diver. Diving in buddy teams is not recommended
- One standby/safety diver
- One air console operator/communications
- Two tenders. If properly briefed, the supervisor may elect to use non-dive qualified personnel
- One upstream spotter

- One downstream safety (more may be utilized depending on DGS discretion)

- Ambulance standby ready for immediate use

b. Single Divers

Single divers are recommended for all swift/fast water diving operations to avoid fouling or entrapment due to additional lines in the water. SSD, particularly the Kirby Morgan BandMasks, are preferred over standard regulators to reduce the risk of accidental loss of the air source due to increased current.

c. Downstream Safety for Divers

Downstream safeties should be positioned at an appropriate location, based on current velocity and navigational obstacles, which allows for the most safe and expedient recovery of a displaced diver or swimmer. Shore-based downstream safeties shall have a throw bag with enough line to reach a victim washed from the dive site. For example, a diver located 75 feet from the near shore would require a shore-based downstream safety to have at least 75 feet of line in his throw bag. This will allow the safety to rescue a diver who is washed downstream and unable to swim towards the shore. If a shore-based safety is not feasible, personnel, in a motorized propeller less (jet) boat, should be positioned downstream.

d. Risk Assessment

An assessment of the site must be made by the DGS. A risk assessment includes identify hazards, develop controls and implement control. Hazards to be considered for a dive in swiftwater are:

- **Poor line management.** An unmanned line in swift or fast moving water can quickly become an entanglement hazard to divers in the water as well as personnel on the surface. It takes focused effort, practice, and skill to avoid getting entangled in a whipping line and pulled into the water.

- **Entrapment.** Any passage that water flows through, but a diver cannot cleanly swim through poses significant risk. For example, sieves, undercut rocks, man-made debris.

- **Pinning.** Water has the ability to press boats and bodies against an obstruction with enough force to hold them there. For example, strainers, broach pin, center pin, and end-to-end pin.

- **Physical hazards.** Turbulent water can throw boats and bodies around. Divers should remain alert and be careful to avoid hazards such as hazards as hydraulics, breaking waves, crashing waves, and extreme helical flow. Moving water alone can cause rapid and uncontrolled downstream movement capable of fatiguing and drowning a diver even if they are not fully submerged. This is known as a flush drowning.

Keeping the above considerations in mind, the DGS then formulates a risk assessment through a simple three step process of identifying hazards, developing controls and implementing controls. Considerations for all three are as follows:

- **Identify Possible Hazards**

  First, identify the major events that are expected to occur during the operation and the hazards associated with all specified and implied tasks. The following are a few of the hazards associated with this type of operation:

  - Drowning
  - Arterial Gas Embolism
  - Entanglement/trapping
  - Tending difficulty
  - Tending line injuries
  - Exhaustion
  - Pollution/raw sewage
  - Floating debris
  - Razor wire
  - Pulmonary Over inflation Syndrome (lung expansion)
  - Lost diver
  - Strainers
  - Foot entrapments

- Low head dams
- Delta-P
- Confined Space
- Hydrology

- **Develop Controls**

  Consider the following when determining what controls should be emplaced:

  - Velocity of the water
  - Suspected location of victim
  - Equipment on hand/logistics (harness, rigging, throw bags, and so forth)
  - Control of the rivers flow
  - Urgency of the dive (recovery versus rescue)
  - Training and experience of the team members
  - Risk vs. Benefit ratio.
  - Use of natural hydrology

- **Implement Controls**

  Once the assessments and controls have been identified, the supervisor must implement them by:

  - Choosing equipment appropriate for the dive and incident.
  - Selecting personnel that are properly trained and experienced.
  - Conducting a pre-dive briefing.
  - Utilizing and Incident Action Plan.
  - Not accepting unnecessary risks.

Hydrology for Dive Operations

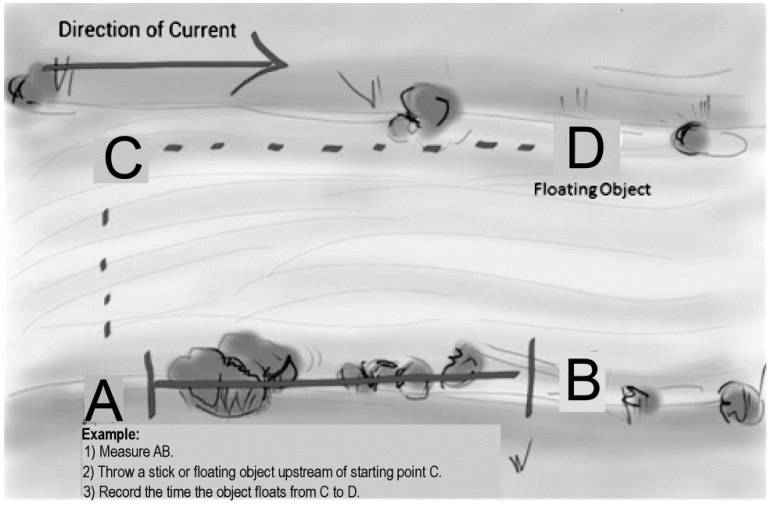
Hydrology is the study of the movement, distribution, and quality of water. Swift/fast water operations require a thorough understanding of the hydrological forces at work on the surface and on the bottom to ensure divers can operate safely. When performing a risk assessment, visually inspect the dive site both upstream and downstream. Watch the flow of the river around bends and turns, look for dead spots and eddies, take velocity measurements if time permits, and evaluate the terrain for access to downstream areas to serve as secondary recovery locations.

Note: Consider using debris such as sticks, float buoys, and submersible mannequins to determine the rivers behavior. Also consider conducting a quick inspection dive along the riverbanks to determine potential hazards caused by roots, rocks, and debris in the area during casualty evacuation.

CAUTION
The river/canal you were on yesterday is different than the river/canal you are on today. Rivers/canals are prone to changing their behavior at any moment and measurements, emergency plans, and dive plans must be evaluated each day during the operation

a. Estimating River Speed

A simple method for estimating river speed is the hasty method. The hasty method uses a floating object and a known distance. Place the floating object in the water at point **a,** and record the time it takes for that object to travel to point **b.** The current is equal to the distance divided by the time in seconds.



Current = Distance AB (Meters)/Time CD (Seconds)

1 foot per second equals .59 knots

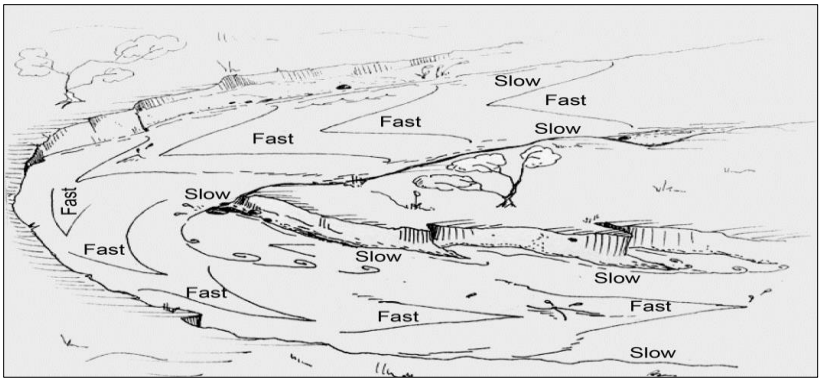
1.69 feet per second equals 1 knot

Table 1-2. Feet per second to knots conversion

Feet Per Second	Knots	Feet Per Second	Knots
1.0	.59	5.5	3.25
1.5	.88	6.0	3.55
2.0	1.18	6.5	3.85
2.5	1.48	7.0	4.14
3.0	1.77	7.5	4.44
3.5	2.07	8.0	4.73
4.0	2.36	8.5	5.03
4.5	2.66	9.0	5.33
5.0	2.96	9.5	5.6

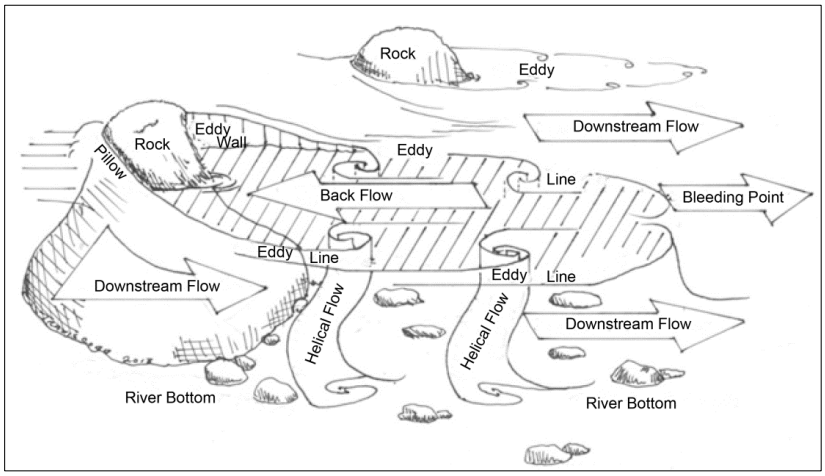
b. Laminar Flow

Water moves in layers. Each layer can be thought of as riding atop one another. This occurrence allows each layer to move faster than the one beside it as it is insulated from drag. Layers of moving water are slower on the bottom and at the banks; moving water is faster toward midstream and on the outside of bends. Man-made canals with smooth surfaces do not have pronounced laminar velocity differences. Water WILL be moving rapidly at the shoreline and on the bottom.



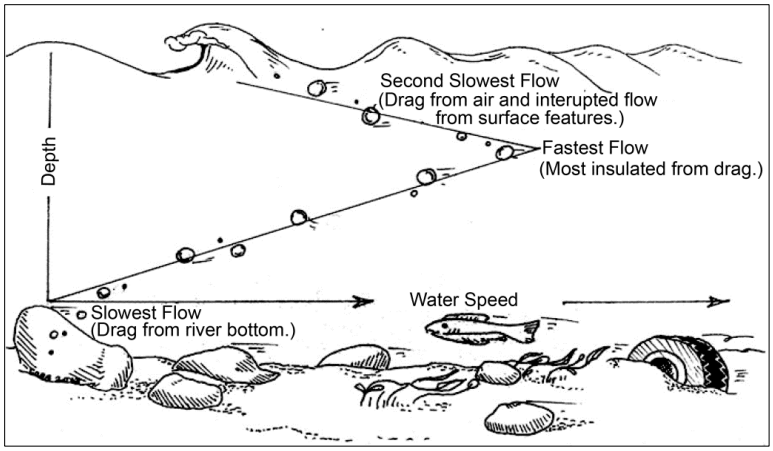
c. Helical Flow

Helical flows occur when two laminar flows move in the opposite directions, interact, and create a whirlpool.



