World Academy of Safety & Health

Flood & Swiftwater Rescue, v.2021

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Flood & Swiftwater Rescue – Student Manual, v.2021

Purpose:

This *World Academy of Safety & Health (WASH) Flood & Swiftwater Rescue Manual, v.2021* is exclusively intended to provide guidance and information to enrolled students in the World Academy of Safety & Health (WASH) Lifeguard certification training course(s). All information contained within this manual is subject to change at any time for any reason and without notice. All updates, changes, alterations, and new editions will be published on *www.lifeguardcertifications.com*.

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ISBN: 979-8-89372-751-7

Disclaimer

World Academy of Safety & Health (WASH) has made all reasonable efforts to ensure the content of this *Flood & Swiftwater Rescue Manual, v.2021* is accurate, up-to-date, and aligned with the most recent industry standards and recommendations at the time of its publication. Scientific and medical information and data can frequently change. Medical recommendations may, in turn, be updated to reflect this latest science and data. In addition to the regular 5-year program and curriculum review and update cycle, the *World Academy of Safety & Health (WASH) Flood & Swiftwater Rescue Manual, v.2021* will be updated as frequently as is needed based upon any changes in medical recommendations. Any and all updates will be published on: *www.lifeguardcertifications.com*.

Each emergency situation is unique and, hence, warrants its own set of guidelines, principles, recommendations, information and/or emergency response protocols. Therefore, it is not possible for *World Academy of Safety & Health (WASH)* to provide blanket emergency response recommendations.

This *Flood & Swiftwater Rescue Manual, v.2021* must not replace or substitute for advanced medical care or emergency services response and treatment. Further, no information contained within this *Flood & Swiftwater Rescue Manual, v.2021* should replace the need to seek care and/or advice from a physician, hospital staff member, or other licensed healthcare provider. Cooperation with local medical direction is necessary when developing a facility Emergency Action Plan (EAP) and best practices. Emergency services should always be contacted when there is an emergency situation.

World Academy of Safety & Health (WASH) utilizes an Advisory and Review Committee in the development of all programs, courses, manuals, resources, and other instructional materials.

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About Us

World Academy of Safety & Health is an international certifying body for Shallow Pool Lifeguards, Pool Lifeguards, Waterfront Lifeguards, Rescue Swimmer, Surf Lifeguard, Lifeguard Instructors, and Lifeguard Supervisors.

Our Maritime Safety Division offers courses that include: Safety at Sea, PWC Operations, PWC Rescue Operations, Rescue Swimmer, Flood & Swiftwater Rescue, Rescue Diver, Aquatics First Response, Night Rescue Swimmer, Defense Maneuvers in the Water, and STCW.

We offer high-quality courses that are an affordable, flexible, and accessible option. Courses are delivered as full in-person classes in select areas across the world. We urge you to utilize our website for the most up to date list of approvals:
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We offer a need-based scholarship program for people to participate in lifeguard certification courses. We rely on outside support in the form of donations, grants, and volunteers.

We invite you to join us in our mission to prevent death by drowning worldwide.

Certification courses available in select areas worldwide. We look forward to serving you!

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World Academy of Safety & Health

PROGRAM ADMINISTRATION

Purpose of Certification and Training Course

The purpose of the World Academy of Safety & Health (WASH) Flood & Swiftwater Rescue Curriculum and Certification program is to provide the participant(s) with the confidence, content knowledge, and physical skills to recognize, respond, and recover in the event of an emergency in or around flood water and/or other fast-moving water.

This program offers the flexibility to be able to adapt the physical skills and/or the type of emergency response and care to the specific and/or special circumstances at an open tidal water setting.

All course participants have electronic access (using the student login on lifeguardcertifications.com) to course manuals, course slide presentations, and course skills video clips beginning with class registration and until the expiration date on the WASH certificate.

Certification Policies & Procedures

Provider-Level Course Prerequisites

Prior to the start of the course participants:

- Must be, at minimum, eighteen (18) years of age by the final meeting date of the course to be eligible to enroll.
- Must successfully demonstrate the course's pre-requisite physical skills:
  - Minimum Swim Ability – 500 meters of Front Crawl without stopping (untimed)
  - Successfully complete the *WASH International Annual Waterman Test* © (located in Appendix A)

Requirements for Successful Completion of Provider-Level Course

In order to earn a World Academy of Safety & Health (WASH) Flood & Swiftwater Rescue certificate, participants:

- Must be present for all class meetings. This includes but may not be limited to classroom sessions, pool sessions, another in-person sessions.
- Must meet the course objective for each lesson by successfully demonstrating each required physical skill.
- Must earn a minimum score of eighty (80) percent on the final proctored written exam.

Certification Period for Provider-Level Course

Each World Academy of Safety & Health (WASH) Flood & Swiftwater Rescue certificate will have a validity period of three (3) years from the date of completion. This date as well as the certificate expiration date will be shown on the certificate itself.

Each American Safety & Health Institute (ASHI), an HSI company, certificate earned during a World Academy of Safety & Health (WASH) course will have a validity period of two (2) years from the date of completion. These dates as well as the certificate expiration date will be shown on the certificate itself.

World Academy of Safety & Health (WASH) reserves the right to suspend, revoke, or otherwise temporarily and/or permanently terminate the validity of any WASH certificate at any time and for any reason. This is at the sole discretion of World Academy of Safety & Health (WASH).

Certification Renewal Requirements for Flood & Swiftwater Rescue Course

There are three (3) options available to World Academy of Safety & Health (WASH) certified Flood & Swiftwater Rescue(s) once their certificate expires.

- If the certificate is no more than 30 days expired, the person may choose to enroll and complete an abbreviated recertification World Academy of Safety & Health (WASH) Flood & Swiftwater Rescue certification course to earn back their Flood & Swiftwater Rescue certificate.
  This Flood & Swiftwater Rescue recertification course requires successful completion of the following components for a participant to earn back their Flood & Swiftwater Rescue certificate: pre-requisite physical skills as outlined in Flood & Swiftwater Rescue Participant Manual, Policies & Procedures, Section I Course Prerequisites; all required physical skills included in the course curriculum; and final exam.

- If the certificate is no more than 30 days expired, the person may choose to CHALLENGE the course. By successfully demonstrating the physical skills and passing the final written exam, the participant can renew his/her World Academy of Safety & Health (WASH) Flood & Swiftwater Rescue certification.

- If the certificate is 31 days or more expired, the person must enroll and successfully complete a full World Academy of Safety & Health (WASH) Flood & Swiftwater Rescue certification course to earn back their Flood & Swiftwater Rescue certificate.

Course Design

Course Overview:
This World Academy of Safety & Health (WASH) course provides the content knowledge, and the physical skills training required, to improve an individual's level of comfort and confidence for safely and proficiently performing contact rescues in open static and surf water environments. Safety, particularly of the rescuers, is strongly emphasized throughout the course. Risk management is reinforced during every skill to establish your level of comfort in the water and to identify and overcome your limitations. The emphasis on risk management helps you determine if your actions meet your agency's Standard Operating Procedure (SOP) in the determination of a rescue being a "offensive" or "defensive" operation. Swimming, stroke technique and body positioning in the water are included in this course. "In water" skills for students include how to read and understand water flow, reading and understanding surf conditions and behavior, contact rescues using rescue buoy devices and boards, dealing with combative and panicked victims, performing self-rescues, and rescues of multiple victims both conscious and unconscious. This course meets the requirements of swimming contact rescue of NFPA 1670 and NFPA 1006 Chapter 11, sections 11.2, Chapter 15, sections 15.2.

Designed For:
Firefighters, Police, EMS, Military and Para-Military, Ocean Lifeguards, and Other First Responders.

Authority:
World Academy of Safety & Health (WASH) Educational Services LLC

Pre-Requisite(s):
Minimum Swim Ability – 500 meters of Front Crawl without stopping (untimed)
Swim Test – with a standard that meets or exceeds the standards set forth in the *WASH International Annual Waterman Test©.*

Hours/Time:
16 hours (this time can be adjusted based upon total enrollment and total course instructor(s) coupled with adherence to the ratio prescribed below).

Maximum Class Size: 32

Instructor(s) Level: WASH Level 3 Instructor OR WASH Flood & Swiftwater Rescue & Swiftwater Rescue Instructor

Instructor/Student Ratio: 1:32 for Lecture/Activities; 1:8 for Physical Skills Practice and Check

Resources/Equipment:

Minimum Resources/Equipment	Texts & Other Resources
Instructor	
World Academy of Safety & Health (WASH) Surf Rescue Manual, 2nd Ed (2021), *WASH Educational Services* & *World Academy of Safety & Health (WASH) Flood & Swiftwater Rescue Manual*, 1st Ed (2022), *WASH Educational Services.*	U.S. Coast Guard Helicopter Flood & Swiftwater Rescue Manual
One Rescue Board for every 8 students	U.S. Naval Search and Rescue Manual
One Landline & Throw Bag for every 8 students	NFPA 1670 Standards on Operation and Training for Technical Rescue Incidents
Laptop with downloaded WASH Course documents and teaching resources	NFPA 1006 Standard for Technical Rescuer Professional Qualifications
	Classroom space to accommodate up to 32 students
	Whiteboards or easel pads with appropriate writing tools
Student	Projector/TV with appropriate laptop connections
World Academy of Safety & Health (WASH) Surf Rescue Manual, 2nd Ed (2021), *WASH Educational Services* & *World Academy of Safety & Health (WASH) Flood & Swiftwater Rescue Manual*, 1st Ed (2022), *WASH Educational Services.*	WiFi/Internet access (not required but encouraged)
Laptop with downloaded WASH Course documents and learning resources	

Course Outline

Module(s)/Topic(s)/Chapter(s)			Module Total Hours
Day 1			
1.1: Course Introduction, Instructor(s) and Student Introduction			**0.25**
2.1 River Rescue Priorities			**0.5**
3.1 Hydrology & Flood Water/River Dynamics			**1.0**
4.1 Team & Individual Gear & Equipment			**0.5**
5.1 Personal & Team Safety			**0.5**
6.1 Communications and Hand Signals			**0.5**
7.1 Components of & Skills Overview – Water Rescues			**0.5**
8.1 Skills & Techniques – Rope Rescues			**1.0**
9.1 Motorized Inflatable Rescue Craft			**1.5**
Day 1 Total Hours			**6.25**
Day 2			
10.1 Pre-Planning, Incident Command, Incident Management – Flood & Swiftwater			**1.0**
11.1 Throw Bags			**0.25**
12.1 Swimming Skills & Techniques			**1.0**
13.1 Entrapments & Vertical Pins			**1.0**
14.1 Skills Stations			**1.5**
15.1 Anchor Rigging			**1.0**
16.1 Tensioned Diagonal Lines			**1.0**
Day 2 Total Hours			**6.75**
Day 3			
17.1 First Aid/Medical Considerations			**0.75**
18.1 Rescue Boards			**1.0**
19.1 Group/Class Review			**0.75**
20.1 Flood/Swiftwater Distance Group Swim			**1.0**

21.1 Course Wrap-Up			**.75**
Day 3 Total Hours			**4.25**

Topic(s)/Chapter(s)			Module Total Hours
Sub-Total Hours/Day			**6.25/6.75/4.25**
Number of Days			**3.0**
Course Total Hours			**17.25**

Notes:

1. This course is objective-based as opposed to time-based and therefore WASH recognizes the time required to adequately deliver content and skills and complete the course may vary from section to another.
2. The Course Totals do not reflect time for lunch or breaks. It is the instructors' responsibility to add this time based on the course delivery schedule and other variables impacting the course delivery process.
3. Application (activities, skills exercises, and formative testing) time will vary depending on various factors and variables to include (but may not be limited to): the number of students enrolled, the number of assigned instructor(s)s, experience level of course participants, cognitive and physical skill level of participants, course environmental conditions, equipment ratios, and the facility where the training is being delivered. The Application time documented is based on the maximum class size identified in the Course Details section.
4. Summative Assessments are determined and scheduled by the authority having jurisdiction. These are in-class assessments to evaluate student progress and calculate course grades.