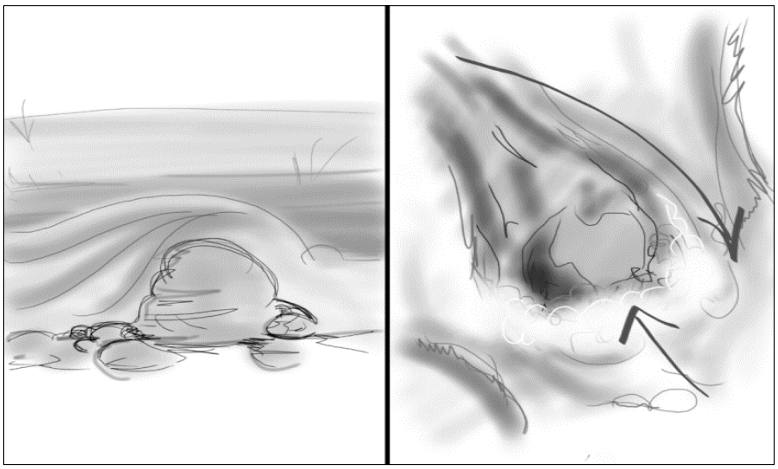
d. Turbulent Flow

Turbulent flow is the opposite of laminar flow. When water encounters an obstruction, the layers of flow twist and turn against one another. Unlike helical flow, turbulent flow is not uniform or predictable. For example, the foam pile of a hydraulic in the graphic below it would be safest for the diver to enter the water at the bank on the river's left and follow the bottom contour to the center of the river.



e. Pillows

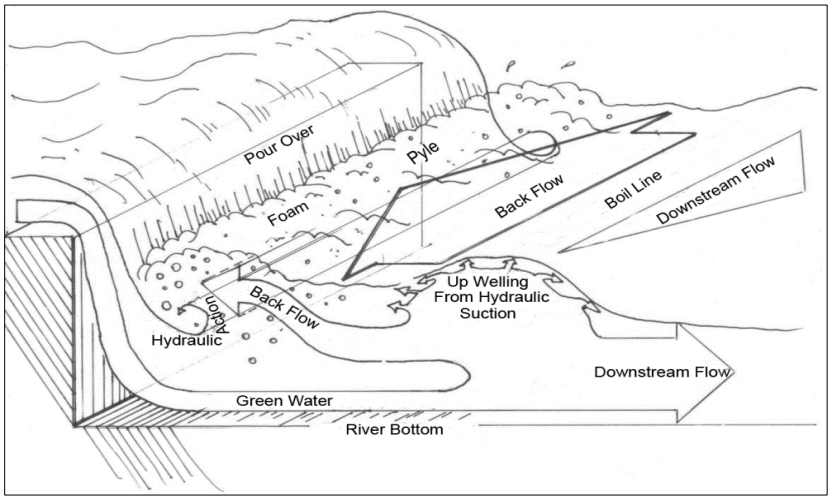
Pillows are the swelling on the surface caused by an obstruction. The obstruction is usually just beneath the surface or may break the surface in which case the pillow will be in front of the object rather than above and in front. In deeper water, pillows may not be visible on the surface, but will exist underwater as the diver approaches the obstruction. This will tend to push a diver off the project.



f. Hydraulics/Holes

Hydraulics/holes are water that drops vertically over an obstruction. The larger the drop, the more defined the hole. A hole creates a back current where water is trapped behind an obstruction. Divers should take care to avoid becoming trapped in a hole. Large, white water holes can even swamp rescue boats. Hydraulics

impedes the downstream flow and can create a useful workspace for divers under the right conditions.



CAUTION
Hydraulics can be an extremely powerful river feature. They can trap divers, swamp rescue boats, and other small vessels.

g. Strainers and Sieve

Sieves and strainers are technically different methods to produce the same hazard. Water moving through either wood (strainer) or rock (sieve) via spaces smaller than a diver is a serious hazard. While water flows relatively unhindered through small spaces, large solid objects (such as divers and equipment) can be pinned to the object and trapped in the same manner as a Delta-P hazard.

General Safety Practices

a. In any swift/fast water diving scenario, the most important safety factor is experienced personnel. Every opportunity should be taken to conduct training dives, or specialized swift/fast water training, prior to an incident. If trained and experienced personnel are unavailable, the diving supervisors should carefully weigh the benefits of conducting the dive against the risk to personnel.

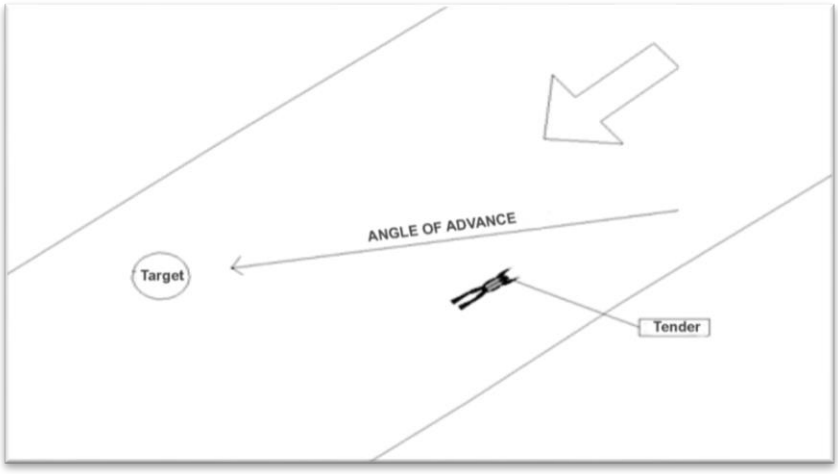
b. In any new environment that is tactically permissive, a full walk through of the emergency action plan and incident action plan shall be conducted. If conducting

swift/fast water operations at multiple locations with different evacuation routes, test the plan at each location.

c. In order to increase the diver's ability to control position, diving in swiftwater requires heavy weighting typically 2-3 times the normal weight of a standard diver. It is imperative that the diver know how to release weights in the event of an emergency. When diving in static water normal weights shall be used which is normal 10-15% of a diver's own weight as a guideline

d. The diver should be properly harnessed to the tending line. When possible avoid the use of a tending line tied around the diver's waist. This will place the fulcrum in the wrong location and may cause injury to the diver in strong currents. A forklift safety harness can be used with slight modification to provide a diver tending line harness by moving the D-ring attachment point from the center of the back to the center of the chest. Other field expedient options are also available, such as running the tending line through the chest strap of a buoyancy compensator after being tied to the waist and thereby placing the fulcrum point higher.

e. When swimming in currents, use the current to push you into place by swimming at a steep approach angle. This will minimize downstream movement and allow the diver or swimmer to move perpendicular to the current. It is generally preferred that Fresno Fire Divers approach from downstream moving upstream. This allows the diver to ensure a clear escape route behind them in the event of being swept away.



Safety Practices Unique to Swift Water

a. Tending the diver at the chest is recommended to avoid pitching the diver head up and risking an arterial gas embolism. The tending line shall not be permanently attached (must use a quick release) in fast water as the chance of entrapment is

high. In fast water the ability to pull a diver who is trapped back upstream is limited and dangerous. All fast water dive emergency procedures should include the releasing of the tending line and defensive swimming to the downstream safety.

b. However, emergency planning should include procedures for pulling the diver into the boat or to shore from the work site.

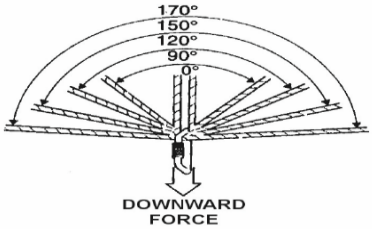
c. In most instances, the diver can either be tended from a small boat or from the shoreline at an angle appropriate to the current. While a diver cannot typically swim against the current, they are usually able to navigate perpendicular to the current.

d. Plastic, neutrally buoyant helmets can be worn to protect the divers head in the event flotsam or other objects impact the diver. Objects and tools should be minimized. The use of special tools like creepers, rebar spikes or other tools may help the diver navigate. All objects should be secured to the diver.

Tending and Rope Systems for Swiftwater Diving

a. Rigging High Lines

Rigging high lines (Tyrolean) for use as an attachment and tending point for divers are ineffective in most cases in wide rivers. The weight of the diver will cause the line to bow heavily and may prevent retrieving the diver. Using a 90-degree or lower angle increases the mechanical advantage and should be used in fast water. If tending from a boat, a belay may need to back up the primary tender, and the boat should be tended by multiple lines at angles not to exceed 45 degrees (90 degrees total) from the direction of the current.

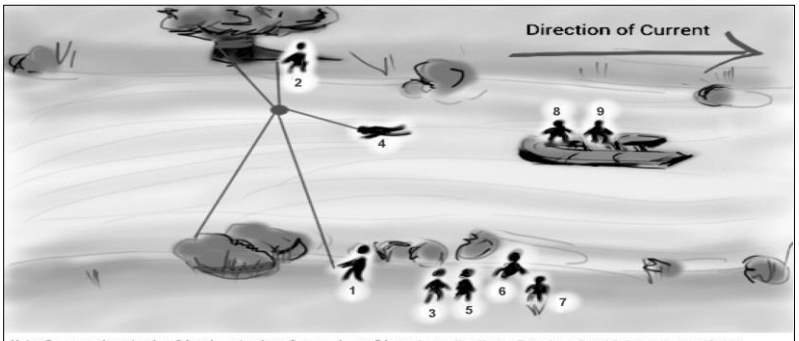


TENSION IN MULTIPLE ANCHOR RIGGING	
ANGLE	RESULTING LEG TENSION*
170°	1150%
150°	200%
120°	100%
90°	70%
0°	50%
*On each leg relative to downward force.	

b. Highline rigging from shore.

High lines were designed as an answer to vertical rescue problems. Under those circumstances, with easily estimated or even known forces, high line techniques are

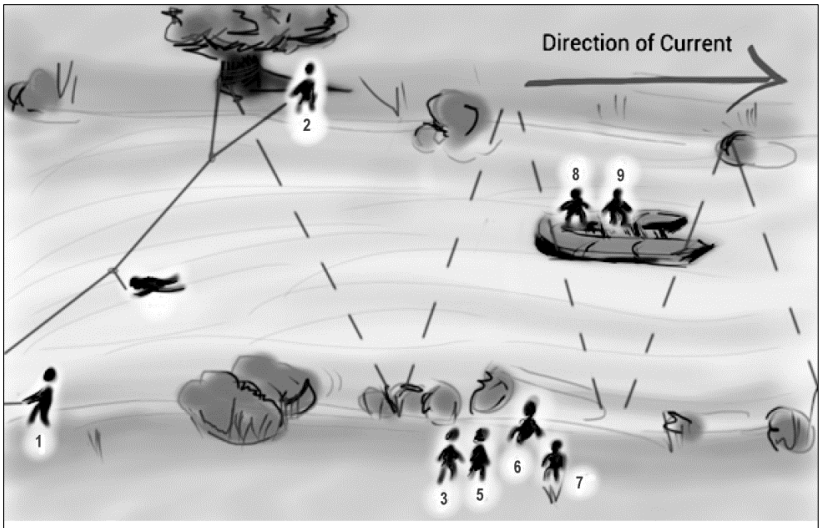
invaluable tools. For swift/fast water applications where immense and varying drag is generated by lowered boats and divers, high lines become difficult to manage and are ineffective. Alternatively, proper use of a multipoint tethered boat lower system can offer the same traversing abilities as the high line system. Additionally, the multi-point tethered boat lower system uses less equipment and provides a more stable workspace.