Suggested Possible Activities

The *Application* section within each module is left to each Instructor's discretion. Choice of activities may be based on the Instructor's experiences, knowledge, and resources. The goal is to enhance an Instructor's ability to teach a specific topic by leveraging his or her expertise as well as enrich the student's course/training experience.

Chosen activities should enable students to apply lecture content through cognitive and use of psychomotor skill exercises. Application experiences included in the course plan are required. Instructor(s)s may add additional application experiences to suit their student population as time permits.

Discussion Questions

The contents of the *Discussion Questions* section within each module is left to each Instructor's discretion. Choice of discussion topics, discussion questions, length of discussion, etc. may be based on the Instructor's experiences, knowledge, and resources. The goal is to enhance an Instructor's ability to teach a specific topic by leveraging his or her expertise as well as enrich the student's course/training experience.

World Academy of Safety & Health

Chapter One

INTRODUCTION

Introduction

WASH has developed this manual to be used in conjunction with practical field training and skills sessions as part of our international flood and swiftwater training program. Becoming a trained flood and swiftwater rescue technician involves developing formal knowledge in this discipline as well as an understanding of your personal physical limitations.

A flood and swiftwater rescue training program teaches tactile skills. More importantly, exposure to the swiftwater environment helps participants develop confidence and knowledge to permit effective decision- making during flood and swiftwater emergencies. Poor decision making and poorly designed and executed rescue attempts have resulted in the death of rescuers.

Success requires disciplined teamwork and knowing when a situation is beyond your abilities.

Prevention

Many flood and swiftwater rescue emergencies are preventable with proper public education, effective decision-making and appropriate equipment selection. Formal public education efforts, which target preventative search and rescue (PSAR) opportunities can reduce the need to have rescue personnel exposed to hazards because of unwarranted situations. PSAR efforts can include signage, printed messages, public education campaigns and targeted patrols at locations with histories of water-related accidents.

FIGURE W1. People ignoring safety barriers and warning signs.

Flood and Swiftwater Rescue

Flood and Swiftwater rescue is a specialized rescue discipline, which has principles and techniques that are employed in moving water. Although some personnel may refer to it as “whitewater rescue,” swiftwater is a more comprehensive term. There is not a single standardized definition of “swiftwater” within the rescue industry, however it is informally understood to refer to water over two feet deep that is flowing at a minimum of one knot (1.15 mph) and occurring in a natural watercourse, flood control channel, or a flood-related environment.

Swiftwater involves water over two feet deep that is flowing at a rate greater than one knot (1.15 mph) and occurring in a natural water course, flood control channel, or a flood-related environment.

Whitewater refers to a stretch of water with a broken foamy surface. This occurs when a river's gradient increases enough to disturb its laminar flow and create turbulence, e.g., forms a bubbly, or aerated and unstable current; the frothy water appears white.

Unlike the term whitewater, swiftwater refers to moving water in nearly any environment, including areas that are not ordinarily inundated by water. Swiftwater can include a remote backcountry drainage as well as a flooded urban area.

The swiftwater rescue field has experienced several efforts to develop and standardize techniques and instruction within the United States. The WASH program is working toward international standardization of flood and swiftwater skills and training.

There are continuing efforts by several agencies and organizations to officially standardize national swiftwater rescue training and qualifications. ASTM International, formerly known as the American Society for Testing and Materials (ASTM), is an organization focused on the development of international voluntary consensus standards. The ASTM International F-32 Committee on Search and Rescue is the development of standards (classifications, guides, practices, specifications, terminology, and test methods) for search and rescue (SAR) activities.

The National Fire Protection Association has established guidelines for fire services professionals. Although the WASH curriculum is not required to conform with NFPA guidelines during SAR operations it is important to have an understanding of these guidelines and how they may impact rescuers from other agencies which may be operating on the same swiftwater rescue incident.

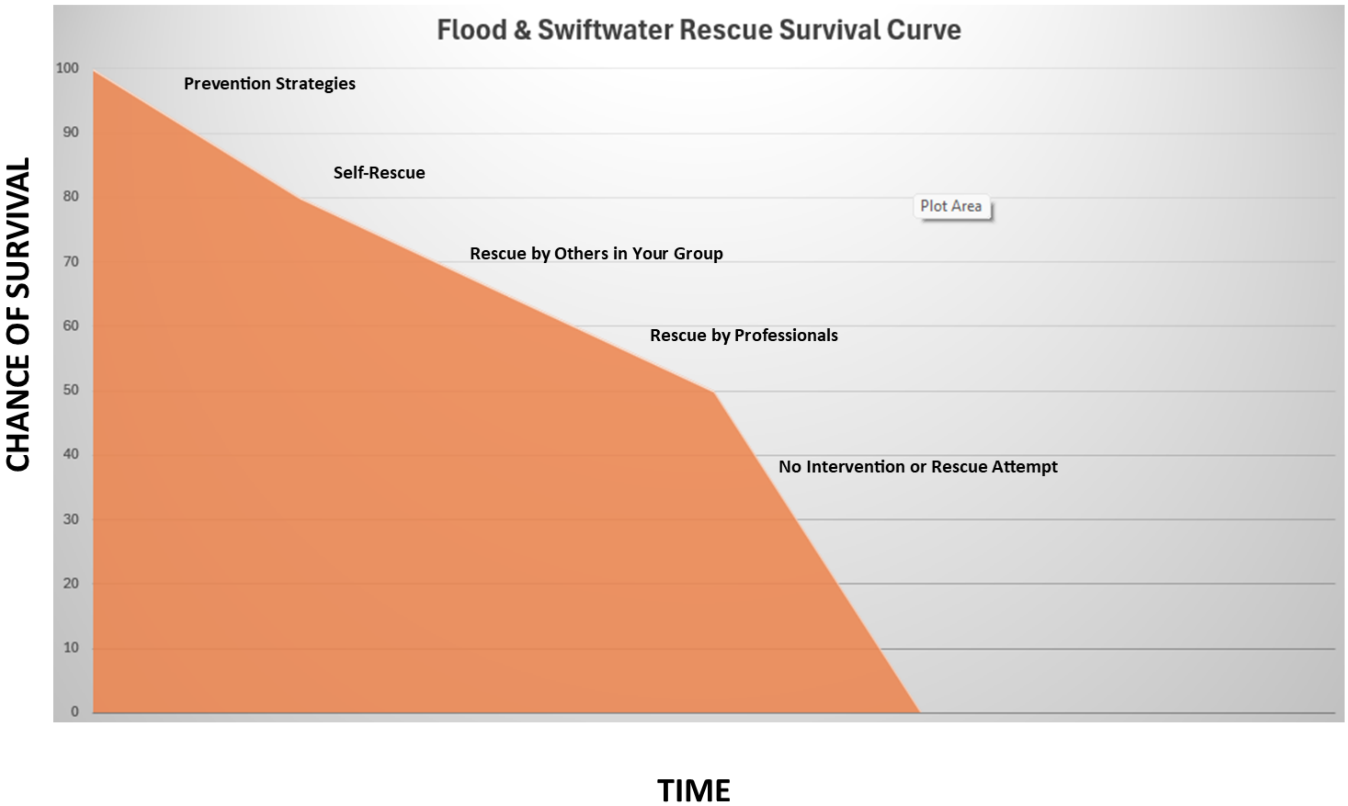
NFPA 1670- STANDARD FOR TECHNICAL RESCUE PROFESSIONAL QUALIFICATIONS delineates water rescue into several sub-disciplines, including surface water rescue (water moving less than one knot) and swiftwater rescue. This guideline describes the requisite knowledge and skills of a Level I Technical Rescuer (apply limited techniques) and Level II Technical Rescuer (apply advanced techniques).

NFPA 1670- STANDARD ON OPERATIONS AND TRAINING FOR TECHNICAL SEARCH AND RESCUE INCIDENTS addresses three operational levels for rescue personnel, which include;

- Awareness- capable of identifying incident hazards and the need for swiftwater rescue.
- Operations- able to apply limited swiftwater rescue techniques.
- Technician- proficient in applying and supervising advanced swiftwater rescue techniques.

An awareness level qualification does not provide an individual with the requisite skills to be deployed, beyond scene control, at a swiftwater rescue incident.

Flood and Swiftwater rescue is low frequency-high risk endeavor. Rescues efforts that are ill-conceived, lack proper equipment, or involve improperly trained personnel can quickly turn tragic.



World Academy of Safety & Health

Chapter

Two

FLOOD & SWIFTWATER HAZARDS

Flood and Swiftwater Hazards

Powerful Force of Water

Flowing water is deceptively strong, surprising many unwary victims. Water weighs 62.4 pounds/cubic foot. The measurement of one cubic foot of water per second (cfs) moving past a given point equates to 449 gallons per minute. Fresh water moving at only 4 mph, a brisk walking pace, exerts a force of about 66 pounds on each square foot of anything it encounters. Double the water speed to 8 mph and the force skyrockets to about 264 pounds per square foot. That's enough force to easily push a car or light truck off a flooded road if the water is up to door level.[2]

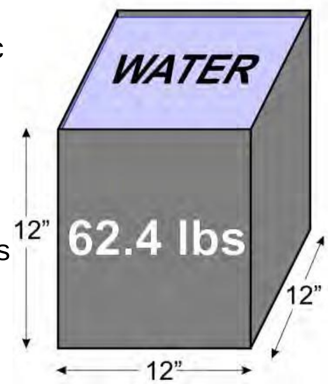


FIGURE W2. One cubic foot of water weighs 62.4 lbs.

Cold Water

Direct exposure to cold water quickly robs a person of heat and can lead to hypothermia, which occurs when the body's core temperature falls below a normal 98.6° F (37° C) to 95° F (35° C) or cooler. Cold water is considered to be below 70° (21°C)[3]. Cold water dangerously accelerates the onset and progression of hypothermia since body heat can be lost 25 times faster in cold water than in cold air.[4] Hypothermia affects the body's core – the brain, heart, lungs, and other vital organs. Even a mild case of hypothermia diminishes a victim's physical and mental abilities, thus increasing the risk of accidents.

The "Cold Shock" response is a physiological reaction that occurs during the first 3-4 minutes of cold water immersion. This precipitates a peripheral vasoconstriction, the gasp reflex, hyperventilation, and tachycardia.

Some reported drowning victims do not die because of poor swimming skills or the effects of hypothermia, but from the "Cold Shock" response. Occasionally the gasp reflex causes victims to inhale water. A person can also die from cardiac arrest brought on by sudden entry into cold water.

How Long Can A Person Survive In Cold Water? [5]

Water Temperature		Expected Time Before Exhaustion or Unconsciousness	Expected Time of Survival
(°F)	(°C)		
32.5°	0.3°	< 15 minutes	45 minutes
32.5–40°	0.3–4.4°	15 – 30 minutes	30 – 90 minutes
40–50°	3.3–10°	30 – 60 minutes	1 – 3 hours
50–60°	10–15.6°	1 – 2 hours	1 – 6 hours
60–70°	15.6–21.1°	2 – 7 hours	2 – 40 hours
70–80°	21.1–26.7°	3 – 12 hours	3 hours – indefinite
> 80°	> 26.7°	Indefinite	Indefinite

Low-head dams

A low-head dam is a man-made feature built across a river or stream for the purpose of holding water where the impoundment, at normal flow levels, is completely within the banks, and all flow passes directly over the entire dam structure within the banks, excluding abutments, to a natural channel downstream.