Note: One nearshore tender; 2 far shore tenders; 3 supervisors; 5 logs; 6 standby divers; 7 tenders; 8 and 9 downstream safeties.
Scuba divers a minimum of 9 personnel.
Extreme Lightweight Diving System (XLDS) a minimum of 10 personnel (preferred method).

c. Tension Diagonals (Zip Lines)

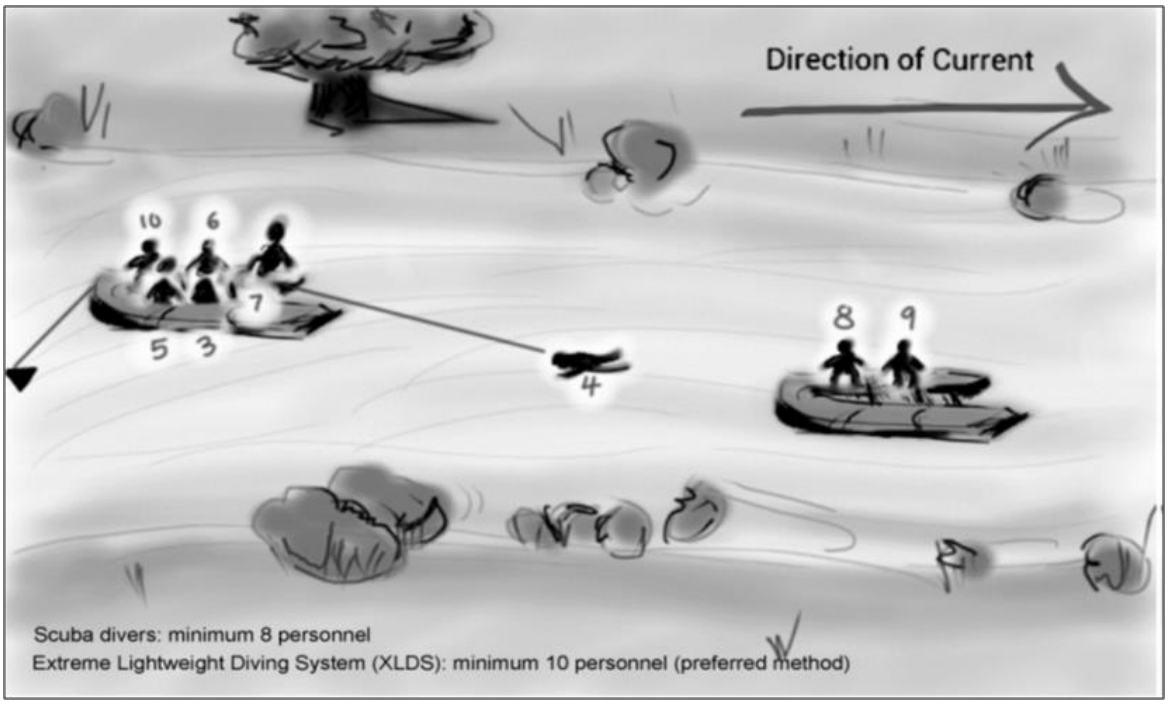
Tension diagonal uses the rivers current to move the diver downstream and across the river from nearshore to far shore. The zip line takes less time to set up than the high line system and can be used in faster currents. Both sides of the river should be secure. Place a transverse line at about a 45-degree angle from the flow of current. The diver will move from the upstream side to the downstream side letting the current push them. Tenders must be placed on the nearshore and the far shore to move the diver or boat both directions. Once the diver has moved to the far shore, the nearshore tender will place the line downstream and allow the diver to move back. The search pattern will then be shaped in a /\/\/\/\ fashion. Ensure that the movement of the downstream tender is not so great as to miss large areas. For working dives, simply drop the diver down the zip line to the project site and hold. The far shore tender can also place a small line at the end of the zip line in order to add a vector pull.

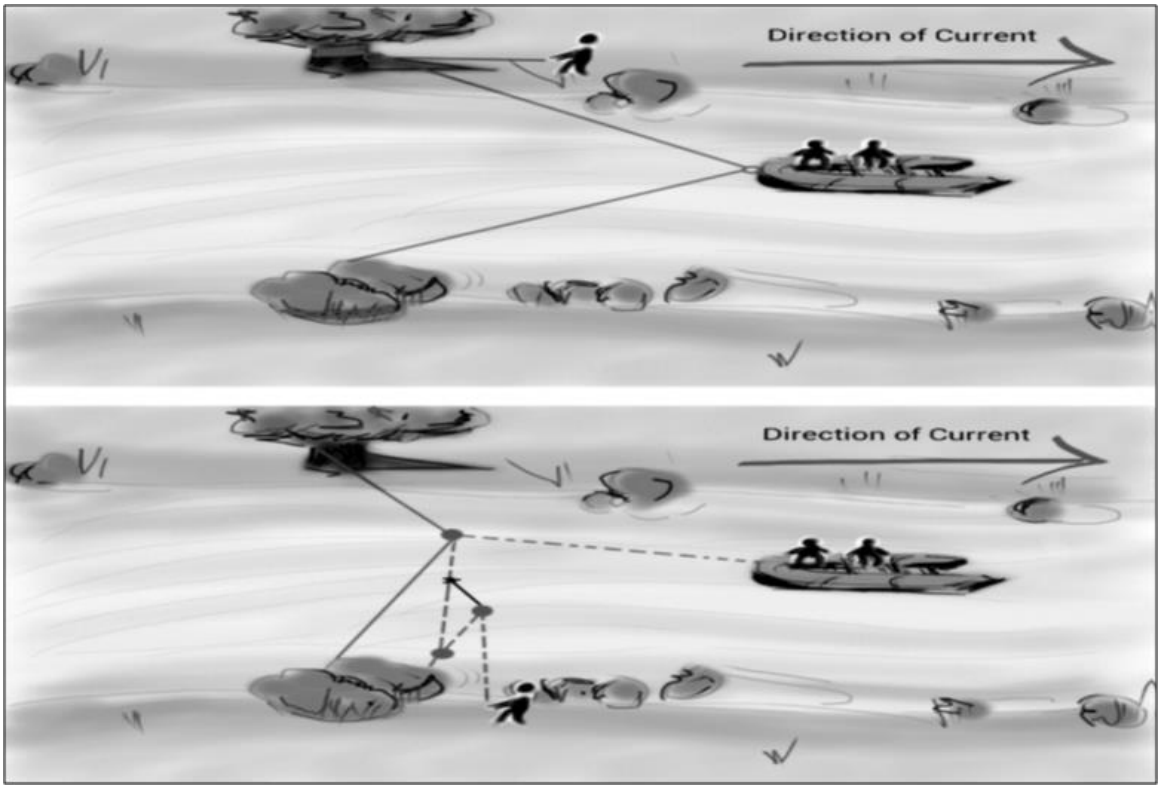


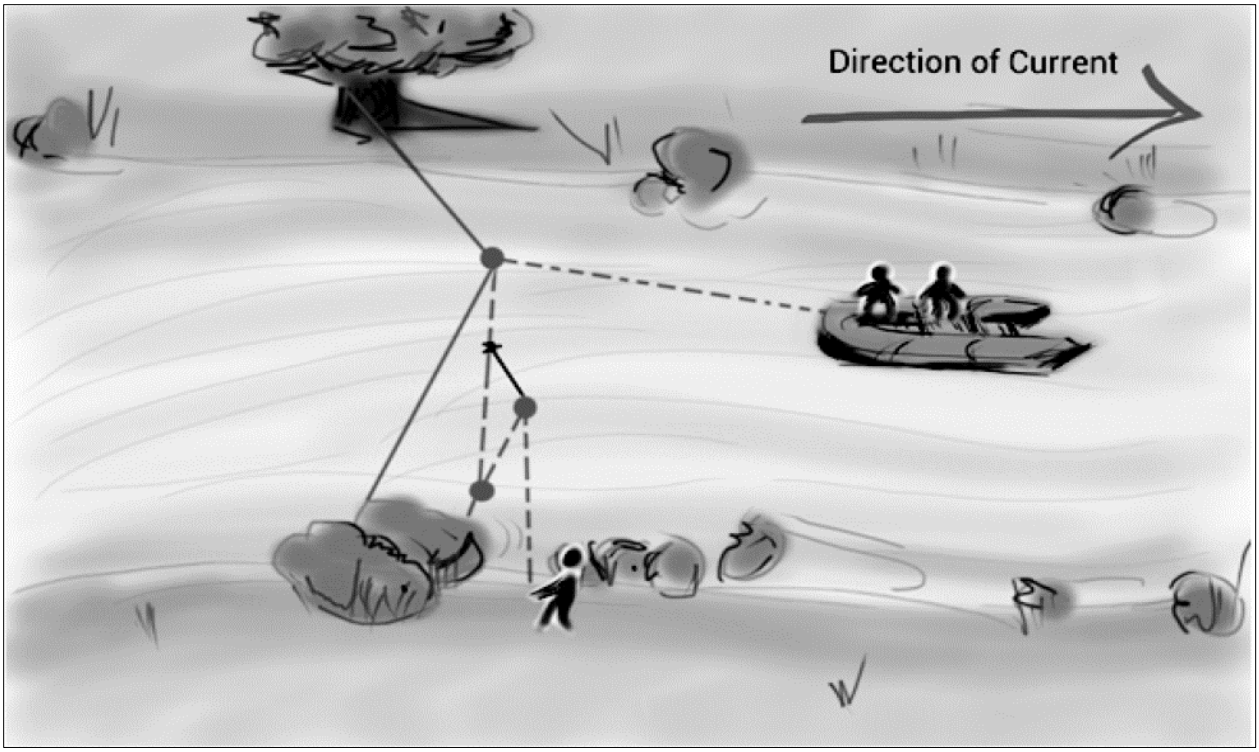
Note. One nearshore tender; 2 far shore tenders; 3 supervisors; 5 logs; 6 standby divers; 7 standby tenders; and 8 and 9 downstream safeties.

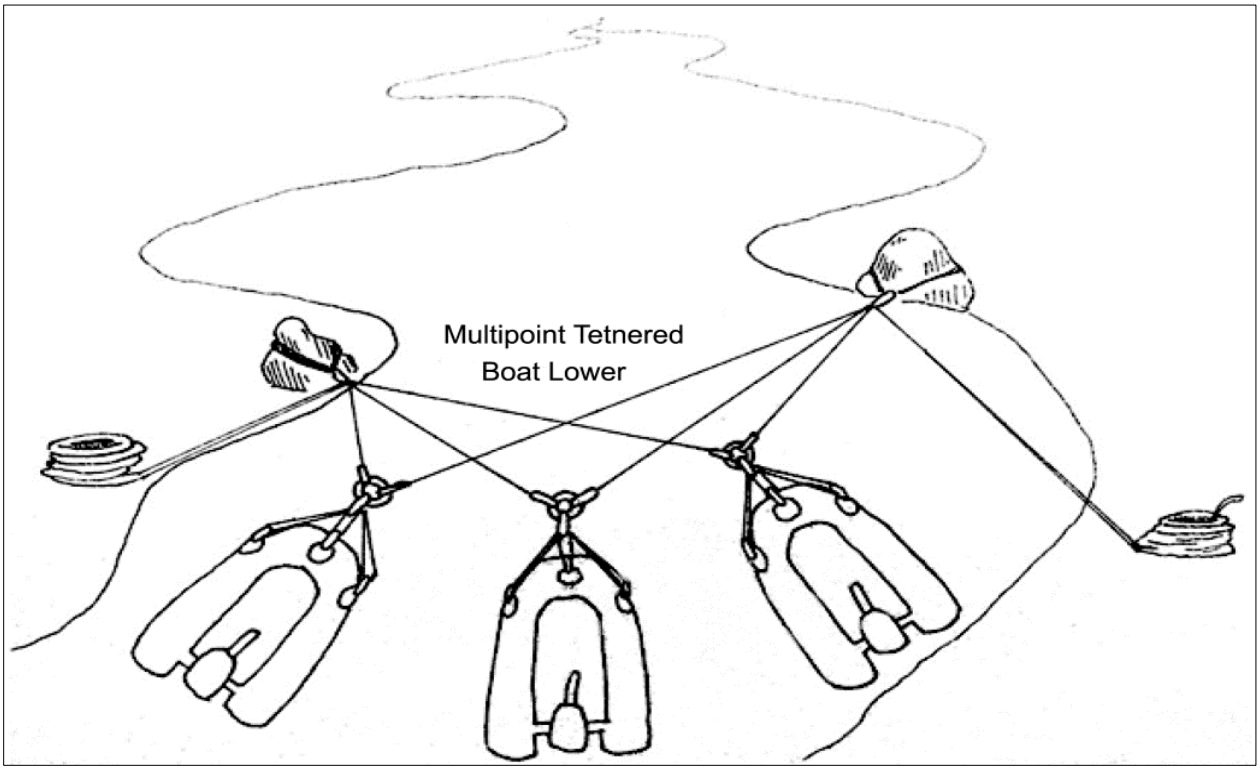
Diving from Small Boats

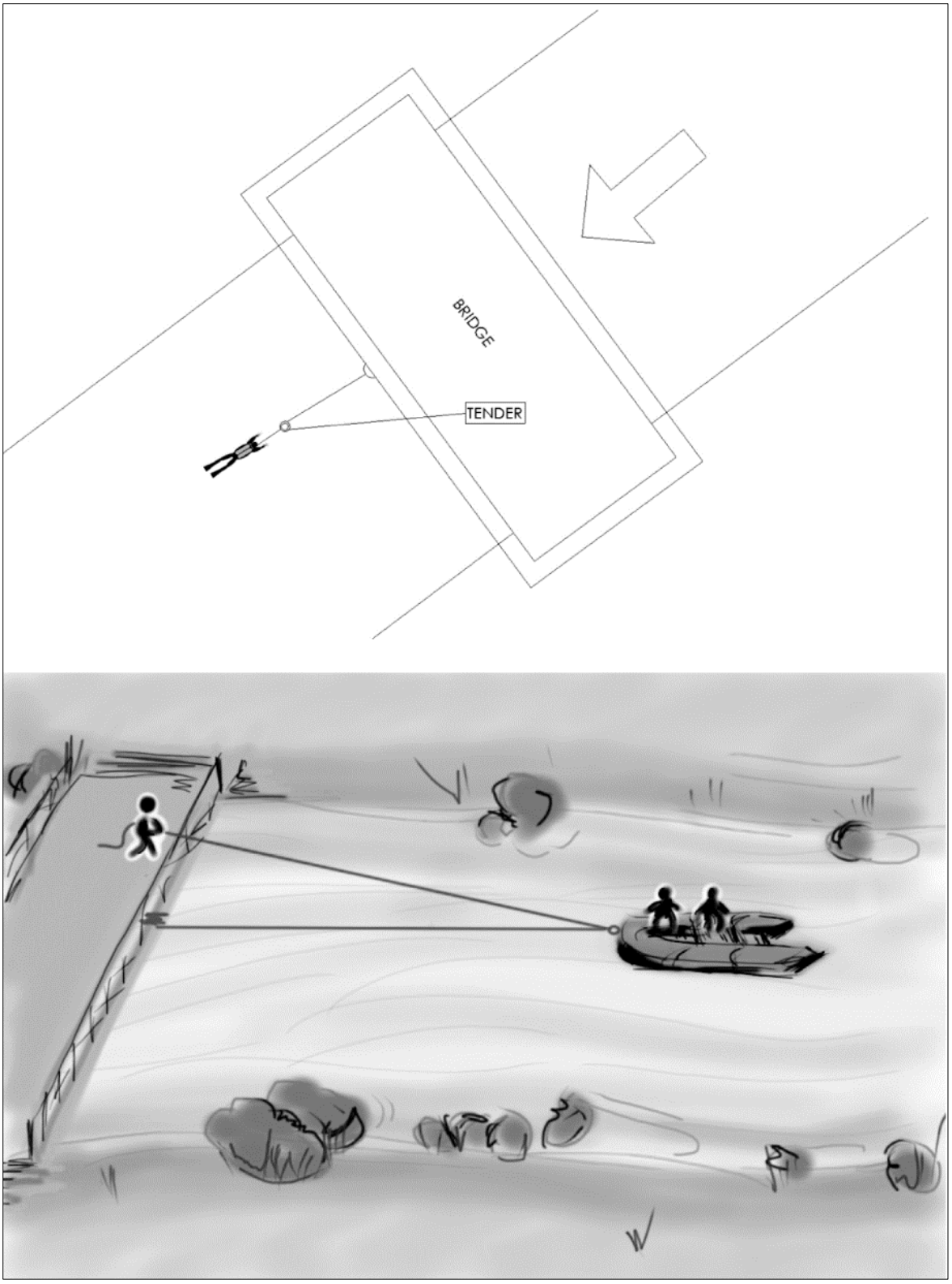
When it is not practical to dive a diver from the shore, small boats can be used to provide a mobile dive side on the river. In slower currents an anchor can be used while in faster currents a high line may be used. Use of the motor should be limited only to establishing lines across the river and as a safety in the event of a line blowout. It is extremely taxing and risky to tend a diver from a boat under use of the motor as a stable platform. The graphics below present options available for use of a boat as a diving platform.


Direction of Current
10
6
7
5
3
4
8
9
Scuba divers: minimum 8 personnel
Extreme Lightweight Diving System (XLDS): minimum 10 personnel (preferred method)


Direction of Current
Direction of Current


Direction of Current


Multipoint Tetnered
Boat Lower


BRIDGE
TENDER

Safety Diver(s)

Similar to IDLH firefighting operations and the use of 2-out, no diver may enter the water without a Safety. If multiple divers are needed than multiple safeties must be provided for each diver. The Dive Group Supervisor may also consider the use of multiple Safeties for one diver at select locations based upon the risk profile and judgment of the Dive Group Supervisor and Diver. The Safety Diver is the most experienced and most skilled diver in an FFD Diving Operation. The sole focus of the safety diver is to recognize potential problems before they become distress problems for the primary diver.

Much like 2-Out the Safety Diver, while in a position suited up ready to enter the water, is gathering situational awareness and intelligence on the dive environment and the primary diver's position and breathing patterns. Any potential concerns by the Safety Diver should be immediately brought to the Dive Group Supervisors attention.

Medical Monitoring of Safety Divers

Safety divers in "standby" mode are in extreme danger of dehydration and possible heat stroke. Heat stress protocols that apply to firefighting operations may also apply to Safety Divers on standby. Provisions must be made to attend to the comfort of these divers during the pre-deployment phase. Insofar as possible, the safety diver(s) should be seated in the shade, near the water, with cooling provisions (i.e., empty bucket) and drinking water available. If personnel are available medical monitoring should be performed both on the primary diver and standby diver including vital signs. This information should be recorded and monitored by the Dive Group Supervisor

Safety Diver Tasking

The following are general tasks that are performed by the Safety Diver

- Shall be fully suited, placed at the water's edge, and ready to respond except that the face mask or FFM 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, tether line, and a safety clip.

- Upon being deployed to assist an entrapped diver, the primary safety diver will attach the contingency line on the entrapped diver's descending line and the other end to his/her harness. Care must be taken not to pull on the entrapped diver's down line, which could cause further injury or entrapment.

- The primary safety diver is responsible for locating the entangled diver, determining the cause and location of the entanglement and freeing the entangled diver, if possible.

- The primary safety diver should leave his/her contingency line affixed to the entrapped diver's tether line and endeavor to work to free the entanglement while affixed to the line in order to avoid losing contact with the entrapped diver.

- In the event it is necessary or desirable for the primary safety diver to disconnect from the contingency line in order to endeavor to free an entanglement, he/she may do so, but must maintain physical contact with the entrapped diver at all times.

- In the event the primary safety diver is unable to free the entanglement, he/she should advise the diving operations supervisor and await the arrival of a secondary safety diver. Upon the arrival of the secondary safety diver, the primary safety diver will ensure the entangled diver has a continuous air supply available and will remove the entangled diver's equipment as necessary in order to facilitate escape from the entanglement.

- The primary safety diver will then guide the entrapped diver on an ascent to the surface.

- In the event the freeing of the entangled diver should become a lengthy endeavor, the primary safety diver must be cognizant of the rescued diver's bottom time and ensure decompression procedures are followed according to the rescued diver's computer or dive tables.