Entrapments

The process by which an extremity or a subject's entire body is forced into a crack, crevice, or undercut and pinned there by the force of the current. A foot entrapment can easily occur when a swimmer attempts to stand in swift moving current and their foot becomes wedged in a crack or crevice. The force of the downstream current against the swimmer pushes them forward and makes release from the entrapment, without outside assistance, nearly impossible. A good rule-of-thumb for a swimmer in swiftwater conditions is to not put their feet down and attempt to stand in water deeper than their knees.

FIGURE W3- A swimmer suffering a foot entrapment can be quickly bent forward by the force of water pushing against them.

Strainers

A strainer is any river obstacle that allows water but not solid objects to pass through it. This is extremely dangerous for swimmers who may be pinned against the object by the force of the water running through it. Strainers can be formed by trees, brush, other debris or undercut rocks. These can pin boats and swimmers against the obstacle. Water pressure on anything trapped this way can be overwhelming.

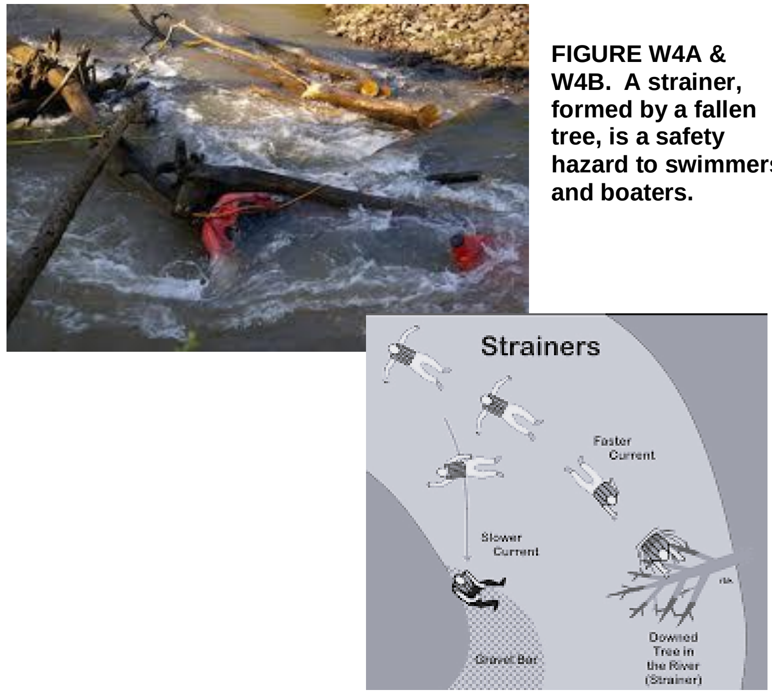


FIGURE W4A & W4B. A strainer, formed by a fallen tree, is a safety hazard to swimmers and boaters.

Culvert openings

A culvert opening can create a man-made strainer. The pressure exerted by water rushing into a culvert opening is extremely powerful and has tragically led to the drowning of road workers and rescuers alike, particularly while attempting to remove debris clogging a culvert inlet. Working directly in front of a culvert opening in flood conditions must be avoided at all costs.

FIGURE W5. Culvert opening nearly submerged with heavy runoff entering the opening, which creates powerful suction and a hazard to anyone positioned in front of such an opening.

FIGURE W6. Heavy flood waters.

Flood Control Channel

Concrete lined flood control channels are man-made watercourse constructed for the purpose of moving floodwaters quickly out of urban areas. This steep sloping wall of concrete channels adds difficulty to a basic shoreline rescue. Anyone operating near this type of channel must be secured with, at a minimum, a belay line with a quick release harness.

FIGURE W7. Storm surge within a concrete flood control channel.

Low-water Crossings

Constructed low water crossings provide a convenient and safe way to cross a watercourse in normal conditions. Once water levels rise to the point where it crosses the road surface, the crossing becomes unsafe and is typically closed. High water levels obscure the roadway making it relatively easy to fall off either side. The force of the moving water can be strong enough to push a vehicle off the side of the flooded roadway. If a vehicle driver exits a stalled vehicle, they are exposed to strong currents, which may sweep them down river causing injury or death.

Motorists repeatedly ignore posted road closures at obvious flooded low-water crossings leading to stranded vehicles or worse outcomes. This poor decision-making epidemic has led the State of Arizona to enact the "*Arizona Stupid Motorist Law*" (Arizona Revised Statute 28-910. *Liability for Emergency Responses in Flood Areas*). The statute holds a driver liable for the expense of an emergency response (not to exceed $2,000), for their own rescue, as well as other occupants, or vehicle removal after entering a flooded roadway that is barricaded closed. Such a statute is one tool in an effort of preventative SAR to decrease these incidents.

FIGURE W8. Low Water Crossing near a highway.

Flood debris

Debris which is picked up and moved along as part of the top load (things that float on the surface) or suspended load (subsurface), is a physical hazard to anyone swimming in a swiftwater environment. This can include trash, wood, logs, vehicles, etc. which could strike and injure a swiftwater rescuer. When working at rescue scene, deployment of an upstream spotter with an effective means of communication can drastically reduce this risk. Keep in mind that debris may not always be immediately visible on the surface and limiting exposure time of rescuers in the water will decrease the associated risk during a rescue operation.

Swiftwater Hydraulics/Hydrology and River Dynamics

Swiftwater appears chaotic and confusing to the untrained eye. Indeed swiftwater is powerful and relentless, however it is also predictable. There are distinct patterns to moving swiftwater. Developing the ability to "read" swiftwater is a valuable skill for every rescuer, that can be applied in performing an effective scene size-up and developing a successful rescue plan.

The measurement of moving water is described as cfs. The width of channel X depth of channel X velocity (feet/sec) = cfs. One gallon of water weighs 8.2 lbs., however keep in mind that one cubic foot weighs 62.4 lbs.

SWIFTWATER TERMINOLOGY:

Downstream - direction water is travelling.
Upstream - the direction water is coming from.
River Right - right shoreline looking downstream.
River Left - left shoreline looking downstream.

Surface Load - debris that is positively buoyant and remains on the water surface.
Suspended Load - neutrally buoyant debris (e.g., silt).
Bottom Load - debris in the waterway, which is negatively buoyant. This creates a hidden danger below the surface.

Laminar Flow - layered downstream flow of the river's main current. The layer in the center just below the surface moves the fastest, while the side and bottom layers are slowed somewhat by friction.

Helical Flow - The corkscrew flow of the

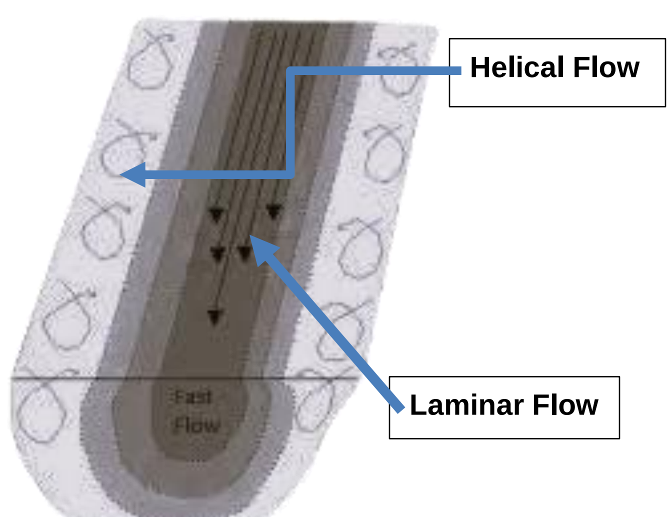


FIGURE W11. **Channel flow orientation.**

water between the shoreline and main current.

River Hazards

Eddy - horizontal reversal of water flow where the differential between the current's pressure on the upstream and downstream sides of an obstacle in a channel causes the water behind the obstacle to flow upstream. Serves as an excellent area to rest or scout.
Eddy Fence - dividing line between laminar flow and the eddy.
Eddy Line - obvious line or demarcation in the river, where the current moves in opposite directions on either side.

Smiling Hole- appearance from upstream. Strong reversal in center with downstream current on either side. Exit to the sides.
Frowning Hole- strongest reversal is side to side. Trying to exit to the side results in being pushed back to the center. Exit is down beneath the surface.

Gradient - amount of elevation loss between two points on a river. Typically expressed as feet per mile or percent of slope.
Volume - amount of water in a river, which is determined by the measurement of water flowing past a given point in one second and expressed as cubic feet per second (cfs) or cubic meters per second (cms).

Chute - clear tongue of water flowing between two obstacles.
Confluence- junction of two or more water features.
Waves - flow affected by obstacles or constrictions.

Boil Line - point downstream of hydraulic the where recirculated water meets with downstream flow unaffected by hydraulic.
Boulder Sieve - collection of boulders in the river channel that acts as a strainer.

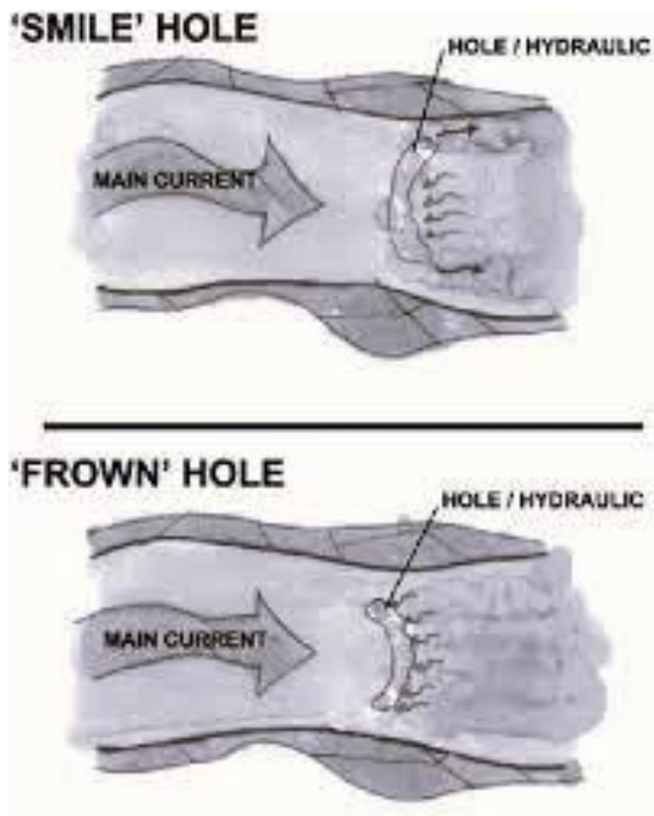


FIGURE W12. Smiling Hole and Frowning Hole.

Hydraulic - formed by water pouring over an obstruction. A low pressure area is formed on the back side of the object. Water is drawn from downstream to fill this void. The recirculation of water frequently traps victims and debris. Known affectionately as “keeper,” “stopper,” or “maytag.”