Search Patterns

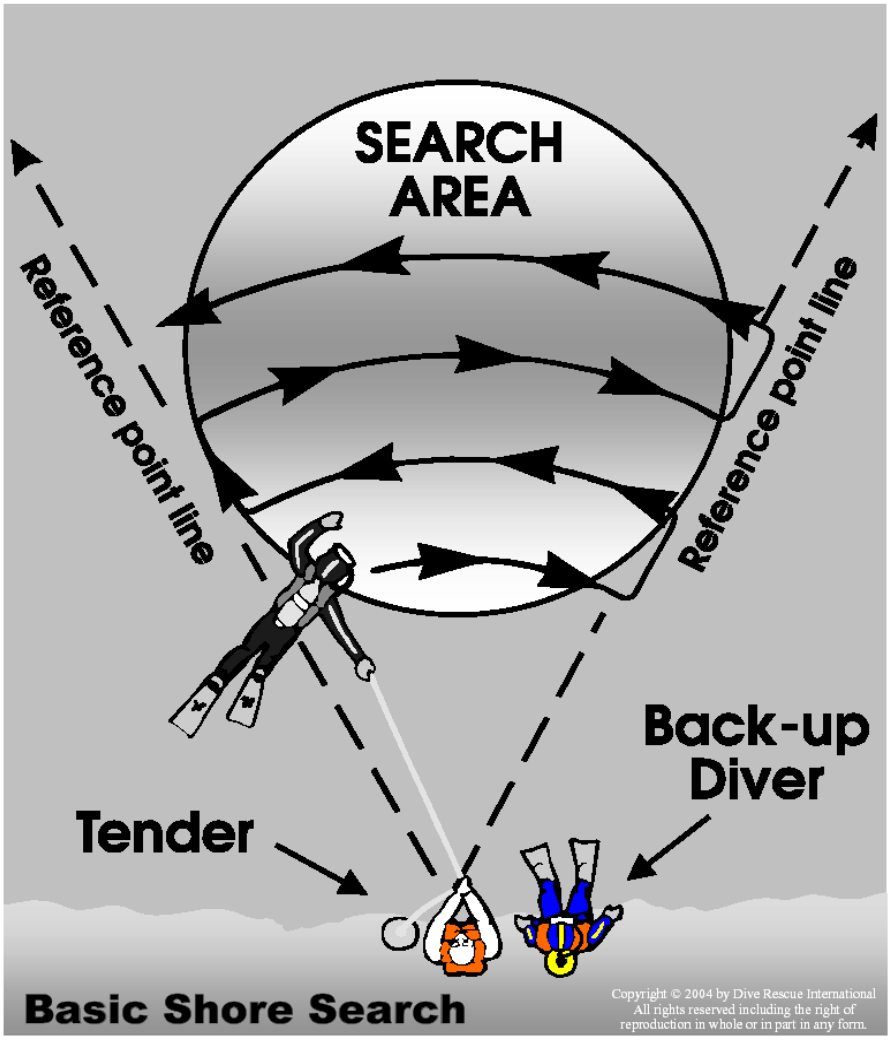
Search patterns are primarily utilized when currents are less than 1 knot and will allow for multiple divers to repeat a search pattern without the risk of being swept away by current. The use of a search patterns versus swiftwater line tending sweeps is at the discretion of the DGS and divers. A variety of search patterns may be utilized by the dive team. Fresno Fire utilizes rope pull signals developed by the Dive Rescue International and are commonly used throughout public safety dive teams. The following graphics depicts search pattern options:

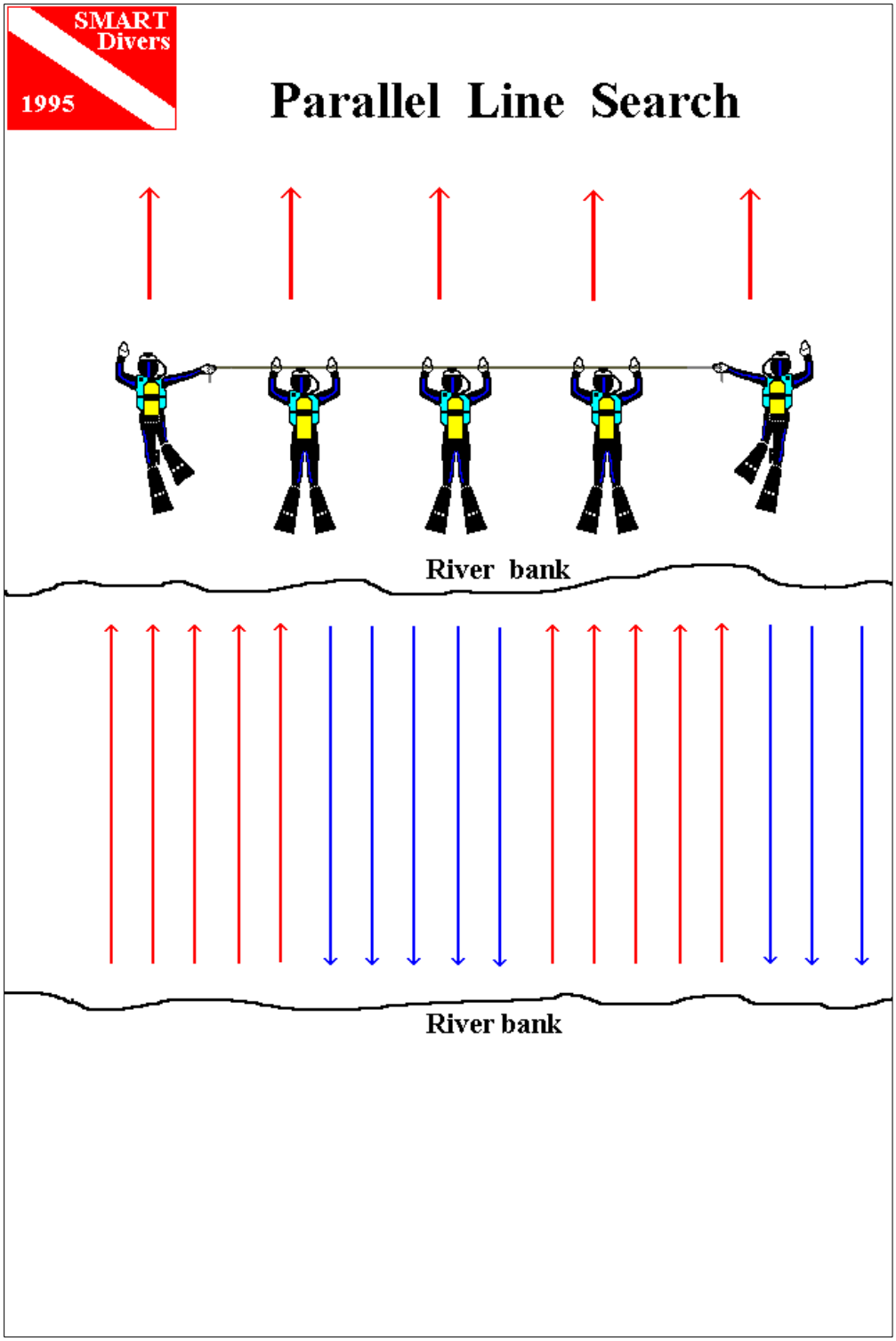
INTERNATIONAL PUBLIC SAFETY DIVER LINE SIGNALS

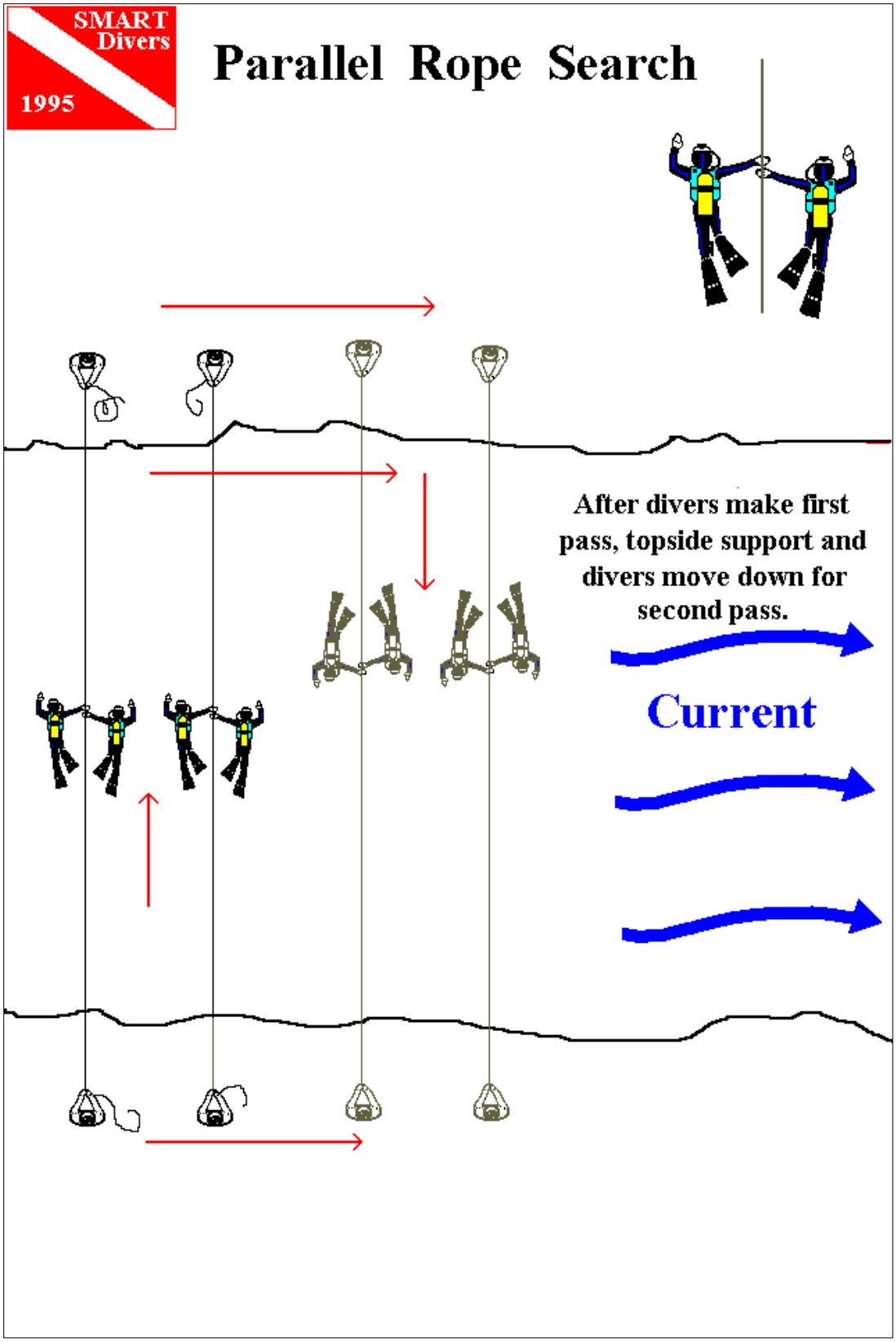
TENDER TO DIVER	
1 pull	Okay? Okay.
2 pulls	Stop, take out slack, reverse direction
3 pulls	Come to the surface
4 pulls	STOP, DON'T MOVE

DIVER TO TENDER	
1 pull	Okay? Okay.
2 pulls	Advance line, give slack
3 pulls	Object found
4 pulls	NEED ASSISTANCE

The International Public Safety Diver Line Signals are similar to the search line signals taught to firefighters worldwide. In fire academies, firefighters learn to use "OATH" (okay, advance, take up slack, help). Except for the 1 pull, signals are NOT acknowledged. If the desired result is not achieved, the signal is repeated.