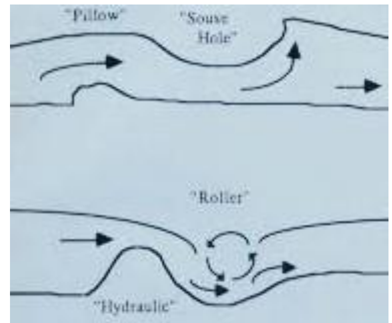
Haystack or Standing Waves - remain stationary in the channel.
Hole - A river wave, usually caused by an underwater obstacle that breaks back upstream. A hole is a surface phenomenon; it may flip or hold a buoyant object like a watercraft but it will not recirculate a swimmer.
Humps - indication of an obstacle beneath the surface. Avoid these features when observing this visual cue.
Pillow - found at upstream side of obstacles. Water pushes up into a higher mound on the upstream side of the obstacle, which forms a cushion pushing away objects like boats from it. These are also known as “cushions.”

Horizon Line - appearance of a horizon downstream on a river formed by the steep gradient. This is an indicator for an on-shore scout.

Strainer - Any river obstacle that allows water but not solid objects to pass through it. This is extremely dangerous for swimmers who may be pinned against the object by the force of the water running through it. Strainers are most commonly formed by trees, brush, or other debris.

Downstream V - point of V (tongue) is downstream. Formed by flow between two obstacles. Indicates deepest, cleanest route.
Upstream V - hydraulic effect creating a V that points upstream. It is caused by caused by an obstruction that is just beneath the surface. Avoid.

FIGURE W13



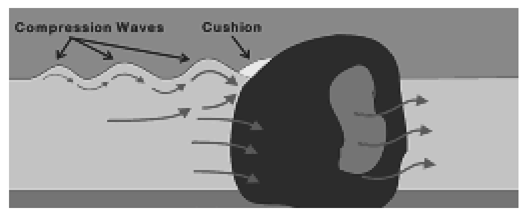


FIGURE W14

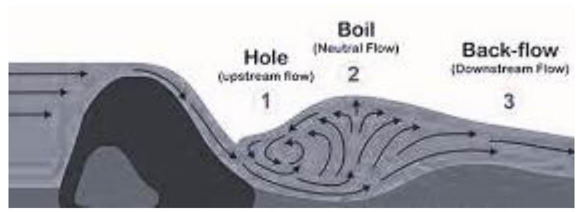


FIGURE W15

FIGURE W16. A hump is formed by water flowing over the surface of an obstacle. 3.) A pillow or cushion is a mound of water formed on the upstream side of an obstacle. 4.) A hydraulic or hole forms on the downstream side of an obstacle.

Current Vector- Strongest laminar flow in a channel may not be parallel to shoreline (e.g., bend in the channel). Ability to identify is an essential skill for a swiftwater rescuer.
Ferry Angle - 45 degree angle to current vector. Using the proper ferry angle allows you to efficiently have the river work for you.

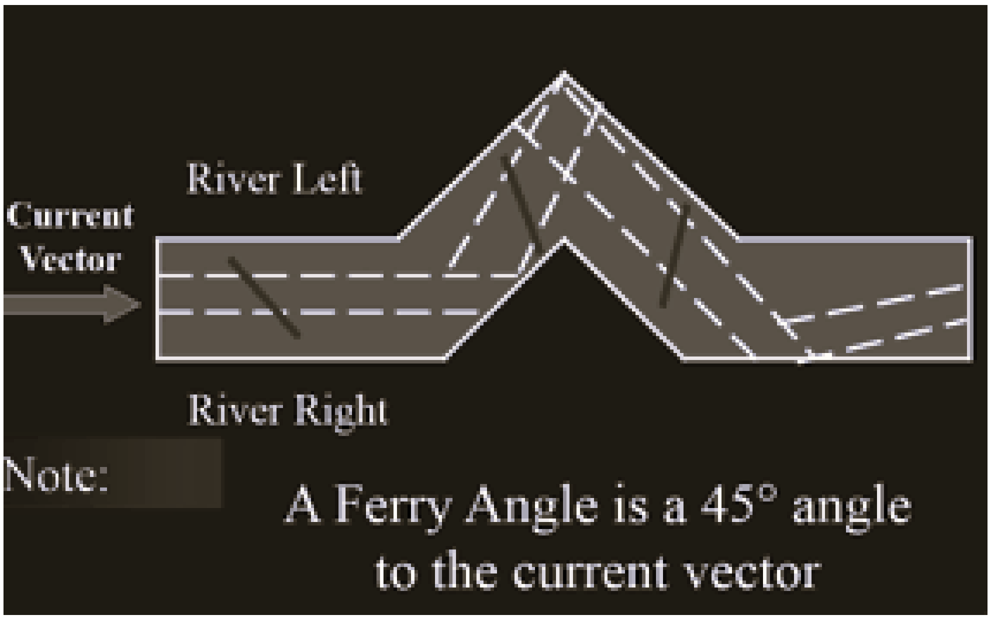


FIGURE W16. Current vectors and ferry angles.

Low Head Dam - man-made obstruction with a sustained reversal that extends from one side of channel to the other. When a low head dam has sufficient water flow, a continuous "hole" may extend across the downstream side of the feature. If a subject is trapped in the recirculating hydraulic, they will quickly drown and unless they can escape the recirculating motion.

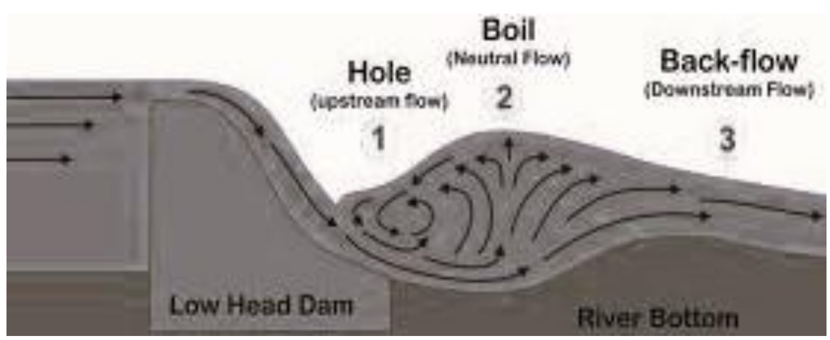


FIGURE W18. Low-head dam.

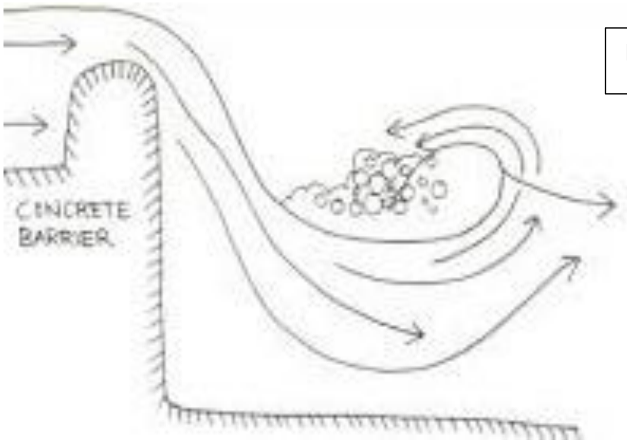


FIGURE W19. Low-head dam.

High Side - A maneuver of shifting the weight of a boat crew to the high side (i.e., downstream) of a boat to prevent flipping. This is done when a boat washes up against an obstacle, hits a large breaking wave, crosses a eddy line, or is caught in a hole.

FIGURE W20. Rescuers demonstrate a high side maneuver in order to prevent a boat flip.

Classifications of River (Whitewater) Difficulty

- **Class I**; Easy. Fast moving water with few riffles and small waves. Few obstructions, all obvious and easily missed with little training.
- **Class II**; Novice. Straightforward easy rapids with waves up to three feet and wide. Occasional maneuvering may be required
- **Class III**; Intermediate. Rapids with high, irregular waves often capable of swamping an open canoe. May require scouting.
- **Class IV**; Advanced. Long difficult rapids with constricted passages that require precise maneuvering in turbulent waters. Scouting is necessary.
- **Class V**; Expert. Extremely difficult, long and very violent rapids with highly congested routes. Rescue conditions are difficult with significant hazard to life with mishaps.
- **Class VI**; Extreme. All the difficulties of Class V with extremes of navigability. Nearly impossible and very dangerous. Experts only.

World Academy of Safety & Health

Chapter Three

FLOOD & SWIFTWATER RESCUE PRINCIPLES

GENERAL FLOOD & SWIFTWATER RESCUE PRINCIPLES

1. **Priorities for rescue are always- self, team, and then victim**
2. **Wear PPE (minimum of a personal flotation device (PFD) within 10 feet of swiftwater)**
3. **Use CAUTION at all times**
4. **Keep the rescue plan simple- complexity increases the chance of failure**
5. **Plan for contingencies- have a backup plan**
6. **Deploy multiple downstream rescuers**
7. **Deploy upstream spotters**
8. **Don't stand inside the rope bight or on downstream side of a tensioned line**
9. **Don't directly tie a rope to a rescuer**
10. **Don't put your feet down in swiftwater deeper than your knees**
11. **Don't tension a line 90 degrees to the current**
12. **Once victim is contacted, don't lose them**
13. **Be proactive- don't count on victim to aid in their own rescue**

Swiftwater Rescue Pre-Planning

Preplanning efforts should be made to address potential swiftwater rescue concerns. Adequate preplanning will increase the operational readiness of agency personnel and increase the success of swiftwater rescue efforts.

Hazard assessment - The initial step with any formal pre-planning effort is to conduct a hazard assessment of the involved area. It is achieved by reviewing historical incident data, interviewing local area experts, analyzing flood data through GIS modeling, and assessing local area/regional swiftwater rescue capabilities.

Hazard Assessment Considerations Include:

- Physical Features
- Specific Hazards
- Pre-Determined Rescue Sites
- Egress Routes and Staging Areas
- Anchor Points
- Landing Zones

Flood & Swiftwater Rescue Considerations

1. **Scene Assessment:** Before taking any action, rescuers must assess the scene thoroughly. This includes evaluating the water conditions, hazards such as strainers (objects that allow water to pass through but not people), foot entrapments, and potential obstacles.
2. **Risk Management:** Flood and swiftwater rescue always involves a level of risk. Rescuers must manage these risks by prioritizing safety, using appropriate personal protective equipment (PPE), and making decisions based on the capabilities of their team and available resources.
3. **Communication:** Effective communication is critical during flood and swiftwater rescue operations. Rescuers must establish clear communication channels with team members, victims, and any other agencies involved in the rescue effort. This includes using standardized hand signals and radio protocols.
4. **Victim Assessment:** Rescuers must quickly assess the condition of the victim(s). This includes determining if the victim is conscious, injured, or in immediate danger. Rescuers also need to consider factors such as hypothermia and the victim's ability to assist in their own rescue.
5. **Self-Rescue:** Rescuers should prioritize self-rescue techniques whenever possible. This means using appropriate equipment and techniques to ensure the safety of themselves and their team members while attempting a rescue.
6. **Anchoring:** Anchoring is a key principle in flood and swiftwater rescue. Rescuers use anchors to secure themselves and their equipment, providing stability and control in fast-moving water. Proper anchoring techniques are crucial for maintaining safety during rescue operations.
7. **Rope Systems:** Swiftwater rescue often involves the use of rope systems for victim retrieval and team safety. Rescuers must be proficient in rigging and deploying rope systems such as tensioned diagonals, Z-drags, and mechanical advantage systems.
8. **Hydraulic Understanding:** Rescuers must have a thorough understanding of hydraulic forces in flood and swiftwater environments. This includes knowledge of features such as eddies, boils, and hydraulics created by obstacles like rocks and debris. Understanding these forces helps rescuers make informed decisions and avoid dangerous situations.
9. **Medical Considerations:** Flood and swiftwater rescue often involves providing medical care to victims. Rescuers should have basic medical training to assess and stabilize victims until advanced medical help arrives.
10. **Teamwork and Training:** Successful flood and swiftwater rescue operations rely on teamwork and continuous training. Rescuers must work together efficiently, practice rescue techniques regularly, and participate in ongoing education to stay updated on the latest safety protocols and equipment.