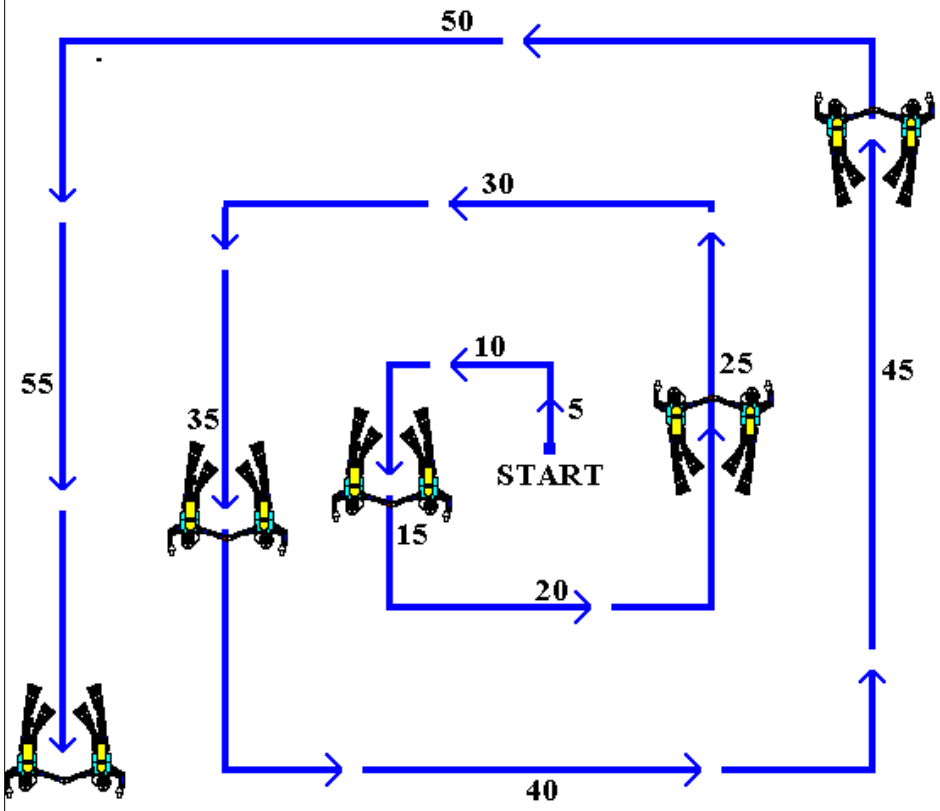



SMART
Divers
1995
Parallel Line Search
River bank
River bank

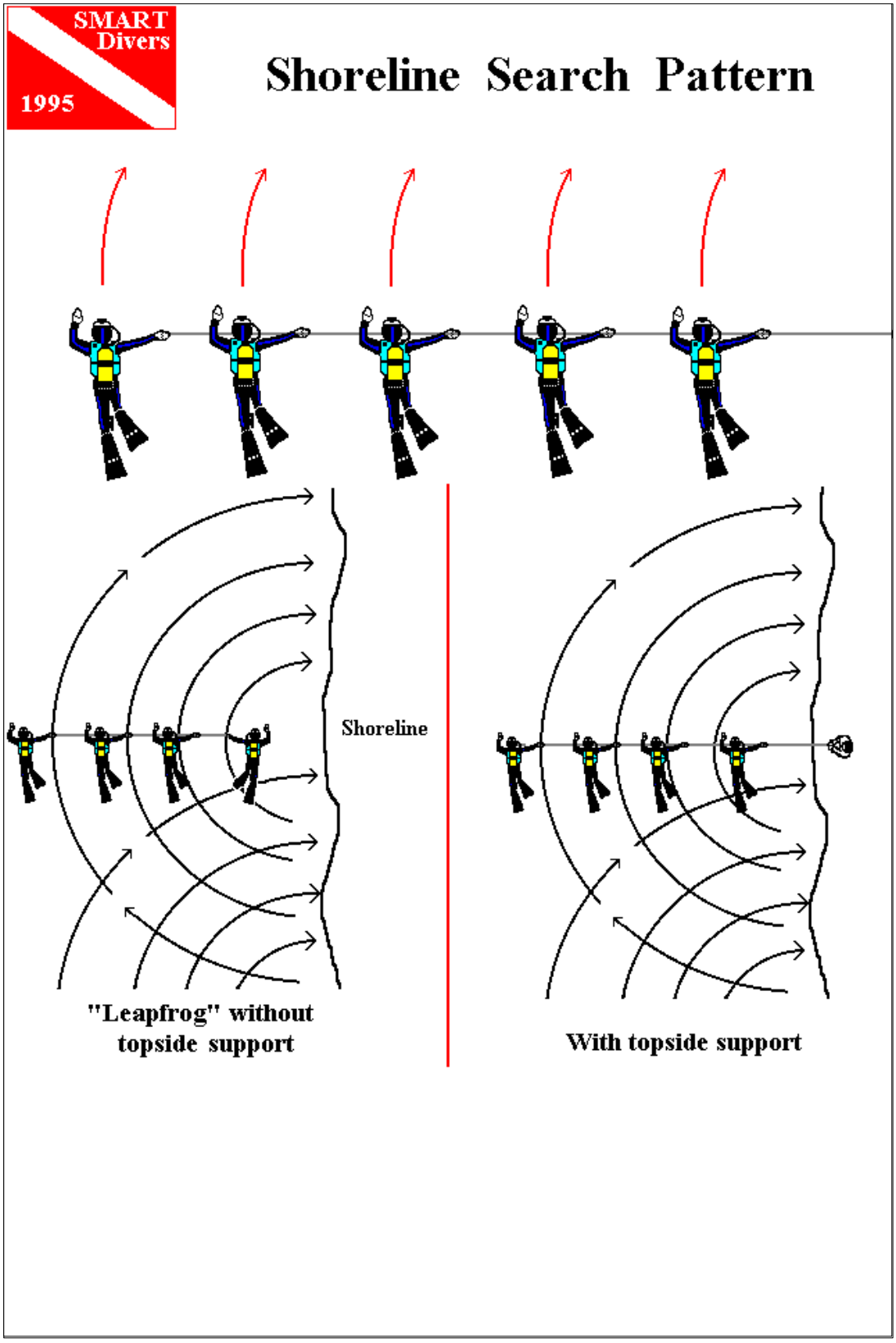

SMART Divers
1995
Parallel Rope Search
After divers make first pass, topside support and divers move down for second pass.
Current

SMART Divers 1995

Circular Navigation Pattern



Divers turn 90 degrees and add 5 kicks to each leg of the circular pattern.


SMART
Divers
1995
Shoreline Search Pattern
Shoreline
"Leapfrog" without
topside support
With topside support

Diver Entrapment

Underwater entrapment is unquestionably the most dangerous and frightening condition presented to the public safety diver. Entrapments can easily occur when ropes are utilized for search patterns and tethering of divers. Entrapment can result from entanglement as a result of being caught up in a myriad of underwater hazards (i.e., fishing line, wire, tree branches, tether line[s], etc.); from inability to reach the surface due to an overhead environment; as a result of being caught in a constriction; or from being held in position against a siphon or drain pipe, etc., by current. 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 the entrapment on his own accord or be assisted in escape by another diver, the result is invariably the same -- either panic by the diver resulting in his/her spitting out his 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 his effort to free himself/herself lead to other, more serious problems.

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

- **The Entangled Diver**
    - Each diver will be deployed with the following equipment:
        - Either an umbilical line or tether (search line) attached to the dive tender at one end; and clipped to the diver's BCD or harness at the other
        - Sharp knife (at least one) and side cutters or trauma shears
        - Full face mask with underwater communication device or use of tether line for rope pull signals
        - Pony bottle (minimum 13 cubic ft.) as a temporary emergency air supply
- **Upon encountering an entanglement, the diver will:**

- Stop and think about where he/she is hung up and what might be causing the entanglement
- Endeavor to determine (by feel) the location and cause of the entanglement
- Endeavor to free himself/herself and/or equipment from the entanglement

- **Should the diver be unable to free the entanglement, he/she will:**
  - Advise the topside communication operator he/she has an entanglement emergency.
  - If radio communications are not possible, the diver will use rope signals, which will consist of four pulls on the rope tether.
  - Remain as still as possible in order to conserve air and facilitate the best possible visibility for responding safety diver(s).
  - If the primary air source is depleted, advise the topside communications operator that he/she is switching to emergency air, activate the valve on the pony bottle, and breathe from the redundant second-stage regulator.

- **Equipment necessary for diver rescue from entrapment:**
  - An orange webbing contingency strap to be affixed to the searching diver's tether line by the safety diver affecting the rescue in order to assist in hands-free location and disentanglement of the entrapped diver.
    - The contingency line should consist of two carabiners fastened together by a length of 1-inch nylon webbing approximately 24 inches long.
    - One of the carabiners on the contingency line is attached to the safety diver's harness or BCD -- the other to the entrapped diver's tether line.
    - Sharp knife and side cutters.
    - Buddy line.
    - Safety cylinder/SCUBA RIC bottle.

- Minimum 80 cubic ft. aluminum or 66 cubic ft. steel with first and second stage regulator attached, and stage bottle strap affixed.

- Additional air cylinders/regulators of varying capacities can be shuttled to the secondary safety diver by supplementary dive personnel as necessary.

Emergency Procedures for Diving-Related Accidents

All dive operations will have an Ambulance on standby. The DGS will have a medical plan as a part of his Incident Action Plan and Risk Management Options. Specialized consultation is available through the Divers Alert Network (DAN) (919) 684-8111. Helicopter evacuations can be requested through normal dispatch procedures by the incident commander. Oxygen should be an absolute necessity on every dive. Oxygen is the one first aid treatment that can be used with the full knowledge that it can only help and usually is the one treatment that will turn a serious diving injury around. It is the first thing you should think of in all serious decompression illness and should be used even if you're uncertain of its need.

a. Diving Accidents requiring immediate transportation to a Chamber Facility

Air Embolism

Recognition (This usually occurs during or immediately after surfacing) Symptoms (one or more of the following)

- Disorientation
- Chest pain
- Paralysis or weakness
- Dizziness
- Blurred vision
- Personality change
- Voice change in tonal quality (mediastinal air)

Air Embolism Signs (one or more of the following)

- Bloody froth from nose or mouth
- Paralysis or weakness
- Unconsciousness
- Convulsions
- Stopped breathing

Air Embolism Management

- CPR, if required
- Open airway, prevent aspiration, intubate if trained person available
- Give O_2, remove only to open airway or if convulsions ensue.
- Mask, if available
- If conscious, give nonalcoholic liquids
- Place in horizontal, neutral position
- Restrain convulsing person loosely and resume O2 as soon as airway is open
- Protect from excessive cold, heat, water or fumes

Transport to nearest emergency facility closely associated with a recompression chamber. Do not waste time evaluating and stabilizing at a facility unaccustomed to diving emergencies. This is possibly the most important thing you can do! Call DAN at 919-684-8111 in the USA

- Air evacuation should be at sea level pressure or as low as possible in unpressurized Aircraft
- Contact hyperbaric chamber, send diver's profile with the diver, and send all diving equipment for examination or have it examined locally.

Decompression Sickness

Recognition (Symptoms usually appear 15 minutes to 12 hours after surfacing)

Signs

- Blotchy rash
- Paralysis or weakness anywhere in the body
- Coughing spasms
- Staggering or instability
- Unconsciousness Personality change

Symptoms

- Tired feeling
- Itching
- Pain, arms, legs or trunk
- Dizziness
- Numbness, tingling or paralysis
- Chest compression or shortness of breath
- Anything unusual after the dive

Early Management

- Stabilize patient the same way as for Air Embolism
- Urgent recompression after stabilization in trauma facility closely associated with a recompression chamber
- Immediate oxygen breathing, continue even if person improves markedly
- Mask, (if available)

- Early recompression treatment for all forms of decompression sickness

Decompression Sickness is preventable! It occurs when a diver has exceeded his/her nitrogen absorption time from breathing compressed gas. The DGS is responsible for creating a strict dive profile (time and depth limits) prior to the dive and ensuring adherence to the profile. Plan the dive and dive the plan!

b. Diving Accidents requiring immediate transportation to the closest facility

Pneumothorax

Symptoms

- Pain in the chest
- Shortness of breath

Signs

- Shallow, rapid breathing
- Cyanosis (blue skin, lips, fingernails)
- Possible crackling under the skin of the neck
- Possible mediastinal shift (Heart sounds not in the usual place)

Treatment

- No recompression necessary, if there is no arterial gas embolism associated
- A physician needs to insert a chest tube, withdraw air so that the lung can re-inflate
- If recompression therapy is required because of AGE or DCS, a chest tube is a must to prevent "Tension pneumothorax"

Mediastinal Emphysema (Lung over pressure accident)

Recognition (Always associated with pneumothorax)

Symptoms

- Pain in the chest (beneath the breastbone)
- Faintness
- Shortness of breath

Signs

- Obvious difficulty breathing
- Brassy change in voice

Treatment

- O_2
- Should be seen by physician and observed for 24 hours
- No chamber recompression needed unless associated with air embolism or DCS

c. Diving First Aid for injuries that do not usually require an immediate transport but may need Physician evaluation.

Nitrogen Narcosis

Signs

- Inappropriate behavior at depth
- Ignoring hand signals and instructions
- Stupor or coma

Symptoms

- Inflexible mentation (thinking)
- Decrease or loss of judgment
- False sense of security
- Lack of concern for safety
- Inability to think through problems
- Panic
- Near unconsciousness or loss of consciousness at depth

Treatment

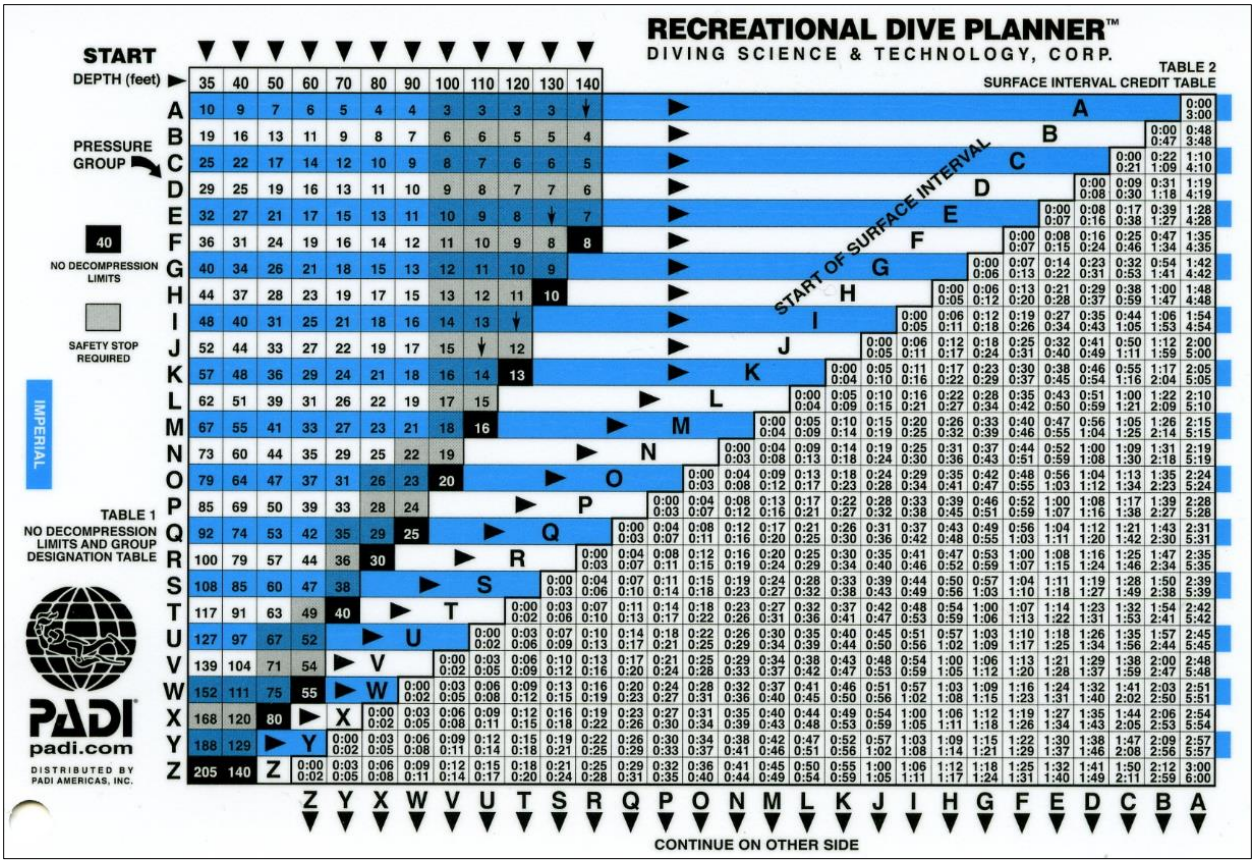
- Ascend until free of symptoms
- Surface with controlled ascent
- Follow up with training

Ear Disorders

Ear injuries occur when improper diving techniques to clear the ears are not performed or when diving with a cold. The failure of a diver to clear his or her ears may result in barotrauma to the middle or inner ear and can include vertigo and dizziness. Suspected ear trauma must be seen by a Physician ENT Specialist and the affected diver may not dive until clearance is obtained by the Physician

Dive Tables

a. It is imperative that all divers track their bottom time and dive according to the plan set forth by the DGS. It is the DGS who sets the maximum time and depth limits for any dive operation. Most dives in the City of Fresno are shallow water dives in swiftwater with a maximum time of 20 minutes. Any deviation from this typical diving environment is considered hazardous and it is up to the DGS and dive team to make a collective decision based upon the risk assessment profile and experience of the divers to dive any depths beyond 1 atmosphere (33 feet). All members of the dive team will be proficient in use of the PADI or NAUI dive tables.


RECREATIONAL DIVE PLANNER™
DIVING SCIENCE & TECHNOLOGY, CORP.
START
DEPTH (feet)
PRESSURE GROUP
40
NO DECOMPRESSION LIMITS
SAFETY STOP REQUIRED
IMPERIAL
TABLE 1
NO DECOMPRESSION LIMITS AND GROUP DESIGNATION TABLE
TABLE 2
SURFACE INTERVAL CREDIT TABLE
START OF SURFACE INTERVAL
CONTINUE ON OTHER SIDE
PADI
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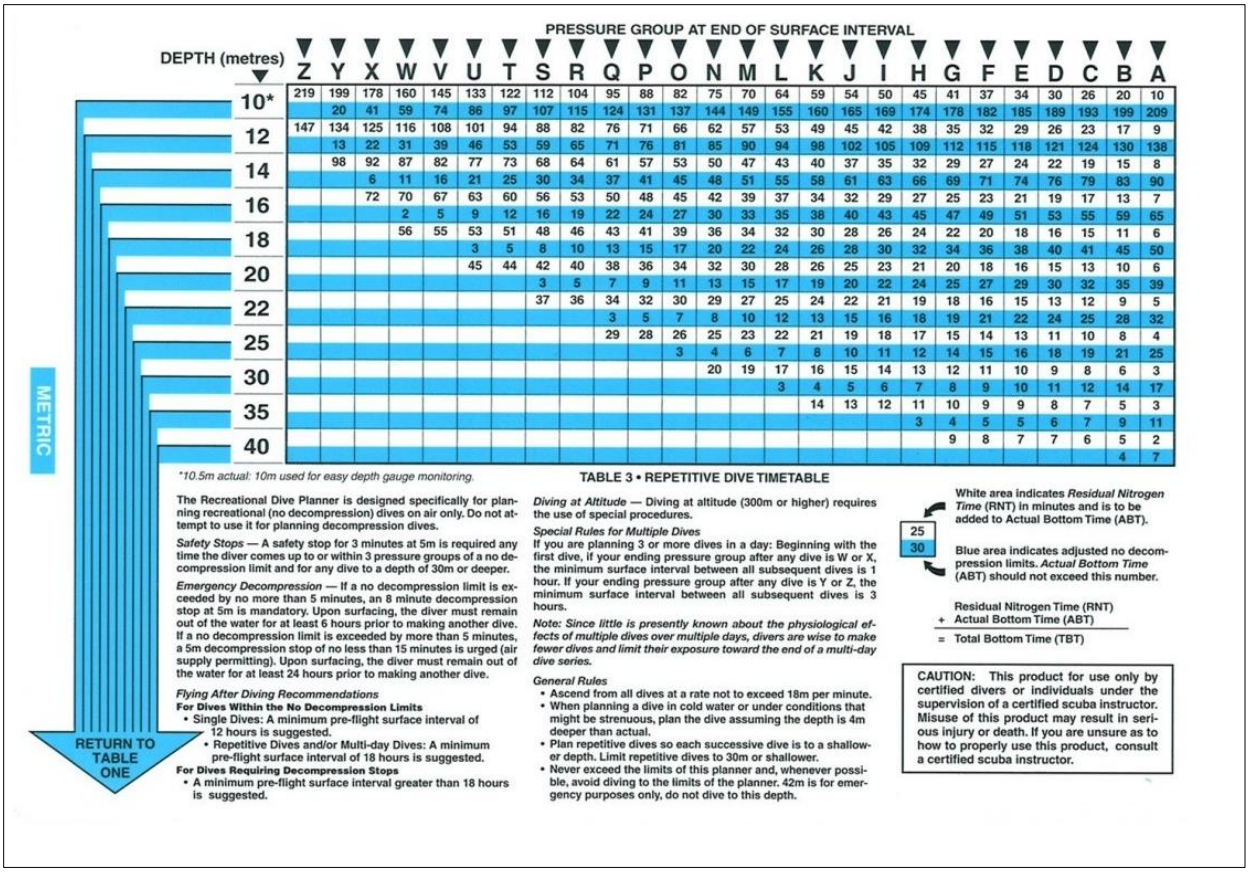