Equipment - Selecting and procuring suitable equipment for the area of responsibility. It needs to be appropriate to meet the type of calls and potential challenges encountered. For example, a watercraft needs to have features which match the capabilities required of a flood and swiftwater response in the response area. Maintenance and replacement of equipment needs to be accomplished on a recurring basis.

Training - Accomplishing an acceptable frequency of realistic training within a team, which truly generates suitable levels of individual proficiency, is much easier said than done. The reality is that conflicting administrative priorities and changes in personnel constantly put most teams in the position of being behind the power curve. That being said, it is the responsibility of all professionals in this field to constantly work to achieve this goal. Strive for regular training sessions that challenge participants. Work to provide training that reaches the greatest number of team members possible. These efforts will truly pay off down the road.

Established Procedures - A formal written plan needs to be completed that addresses flood and swiftwater rescue operations. This can be part of a more comprehensive written SAR Plan. This type of document should address the framework on how operational flood and swiftwater responses will occur. The plan will still leave plenty of discretion for decision-making by personnel at the scene of action. Team members need to know the plan and it should be exercised. A poorly written plan will gather dust on a shelf. Consider including checklist or job aids, which improve the understanding of the plan by agency personnel (Refer to Appendix C for a Sample Swiftwater Rescue Preplan). Finally, the plan should be dynamic. Review the plan annually and make updates, which reflect lessons learned, best practices, and local area changes.

Rescuer Fitness

Flood and swiftwater rescue involves exposure to cold water and the forces of rapidly moving water. It requires a physically fit individual with a strong swimming ability. Not all emergency personnel fit this requirement. An overweight poorly conditioned flood and swiftwater rescuer becomes a detriment to themselves and their fellow team members. If an unfit rescuer became incapacitated in the water, it could lead to an incident within an incident. This is preventable through a strong selection process for a rescue, which should select participants based upon who is most qualified to perform the rescue task.

Situational Awareness

All involved emergency personnel need to practice effective *situational awareness*. This involves being aware of what is happening around you, as well as communicating and utilizing accurate available information in effective decision-making. Poor situational awareness has been identified as one of the primary factors in accidents attributed to human error. Emergency incidents are very dynamic and the flow of information-sharing is a key factor to successful and safe operations.

Size-Up

As an initial rescuer approaches an emergency scene they begin the size-up process. The chaos of the incident can lead to a responder becoming overwhelmed and unable to make sound decisions.

Factors for consideration in a flood and swiftwater size-up include:

- Stable situation (e.g., uninjured subject sitting on a rock in the middle of a river)
- Unstable situation (e.g., vehicle with occupants stranded in rapidly rising flood waters)
- Number of subjects and possible injuries
- Location for immediate deployment of downstream safety rescuers
- Presence of debris coming downstream
- Ability to deliver a PFD to a subject
- Need to deploy rescuers for an in-water rescue

Like a jet fighter pilot in a dogfight, employing the Observe-Orient-Decide-Act (OODA) Loop is an effective method to process the information received about a flood and swiftwater rescue emergency and take the most appropriate action in an efficient manner. The OODA Loop consists of observing, orienting, deciding, and acting phases.

Military pilots have come to relate situational awareness to the *observe* and *orient* phases of the famous OODA Loop or Boyd Cycle, as described by the USAF fighter ace and war theorist Col. John Boyd.

- Observation: the collection of data by means of the senses
- Orientation: the analysis and synthesis of data to form one's current mental perspective
- Decision: the determination of a course of action based on one's current mental perspective
- Action: the physical playing-out of decisions

Another important concept of good situational awareness involves having an accurate mental model. During an emergency incident, we all develop a personal mental understanding of what the mission involves and the game plan for the operation. Our personal mental model may be filled with inaccuracies or assumptions, which differ from our team members on the incident. Accurate mission briefings and communicating updated information among team members will lead to the development of a shared mental model, which is highly accurate and increases situational awareness.

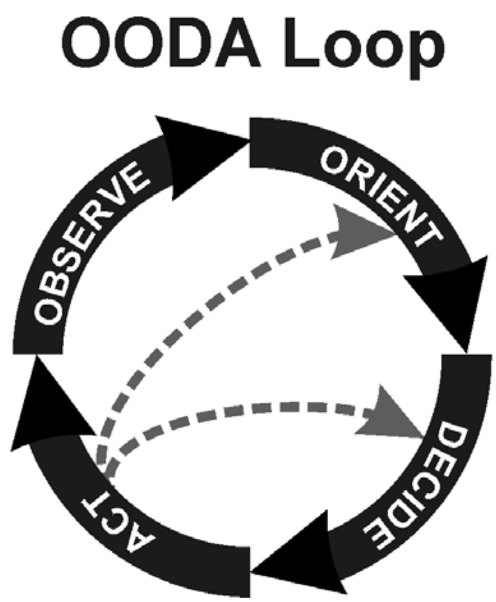


FIGURE W9. OODA Loop.

The checklist at right provides a suggested briefing format to be used for SAR personnel. The format encourages team member feedback and the sharing of important information. Being disciplined, in spite of the perceived urgency of the moment, will get all personnel on the same operational plan and enhance the likelihood of success. A team lacking such discipline will charge ahead without a clear plan and take operational shortcuts that could have tragic consequences.

Operational Risk Management

Operational risk management (ORM) is a continuous, systematic process of identifying and controlling risks in all activities according to a set of pre-conceived factors by applying appropriate management policies and procedures. As an operation progresses and evolves, personnel should continuously employ the following operational risk management principles.

Key ORM Principles

1. **Accept No Unnecessary Risk:** SAR operations entail risk. Unnecessary risk conveys no commensurate benefit to safety of a mission. The most logical courses of action for accomplishing a mission are those meeting all mission requirements while exposing personnel and resources to the lowest possible risk. If all hazards that could have been detected have not been detected, then unnecessary risks are being accepted.

2. **Accept Necessary Risk When Benefits Outweigh Costs:** Compare all identified benefits to all identified costs. The process of weighing risks against opportunities and benefits helps to maximize unit capability. Even high-risk endeavors may be undertaken when decision-makers clearly acknowledge the sum of the benefits exceeds the sum of the costs. Balancing costs and benefits may be a subjective process open to interpretation. Ultimately, the appropriate decision authority may have to determine the balance.

3. **Make Risk Decisions at the Appropriate Level:** Depending on the situation, anyone can make a risk decision. However, the appropriate level to make those decisions is that which most effectively allocates the resources to reduce the risk, eliminate the hazard, and implement controls. Incident personnel at all levels must ensure subordinates are aware of their own limitations and when to refer a decision to a higher level.

4. **Integrate ORM into Operations and Planning at All Levels:** While ORM is critically important in an operation's planning stages; risk can change dramatically during an actual mission. Incident personnel should remain flexible and integrate ORM in executing tasks as much as in planning for them.

Operational Risk Management (ORM) includes the following seven steps:

1. Identify mission tasks
2. Identify hazards
3. Assess risks
4. Identify options
5. Evaluate risk versus gain (benefits outweigh potential costs)
6. Execute decision
7. Monitor situation

Risk Assessment and Management

The low-to-high risk algorithm for flood and swiftwater rescue reflects the increasing level of personal exposure to risk by rescuers based upon the method of rescue. Previously this read *“reach-throw-row-go- helo”*, however it has been updated to reflect the increased safety of helicopter operations and the increased deaths of rescuers in boats.

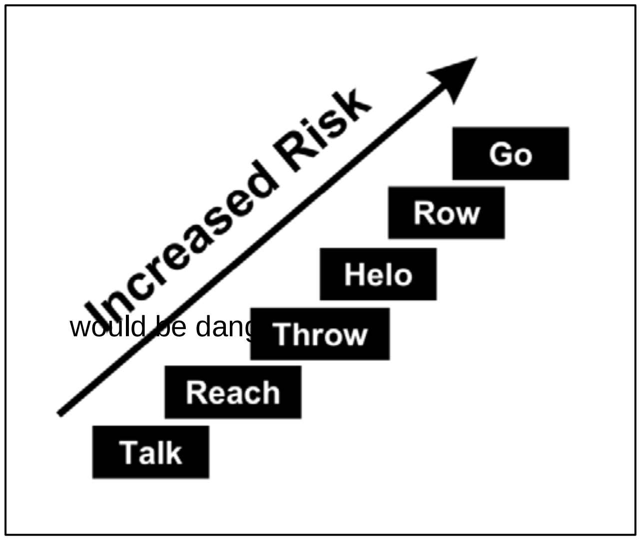


FIGURE W10. Updated Low-to-High Risk Algorithm; TALK- REACH- THROW- HELO- ROW- GO.

Keep in mind that **no algorithm reflects an absolute rigid means of how flood and swiftwater rescue is to be performed**. Every incident is unique and involves numerous factors that require an incident commander to decide, based upon totality of the circumstances, the best way to proceed. In some scenarios one tool, such as a boat makes the most sense, while in another it would be dang inappropriate. Finally, understand that while it is safest to talk a victim into performing a self-rescue, there truly is a substantial increase in danger once a rescuer enters the water.

Talk refers to the dialogue that takes place between the rescuer and victim, and includes the rescuer directing the victim in methods of self-rescue, such as swimming to shore.

Reaching is the first and easiest form of water rescue. If a subject can be saved by an outreached arm, an outreached leg, or an extended branch use this method. Remember to yell clear, simple, and distinct orders to grab the extended object as persons in danger of drowning are often experiencing an adrenalin rush and are very confused. An order such as "Grab the stick and hold on" is simple and useful. Remember in flood and swiftwater applications, the current is very strong so be ready for a jolt when the current pulls on the subject in the water. It may not be possible for a single rescuer to actually remove an individual from the water after the subject has been grabbed. If so, hold the subject close to an edge, maintain an open airway, attempt to protect him from further injury, and wait for additional help to extract the subject.

Throwing pertains to anything that is thrown to a subject to assist them. This type of rescue includes the use of throw lines, life rings, and floats. The three major types of rope throw assemblies are the throw bag, the coiled rope, and the life ring with rope. The use of rescue throw bag should be practiced to proficiency by every flood and swiftwater rescuer. This type of rescue is only useful if the subject is cooperative. Throwing should be accompanied with orders given loudly and clearly by a single person to prevent confusion. Throwing also includes throwing something that floats. Including a life ring, PFD, boogie board, cooler, etc. The objective is to provide the subject with an aid to keep him afloat until further help can be rendered.

Helo rescue may be appropriate in specific situations, however there needs to be an understanding that this requires sound decision making that matches the capabilities of the involved personnel and aircraft. Helicopters can access a subject from overhead and potentially avoid hazards that rescuers on the water would be exposed to (e.g., strainers, flood debris, pour-overs, etc.). Extraction of a subject in the flood and swiftwater environment can be efficiently accomplished with a hoist rescue or short-haul technique. Keep in mind that helicopter rescue accidents do repeatedly occur and they commonly involve poor decision-making.

Rowing in the classical sense means rowing a watercraft to the subject. This can include paddling a kayak or raft, as well using powered watercraft such as a motorized inflatable of personal watercraft (PWC) to reach a subject. The intent is to either have the subject climb into the watercraft or to simply hold onto the craft until the subject can be dragged to safe water.