PRESSURE GROUP AT END OF SURFACE INTERVAL

DEPTH (metres)	Z	Y	X	W	V	U	T	S	R	Q	P	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A
10*	219	199	178	160	145	133	122	112	104	95	88	82	75	70	64	59	54	50	45	41	37	34	30	26	20	10
		20	41	59	74	86	97	107	115	124	131	137	144	149	155	160	165	169	174	178	182	185	189	193	199	209
12	147	134	125	116	108	101	94	88	82	76	71	66	62	57	53	49	45	42	38	35	32	29	26	23	17	9
		13	22	31	39	46	53	59	65	71	76	81	85	90	94	98	102	105	109	112	115	118	121	124	130	138
14		98	92	87	82	77	73	68	64	61	57	53	50	47	43	40	37	35	32	29	27	24	22	19	15	8
			6	11	16	21	25	30	34	37	41	45	48	51	55	58	61	63	66	69	71	74	76	79	83	90
16			72	70	67	63	60	56	53	50	48	45	42	39	37	34	32	29	27	25	23	21	19	17	13	7
				2	5	9	12	16	19	22	24	27	30	33	35	38	40	43	45	47	49	51	53	55	59	65
18				56	55	53	51	48	46	43	41	39	36	34	32	30	28	26	24	22	20	18	16	15	11	6
						3	5	8	10	13	15	17	20	22	24	26	28	30	32	34	36	38	40	41	45	50
20						45	44	42	40	38	36	34	32	30	28	26	25	23	21	20	18	16	15	13	10	6
								3	5	7	9	11	13	15	17	19	20	22	24	25	27	29	30	32	35	39
22								37	36	34	32	30	29	27	25	24	22	21	19	18	16	15	13	12	9	5
										3	5	7	8	10	12	13	15	16	18	19	21	22	24	25	28	32
25										29	28	26	25	23	22	21	19	18	17	15	14	13	11	10	8	4
												3	4	6	7	8	10	11	12	14	15	16	18	19	21	25
30													20	19	17	16	15	14	13	12	11	10	9	8	6	3
															3	4	5	6	7	8	9	10	11	12	14	17
35																14	13	12	11	10	9	9	8	7	5	3
																			3	4	5	5	6	7	9	11
40																				9	8	7	7	6	5	2
																									4	7

METRIC

RETURN TO TABLE ONE

*10.5m actual: 10m used for easy depth gauge monitoring.

TABLE 3 • REPETITIVE DIVE TIMETABLE

The Recreational Dive Planner is designed specifically for planning recreational (no decompression) dives on air only. Do not attempt to use it for planning decompression dives.

Safety Stops — A safety stop for 3 minutes at 5m is required any time the diver comes up to or within 3 pressure groups of a no decompression limit and for any dive to a depth of 30m or deeper.

Emergency Decompression — If a no decompression limit is exceeded by no more than 5 minutes, an 8 minute decompression stop at 5m is mandatory. Upon surfacing, the diver must remain out of the water for at least 6 hours prior to making another dive. If a no decompression limit is exceeded by more than 5 minutes, a 5m decompression stop of no less than 15 minutes is urged (air supply permitting). Upon surfacing, the diver must remain out of the water for at least 24 hours prior to making another dive.

Flying After Diving Recommendations

For Dives Within the No Decompression Limits

- Single Dives: A minimum pre-flight surface interval of 12 hours is suggested.
- Repetitive Dives and/or Multi-day Dives: A minimum pre-flight surface interval of 18 hours is suggested.

For Dives Requiring Decompression Stops

- A minimum pre-flight surface interval greater than 18 hours is suggested.

Diving at Altitude — Diving at altitude (300m or higher) requires the use of special procedures.

Special Rules for Multiple Dives

If you are planning 3 or more dives in a day: Beginning with the first dive, if your ending pressure group after any dive is W or X, the minimum surface interval between all subsequent dives is 1 hour. If your ending pressure group after any dive is Y or Z, the minimum surface interval between all subsequent dives is 3 hours.

Note: Since little is presently known about the physiological effects of multiple dives over multiple days, divers are wise to make fewer dives and limit their exposure toward the end of a multi-day dive series.

General Rules

- Ascend from all dives at a rate not to exceed 18m per minute.
- When planning a dive in cold water or under conditions that might be strenuous, plan the dive assuming the depth is 4m deeper than actual.
- Plan repetitive dives so each successive dive is to a shallower depth. Limit repetitive dives to 30m or shallower.
- Never exceed the limits of this planner and, whenever possible, avoid diving to the limits of the planner. 42m is for emergency purposes only, do not dive to this depth.

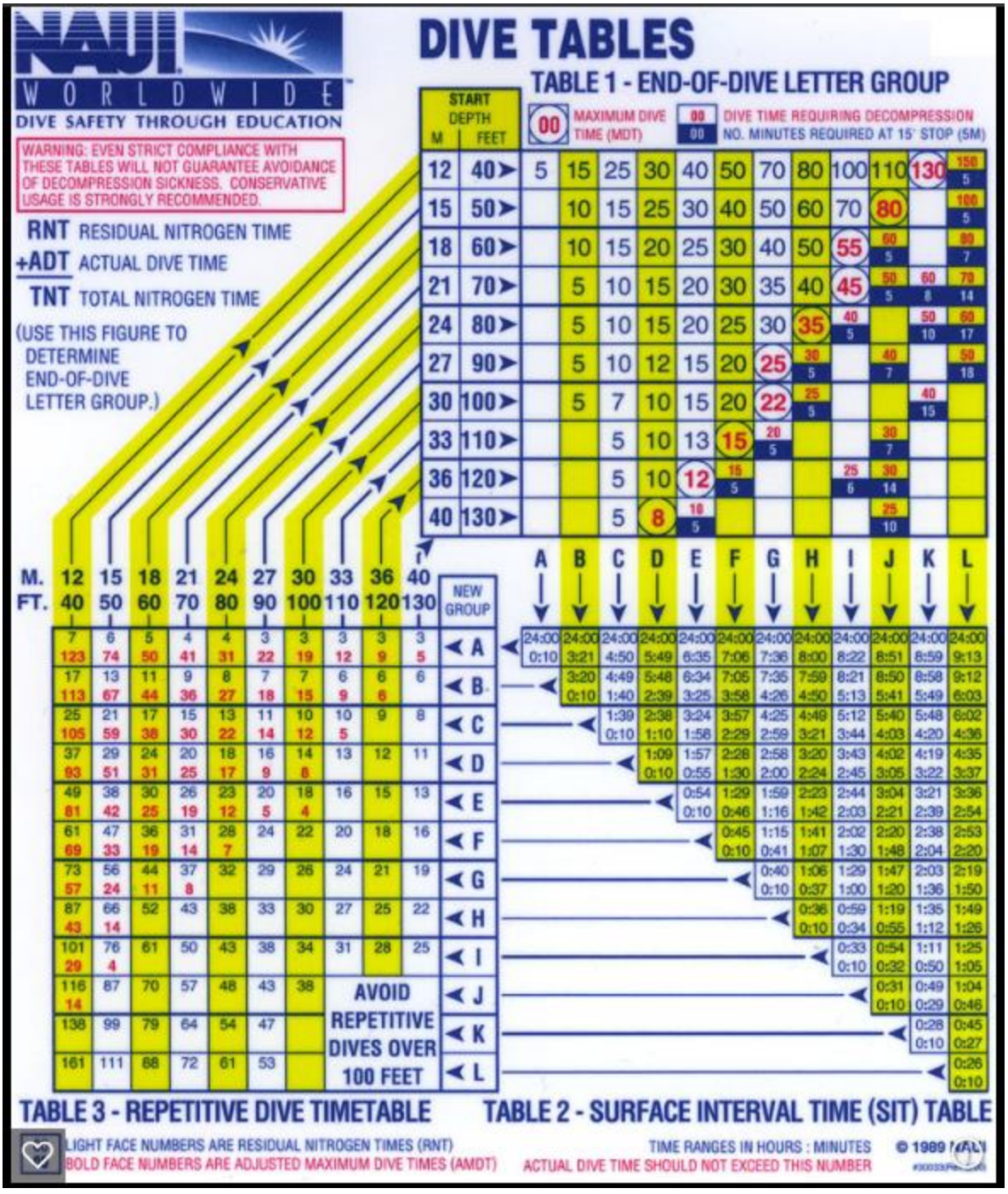
25
30

White area indicates *Residual Nitrogen Time* (RNT) in minutes and is to be added to Actual Bottom Time (ABT).

Blue area indicates adjusted no decompression limits. *Actual Bottom Time* (ABT) should not exceed this number.

Residual Nitrogen Time (RNT)
+ Actual Bottom Time (ABT)
= Total Bottom Time (TBT)

CAUTION: This product for use only by certified divers or individuals under the supervision of a certified scuba instructor. Misuse of this product may result in serious injury or death. If you are unsure as to how to properly use this product, consult a certified scuba instructor.


NAUI WORLDWIDE
DIVE SAFETY THROUGH EDUCATION
WARNING: EVEN STRICT COMPLIANCE WITH THESE TABLES WILL NOT GUARANTEE AVOIDANCE OF DECOMPRESSION SICKNESS. CONSERVATIVE USAGE IS STRONGLY RECOMMENDED.
RNT RESIDUAL NITROGEN TIME
+ADT ACTUAL DIVE TIME
TNT TOTAL NITROGEN TIME
(USE THIS FIGURE TO DETERMINE END-OF-DIVE LETTER GROUP.)
DIVE TABLES
TABLE 1 - END-OF-DIVE LETTER GROUP
START DEPTH M | FEET
MAXIMUM DIVE TIME (MDT)
DIVE TIME REQUIRING DECOMPRESSION
NO. MINUTES REQUIRED AT 15' STOP (5M)
M.
FT.
NEW GROUP
AVOID REPETITIVE DIVES OVER 100 FEET
TABLE 3 - REPETITIVE DIVE TIMETABLE
TABLE 2 - SURFACE INTERVAL TIME (SIT) TABLE
LIGHT FACE NUMBERS ARE RESIDUAL NITROGEN TIMES (RNT)
BOLD FACE NUMBERS ARE ADJUSTED MAXIMUM DIVE TIMES (AMDT)
TIME RANGES IN HOURS : MINUTES
ACTUAL DIVE TIME SHOULD NOT EXCEED THIS NUMBER
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ACRONYM GLOSSARY

DGS = Division Group Supervisor
NAUI = National Association of Underwater Instructors
PADI = Professional Association of Diving Instructors
SOP = Standard Operating Procedure
SSD = Supply Side Diver
WRT = Water Rescue Team

REFERENCES

- PADI Open Water Diver Manual, PADI
- PADI Rescue Diver Manual, PADI
- NAUI Open Water Diver Manual, NAUI
- Dive Rescue International, Public Safety Search Pattern
- Swiftwater Rescue Technician Unit-1 Manual
- Public Safety Diving, Andrea Zaferes and Walt Hendrick
- TM 3-34.84 Swift Water Diving Operations, U.S. Army, March 2015
- Oconee Dive Team Operations Manual,

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