Go is the deployment of an in-water swimming rescue. These are planned and practiced maneuvers that apply to the engagement of a drowning subject in open water. The technique includes the use of river boards for added flotation that delivers an extension to the subject so "subject to rescuer contact" is avoided. This can be combined with a “tethered swimmer” rope technique facilitating retrieval of the rescuer to shore upon contacting the subject. When one considers the dangers of open water swimming rescues, compounded with the dangers of flood and swiftwater, swimming rescues are the least attractive option. Swimming rescues are more applicable once a subject has been carried to a wide watercourse or they move into slower moving water.

GAR Risk Assessment

During extreme flood conditions, you are requested to affect a body recovery in the flood and swiftwater environment with a highly inexperienced team. How would you go about quantifying the perceived risk of the mission?

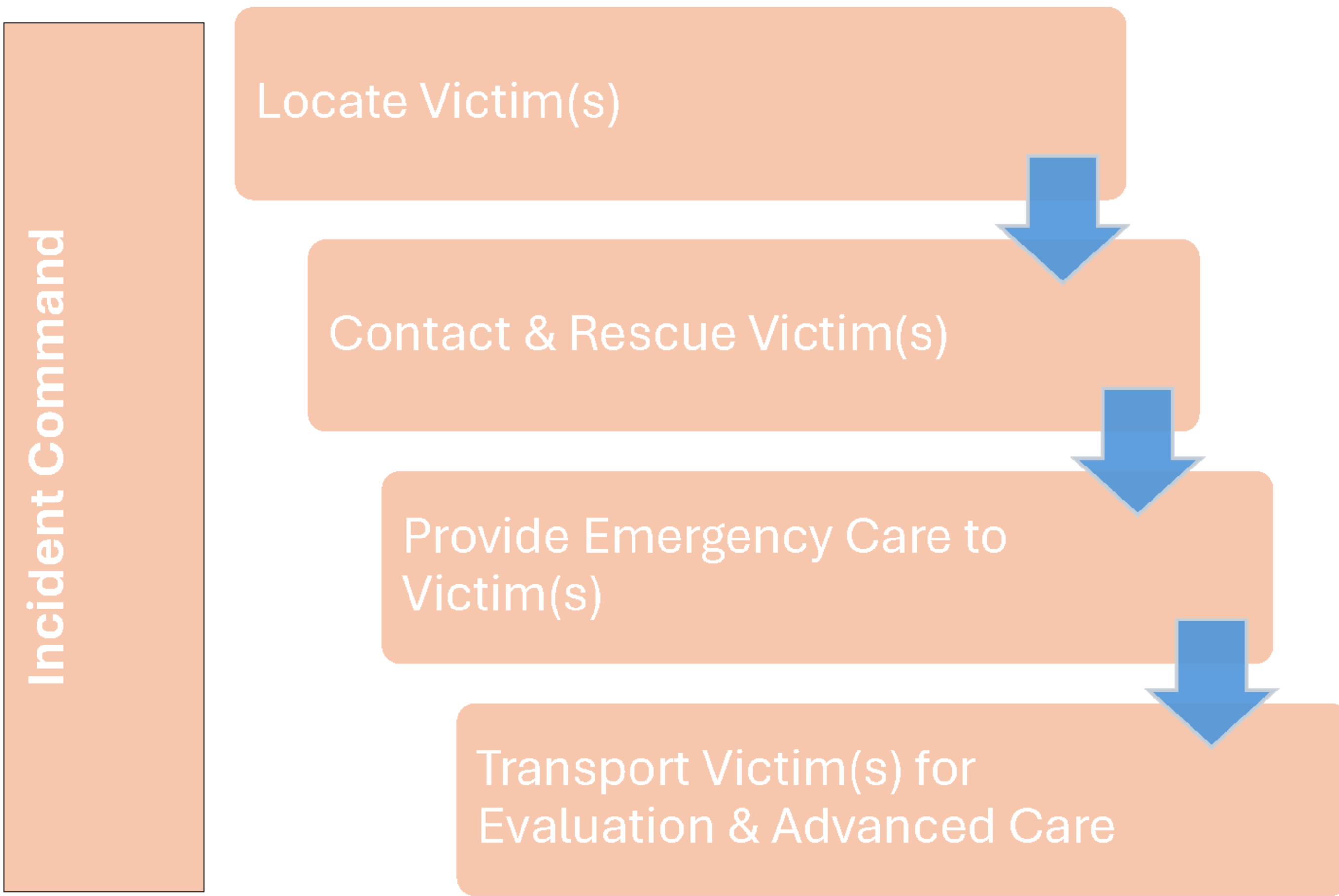
The GAR (Green-Amber-Red) Risk Assessment, creates a GO-NO GO decision tool. A strength of the GAR process is that it includes input directly from the involved personnel. Respondents independently assign a personal score of perceived risk (subjective estimate) to eight different elements associated with a mission. The risk score is 0 (No Risk) through 10 (Maximum Risk).

The standard elements of the GAR risk assessment include;

1. **SUPERVISION** - Qualified, accessible and effective supervision on the incident.
2. **PLANNING** - Adequate incident information is available and clear.
3. **CONTINGENCY RESOURCES** - Backup resources that can assist if needed.
4. **COMMUNICATION** - How well personnel are briefed and communicating.
5. **TEAM SELECTION** - Qualifications and experience level of the individuals.
6. **TEAM FITNESS** - Consider physical and mental state of the crew.
7. **ENVIRONMENT** - Factors affecting performance of personnel and equipment such as time, temperature, precipitation, topography and altitude.
8. **INCIDENT COMPLEXITY** - Severity, exposure time and probability of mishap.

If the total risk score falls in the green zone (1-35), then the risk is rated low and the mission is considered a “go.” A score in the yellow zone (36-60) indicates moderate risk and additional control efforts should be in place before proceeding with the mission. If the total score falls in the red zone (61-80), the risk is significant and this indicates a “no go.”

The ability to assign numerical scores is not the most vital feature in the GAR process. Upon completion of the individual assessment, members discuss their results collectively. This generates valuable discussion toward understanding the mission risks and how the team will manage them.



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Chapter

Four

FLOOD & SWIFTWATER COMMUNICATIONS

Flood & Swiftwater Communications

The noise of moving flood and swiftwater and possibly helicopters may prevent effective communications between rescuers. Radios may not always be practical for rescuers in the water. Hand and whistle signals provide a simple form of communications during flood and swiftwater rescue operations.

Not all team members may be in possession of waterproof radio communications and in addition, having a reliable backup of standardized whistle communications permits communication over the background white noise of the flood and swiftwater environment.

Standardized whistle signals using the "SUDOT" system
are as follows:

- 1 blast- **S**top, Look at me
- 2 blasts- **U**p
- 3 blasts- **D**own
- 4 blasts- **O**kay, Off Rope
- Sustained- **T**rouble

Standard flood and swiftwater hand signals:

- **Distress / Help**: One hand held above head
- **Okay**: Hand tapping on head or create on "O" with both arms
- **Move / Swim**: Two hands up then point
- **Eddy out here**: Two hands up, wave then point
- **Need medical help**: Both arms crossed at chest

Waterproof Radio Communications

- **Waterproof Cases** (Bag) - Employ a waterproof case to protect a portable radio in the flood and swiftwater environment. The radio is placed in the transparent case and then secured in a radio chest harness. The design requires the user to transmit and receive with the radio inside the case. The best deployment of these types of cases is for shore-based and boat-based rescuers.

  Features:

  - Radio can be operated in a normal manner through the case, it doesn't interfere with sound or radio signals.
  - Protects the radio from water, dust, dirt, and sand.
  - The case can float if dropped in the water.
  - The seams of the bags are high-frequency welded for strength.

- **Tactical Waterproof Headsets** - A more expensive option for waterproof radio communications by a swimmer is the use of a tactical submersible radio headset and bag. These units are built to military specs and provide superior in-water radio communications. They are also an excellent choice for high ambient noise environments like a motorized inflatable operator. These should be worn on the rescuer's back inside their PFD.

  Features:
  - Communicate effectively in or out of the water
  - Volume control and push-to-talk switch can be clipped to rescuer PFD

Incident Management

Within the United States, Homeland Security Presidential Directive 5 (HSPD-5) mandates the use of the National Incident Management System (NIMS) and ICS. ICS is a key element of NIMS and its use is required of federal agencies. When multiple agencies have overlapping jurisdiction of an incident, unified command should be established.

SAR Operations need to be managed by qualified personnel using the Incident Command System (ICS) to the extent dictated by the complexity of the event. The more complex the mission, the greater the need for individuals with specialized training to carry out each function. Span-of-control ratio is normally considered to be a five-to-one ratio of subordinate personnel to a single supervisor, but in some cases may be increased to seven.

The most qualified people and those in need of special training and experience will be assigned accordingly. Participation in potentially hazardous SAR operations requires specialized technical skills, a strong commitment to teamwork, and the ability to accept direction from designated leaders. Critical resource positions are to be filled with persons who best meet these qualifications. An effort should be to maintain a current list of available trained SAR personnel along with their qualifications.

Below is an example of an ICS organization established under unified command for a response to a vehicle stranded in a flooded low-water crossing with several victims.

Flood & Swiftwater Rescue Incident Overview Guide

I. Command Structure
   A. Incident Command:
      1. First On Scene
      2. Who Has Jurisdiction
      3. Team Approach
      4. Hierarchical Levels of Command
   B. Flotation Group/Team
   C. Decontamination Group/Team
   D. Logistics Group/Team:
      1. Lightning for Night Rescue
      2. Vessel Support
      3. Air Support
   E. Medical/First Aid Group/Team
   F. Rescue Group/Team:
      1. Upstream Spotters
      2. Downstream Rescuers/Safety Team
      3. Rescue Systems Team
      4. Evacuation Team
   G. Law Enforcement Group/Team:
      1. Traffic Control
      2. Crowd Control
      3. Investigations Unit

II. Tasks & Group/Team Members
   A. Establish Point Last Seen (PLS)
   B. Establish Flotation Point
   C. Establish Rescue Point

***PLEASE NOTE*: See Figure W21 for a graphically organized breakdown.**

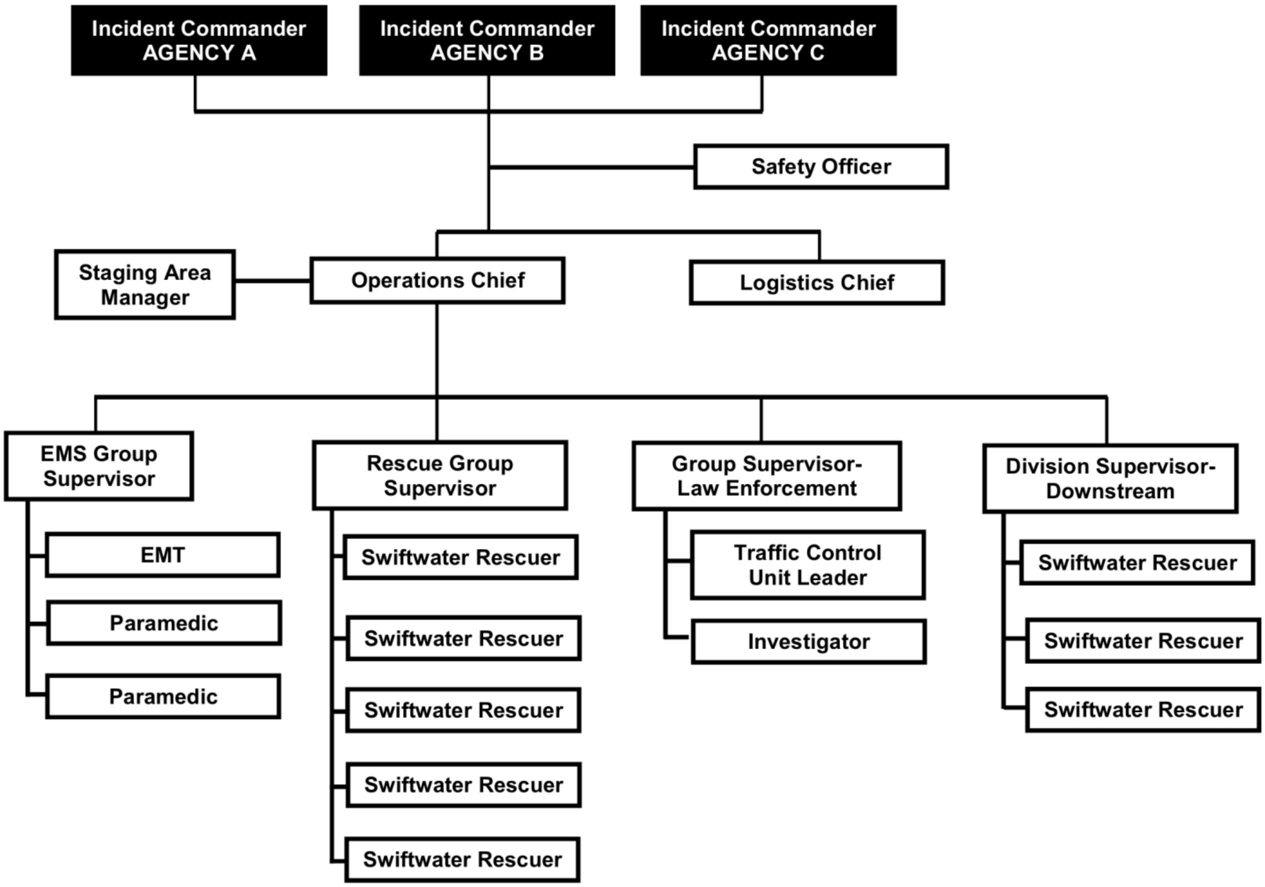

FIGURE W21. Swiftwater rescue incident command organization employing unified command

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Chapter

Five

FLOOD & SWIFTWATER EQUIPMENT

Personal Swiftwater Rescue Equipment

Personal Flotation Devices- USCG Ratings

Life jackets are known as PFDs. The U.S. Coast Guard has developed an approval and rating system for recreational and industrial PFD's.

Type I; Off-Shore Jacket

- These vests are geared for rough or remote waters where rescue may take a while. They provide the most buoyancy, are excellent for flotation, and will turn most unconscious persons face up in the water
- Minimum buoyancy 22 lbs.
- Best for all waters, open ocean, rough seas, or remote water, where rescue may be slow coming. Abandon-ship lifejacket for commercial vessels and all vessels carrying passengers for hire.

Type II; Near Shore Buoyant Vest.

- These vests are good for calm waters when quick assistance or rescue is likely. Type II vests will turn some unconscious wearers face up in the water, but the turning is not as pronounced as with a Type I.
- Minimum buoyancy 15.5 lbs.
- For general boating activities. Good for calm, inland waters, or where there is a good chance for fast rescue.

FIGURE W22. Type I Off-Shore PFD.

FIGURE W23. Type II Near-Shore Buoyant Vest PFD.

Type III; Flotation Aid

- These vests or full-sleeved jackets are good for calm waters when quick assistance or rescue is likely. They are not recommended for rough waters since they will not turn most unconscious persons face up. Type III PFDs are used for water sports such as water-skiing. Some Type III PFDs are designed to inflate when you enter the water.
- Minimum buoyancy 15.5 lbs.
- For general boating or the specialized activity that is marked on the device such as water skiing, hunting, fishing, canoeing, kayaking and others. Good for calm, inland waters, or where there is a good chance for fast rescue. Designed so that wearing it will complement your boating activities.

FIGURE W24. Type III Flotation Aid PFD.

Type IV; Throwable Device

- These cushions and ring buoys are designed to be thrown to someone in trouble. Since a Type IV PFD is not designed to be worn, it is neither for rough waters nor for persons who are unable to hold onto it. Minimum buoyancy 16-18 lbs.

Figure W25. Type IV Throwable Device.

Type V; Special Use Device

- These vests, deck suits, hybrid PFDs, and others are designed for specific activities such as windsurfing, kayaking, or water-skiing. Some Type V PFDs are designed to inflate when you enter the water. To be acceptable, Type V life jackets must be worn and used in accordance with their label.
- Minimum buoyancy 15.5-22 lbs.
- These include Hybrid Inflatable PFDs, Canoe/Kayak Vest, Boardsailing Vests, Deck Suits, Work Vests for Commercial Vessels, Commercial Whitewater Vests, Man-Overboard Rescue Devices, and Law Enforcement Flotation Devices.

Approval Ratings and Swiftwater PFD's: It is important to understand that most flood and swiftwater rescue PFD's are lumped into the Type III or V classification. Type V PFDs are approved for special uses and conditions identified on their label, including swiftwater rescue. Excellent PFD's manufactured outside of the U.S. may not have a USCG rating, however typically meet the standards from the country of orgin (e.g., Canadian Coast Guard, Conformité Européenne (CE), and European Norm (EN)).

Finally, the U.S. Coast Guard is revising the classification and labeling of PFD's, which hopefully will address the specialized nature of flood and swiftwater rescue PFD's.

Definitions Relating to PFD's:

Buoyancy - The tendency of a body to float or sink in water. Most people will naturally float in water, especially if they fill their lungs with air. Most require only about 11 pounds (50 Newtons) of extra buoyancy to keep their head out of water. That is why a PFD with just 15.5 pounds (70 Newtons) of buoyancy can provide adequate flotation for an adult -- even a very large person. PFDs with 22 to 34 pounds (100 to 155 Newtons) can provide superior performance.

Buoyancy is determined by Archimedes' Principle: A body partially or completely submerged in a fluid is buoyed up by a force equal to the weight of the fluid displaced by the body. This means someone immersed in water is "buoyed" upward by a force equal to the weight of the volume of water that their body takes up (displaces). Gravity pulls a person's body downward by a force equal to their weight. The difference between these forces is a person's net buoyancy. A PFD is very lightweight, but displaces enough water to make the PFD and the person wearing it very buoyant.

It also follows that the people hardest to float are those with compact, dense bodies. These tend to be people with athletic body builds, with a lot of bone and muscle mass, and not much fat. Fat is not as dense as muscle and bone, so people who are overweight can actually be easier to float than someone who is much smaller and leaner. Heavy people do not need a higher buoyancy PFD because of their weight.

HIGHER BUOYANCY MEANS HIGHER LIFT [6]

Type PFDs	Minimum Adult Buoyancy in Pounds (Newtons)
I - Inflatable	33.0 (150)
I - Buoyant Foam or Kapok	22.0 (100)
II - Inflatable	33.0 (150)
II - Buoyant Foam or Kapok	15.5 (70)
III - Inflatable	22.0 (100)
III - Buoyant Foam	15.5 (70)
IV - Ring Buoys	16.5 (75)
IV - Boat Cushions	18.0 (82)
V - Hybrid Inflatables	22.0 (Fully inflated) (100) 7.5 (Deflated) (34)
V - Special Use Device - Inflatable	22.0 to 34.0 (100 to 155)
V - Special Use Device - Buoyant Foam	15.5 to 22.0 (70 to 100)

Inflatable - A device which depends on flexible air chambers which can be filled with air or other gas (usually carbon dioxide) for flotation.

Inherently Buoyant - A device which relies on buoyant material for flotation. Buoyant materials used in Personal Flotation Devices include -

Plastic Foams - Materials consisting of closed plastic cells which trap air and provide flotation. Flexible plastic foams used for buoyancy include Polyvinyl Chloride (PVC), Polyethylene (PE), and Neoprene. Rigid foams used in ring lifebuoys are often polyurethane.

Kapok - A natural silky fiber produced from the seed of the kapok (Ceiba pentandra) tree which floats because of air trapped in the fibers' hollow cells. Used by some PFD manufacturers as a eco-friendly buoyant material.

Newton - The metric (SI) system measure of force. One pound force equals 4.4 Newtons.

Guidelines for Retiring A PFD

A PFD should be removed from service if any of the following conditions exist:

- Securing metal or plastic hardware on the PFD is broken, deformed, or weakened.
- Webbings used to secure the PFD is ripped, torn, or become separated from an attachment point.
- Rotted or deteriorated structural component that fails when tugged.
- Rips, tears, or open seams in fabric or coatings are large enough to allow the loss of buoyant material.
- Buoyant material that is hardened, non-resilient, permanently compressed, waterlogged, oil-soaked, or which shows evidence of fungus or mildew.
- Any loss of buoyant material or buoyant material that is not securely held in position.
- Consider the age of the PFD by reviewing the date of manufacture. Although there is no standardized life cycle for retirement of a PFD based upon age, consider that this device is required to perform reliably in emergencies. A flood and swiftwater rescue PFD that is over ten years old should be carefully inspected and be considered a candidate for replacement.

Features of a Swiftwater Rescue PFD

- Type III or V USCG approved. However many excellent foreign-made flood and swiftwater rescue specific PFDs are not USCG approved
- Minimum 22 pounds of flotation
- Two styles of entry include pullover and zip-up
- Constructed for durability and excessive wear
- A quick-release tether
- Storage pouches and lash tabs for a knife
- High visibility color
- Reflective trim
- Optional- leg straps for add extra security in big water.
- Most importantly- It fits very well!

FIGURE W26. Rapid Rescuer Type V PFD.

Sizing A PFD

Your chest size, not your weight, will determine what PFD size is right. A PFD should be snug and fit like a glove, yet allow you to move freely and not chafe while working. PFDs have different designs and foam placement to fit the contours of the body. It doesn't matter where the foam is located safety-wise, however for comfort the placement will matter greatly. A greater number of adjustment straps will allow you to customize the fit.

Fitting: Once you've selected the right size PFD, follow these fitting steps:

- Loosen all the straps, put the PFD on and zip it up.
- Start at the waist and tighten all the straps. If it has shoulder straps, tighten them last. It should feel snug but not uncomfortable.
- Next, have someone pull up on the PFD shoulders. If it moves up past your nose or head, the PFD is too large.
- Test your PFD in the water to see how it works. It should not compromise your breathing. It should not ride up or slip over your chin while floating.

Helmets

Wearing a helmet during flood and swiftwater rescue operations needs to be a habit practiced by every team member, regardless of working only on the shoreline. A climbing helmet with adequate ventilation holes for drainage may be used effectively in flood and swiftwater rescue for head protection. The full cut water sports helmet has the distinct advantage of the lower cut covering the ears. This does provide additional protection to the wearer, if struck from the side.

Water sport helmets, including kayaking helmets, meet the CE EN 1385 Standard (Safety Standard for Water Sports). There are six major requirements for a helmet to pass to receive the 1385 standard;

1. **Field of vision** - helmet design does not interfere with the user's field of vision.
2. **Extent of coverage** - helmet covers all necessary parts of the head.
3. **Shock absorbing capacity** - The most important is the shock absorbing capacity of the helmet. This is tested in a specialized instrument where the helmet is dropped with the speed of 2,5m/s onto a solid metal anvil with a 4 kg metal head inside. Inside the metal head there's an accelerometer that measures the forces within the impact. The helmets are tested in four different conditions: High temperatures (+35ºC), low temperature (0ºC), after artificial aging, and after the helmet has been submerged for four hours. Each helmet is tested on several areas including the crown, side, rear and front. The peak acceleration must not exceed 250G for any of the impacts.
4. **Retention system performance** - test of the strength of the retention system (webbing), as well as its effectiveness to keep the helmet securely positioned on the head.
5. **Buoyancy** - the helmet must float to the surface, after being submerged for four hours
6. **Durability** - after all these tests the helmet should not show any damage that would cause any additional damage to the wearer.

NOTE: Ironically, due to the nature of the test standards, a helmet tested to the CE EN 1385 standard is not intended for use in whitewater class four and five as described by the International Canoe Federation. Helmets intended for use in those conditions are actually outside the scope of the CE EN 1385 Standard.[7]

FIGURE W27. This helmet meets CE EN 1385 safety standards.

Helmet Features

- Durable shell designed to dissipate impacts well.
- A foam liner or suspension system that provides comfort and protection.
- Ventilation or drain holes depending upon design.
- Meets CE EN 1385 standards for whitewater safety.
- High visibility color for recognition in the water.

Visor - An aftermarket sun visor can be attached to the helmet to deal with the sun's glare.

Helmet Liner - A helmet liner of 1 mm neoprene or Polartec® fleece, worn inside a helmet, helps prevent heat loss and the discomfort of an "ice cream headache" from cold water exposure.

FIGURE W28. Neoprene Helmet Liner is constructed with 1mm neoprene and a fabric liner.

Wetsuit or Dry Suit?

Both pieces of apparel have their application in flood and swiftwater rescue. In cold water environments (60° F or 15° C), a dry suit with a fleece liner provides the single best thermal protection for a rescuer. A rescuer wearing a dry suit and working on shore in the hot sun will quickly become dehydrated and exhausted.
Working on shore in an extremely hot climate, a rescuer in a farmer john wetsuit with a lightweight HydroSkin™ shirt for insulation would be more comfortable. When wearing a full wetsuit on shore in a hot environment, depending upon the zipper design, it may be possible to regulate body temperature slightly by opening the main zipper. A wetsuit wearer also has the option of getting temporarily immersed in the water to provide quick relief from the heat as cold water reenters the wetsuit. A wetsuit is more durable around sharp rocks than a dry suit.

In the long run, the choice between a wetsuit of dry suit comes down to the operating environment of the user. A dry suit will ultimately be the preferred swiftwater rescuer apparel when operating in cold-water environments.

Wetsuits

A wetsuit is constructed of foamed neoprene, which provides thermal insulation, abrasion resistance and buoyancy. The insulation properties depend on bubbles of gas enclosed within the material, which reduce its ability to conduct heat. The bubbles also give the wetsuit a low density, providing buoyancy in water. The layer of warm water normally trapped between the suit and the skin provides very little thermal insulation, contrary to popular beliefs regarding wetsuits.

A wetsuit should be a tight fitting garment, which should be gently squeezing you all over. When you enter the water a very thin layer of water will squeeze between the wetsuit and your skin. If the wetsuit is baggy then a whole lot of water will flood in to fill the gaps between the wetsuit and your body. In both of the previous situations the cold water entering your body will have an instant cooling effect on your body.

FIGURE W29. Rescue Wetsuit constructed of 3mm neoprene and a reinforced 5 mm seat.

Different types of wetsuit are made for different uses and for different temperatures. Suits range from a thin (2 mm thickness or less) "shortie," covering just the torso, to a full 8 mm semi-dry, usually worn with neoprene boots, gloves, and hood.

Some wetsuits have a titanium lining, which is a silvery material with a degree of reflecting ability. The benefits of having a titanium lining for the purposes of reflecting the body's heat back towards itself are negligible. Firstly, the titanium is not an efficient reflector. Secondly, it is normally placed behind the nylon lining of the wetsuit thus blocking its ability to reflect anything. Thirdly, when your body's radiant heat hits the back interior of the wetsuit, it heats it up as black is a poor reflector. Thus the heat emitting from your body is not all lost, some of it heats up the inner surface of the wetsuit which then touches your body.

A small amount of water will seep through many types of stitching and through the seams where the material comes together. This is not a flood of water and for some types of suit this is acceptable. Summer 3mm wetsuits for example have flatlock stitching that allows such a slow seepage. However, for a summer wetsuit this is perfectly acceptable. The suit is more than efficient enough, even with a small amount of seepage, to keep the user warm in cool summer waters. In winter conditions it is important to retain as much heat as possible inside the suit.

Most wetsuits use standard design zippers, which are not totally watertight as an amount of water can pass between the teeth. It is normal to have a flap behind the zip which presses up against it when worn. This flap reduces the amount of water that can enter the suit through the zipper teeth. Some wetsuits have dry zippers, such as used in a dry suit, in place of a regular zipper to eliminate any water ingress through the zipper.

Most wetsuits are made from what is termed "double lined neoprene." This means that the neoprene rubber is laminated to a fabric, normally stretch nylon, to give it added durability and to allow it to be stitched together.[8]

Swiftwater Rescue Wetsuit Features

- 3-mm neoprene with Titanium provides protection from the cold.
- PowerSpan neoprene panels that increase mobility and reduce binding in extremities.
- Heavy YKK® zippers along with wrist and ankle zippers to permit easier donning.
- Glued and stitched seams for durability.

- Padded knees and shins for longer wear and added protection.
- Thicker seat for extra padding and wear resistance.
- High visibility color to provide identification at a rescue scene.

FIGURE W30. Extreme SAR Drysuit.

Dry Suits

Dry suits, unlike wetsuits, are designed to prevent water from entering. This permits better insulation making them more suitable for use in cold water. Dry suits can be uncomfortably hot in warm or hot air, and are typically more expensive and more complex to don. Swiftwater rescue employs membrane style dry suits. Care should be maintained to not puncture the outer membrane against rocks, since it will compromise the waterproofness. Divers employing a dry suit make changes by inflating or deflating their suit with changes in depth. A surface rescue swimmer should only need to remove all air from the suit once as they enter the water. The rescuer can “burp” the suit as they enter the water, by pulling the neck gasket open with two fingers. This permits accumulated air to leave the suit as they get into deeper water.

An over-tight neck seal can put pressure on the carotid artery, causing a reflex which slows the heart, resulting in poor oxygen delivery to the brain, light-headedness and eventual unconsciousness. For this reason, neck seals should be stretched or trimmed to the correct size.

Donning a dry suit is more complex and time consuming than a wetsuit. Care with gaskets to prevent structural failure involves stretching the gasket and then putting a head, hand, or foot through. This is preferred over simply pushing an appendage through against the tight gasket which can cause it to fail.

Dry Suit Features:

- Cordura® exterior material reinforces seat, elbows and knees for rugged protection in high-wear areas.
- Neoprene padding in the elbows and knees provide extra protection while working in the field.
- Attached latex socks keep the water out and feet are warmer.
- Internal suspenders and a pull cord waist adjustment provide a more custom fit and permit wearing the top of the suit down around waist while away from the water.
- Men's relief zipper.
- YKK waterproof entry zipper seals out water.
- Seams sealed.
- Neoprene neck and wrist latex gaskets create a waterproof seal.

Fleece Liner - A single piece union suit provides insulating warmth against the skin inside a drysuit. Constructed of Polartec® Power Stretch® fleece, which gives a liner flexibility of movement and wicking capability.

Footwear

The best rescuer footwear are neoprene boots which provide protection when walking along the shoreline and insulation when swimming. A supportive lug sole is important for adequate traction. Boots have a secure lacing system for a custom fit and excellent ankle support These may be worn in conjunction with neoprene booties or “wetsocks.” These can be a struggle to get in to a pair of swim flippers, however they still are the best choice to provide overall protection for your feet.

FIGURE W31. Workboot Wetshoe.

Gloves

Flood and swiftwater rescue tasks in cold water require well designed and insulated gloves. Working with an inferior or leather or thin neoprene gloves can quickly lead to an incapacitated rescuer.

Rescue Glove Features:

- 3.5 mm neoprene.
- Constructed with rubberized and armored palm for grip and durability. This is essential for rope handling.
- Fingers cut pre-curved to relieve hand fatigue while gripping paddles and ropes.
- Glued seams blind-stitched for durability and warmth.
- Stretch fabric for increased finger mobility.
- Hook and loop closure on wristband for secure fit.

FIGURE W32. Neoprene Rescue Gloves.

Swim Fins

The best swim fins for flood and swiftwater rescue are the stubby style favored by body boarders. The Viper Fins provide a more useful swimming aid for developing thrust than a larger traditional scuba swim fin in the challenging flood and swiftwater rescue environment. These are manufactured of natural gum rubber which permits them to float

FIGURE W33. Viper swim fins.

Eye Protection

A foreign object or stick making contact with the eye of a rescuer could leave them immediately incapacitated during an emergency response. It is recommended that a rescuer wear clear eye protection or sunglasses for personal protection at all times in the flood and swiftwater environment.

Whistle

A pealess whistle, which has no ball inside that can swell up when wet or get jammed. This whistle design has chambers that self-clear when submerged in water making it a superior piece of equipment for water rescue. The Canadian-made Fox 40 Classic is a popular plastic pealess whistle that produces 115 dB of sound.

FIGURE W34. Fox 40 pealess whistle.

An important consideration is how and where to secure a whistle on a PFD for immediate deployment. The attachment point on a PFD should make it accessible when it is needed and yet won't become an entanglement hazard from its tether or constantly hit the user in the mouth.

Knife

A knife needs to be standard equipment, along with a whistle, on every flood and swiftwater rescue PFD. Two basic styles of knives include folding and sheathed knives. It will come down to user preference. A sheathed knife provides quick access during an emergency. The blade may include a serrated style to aid in quickly cutting a line. A pointed blade tip permits puncturing a broached boat, however a blunt tip will prevent accidents during deployment.

Although some individuals have a lanyard tether to secure their knife from being lost, this can become an entanglement hazard. Another practice is to go without a lanyard, which also permits throwing the deployed knife away in a desperate situation. Carrying a second knife is also an excellent idea.

FIGURE W35. Shorty knife with sheath that can be attached to PFD

Lights

To work effectively during night conditions, consider a headlamp as well as a strobe light or chemical lightstick to indicate your location. For night operations have a second light source and spare batteries. Headlamps should be water resistant.

Flood and Swiftwater Rescue Equipment- Team Gear

Throw Bags

FIGURE W36. Rescue throw bag contains 75 feet of 3/8 inch polypropylene line for deployment.

A rescue throw bag is the essential tool for all rescue personnel involved in flood and swiftwater rescue. Effectively deployed by a proficient rescuer, a rope deployed from a throw bag contacts the victim and decreases personal risk for the rescuer by eliminating direct water entry. A standard throw bag contains 50-75 feet of 3/8 inch or 1/4inch polypropylene rope, which floats on the water surface. The full length of line will not effectively be deployed to a target due to friction from the bag, wind, and drag in the water.

Throw bags are constructed of high visibility nylon and Cordura® and may include a mesh panel for drainage and reduced drying time. A bag can be secured to watercraft with a quick-release straps. Bag designs include a barrel-lock drawstring opening at the top for smooth deployment during throws and equally important easy reloading. Internal flotation foam and the combination of using floating rescue rope keep the line on the surface of the water.

Waist throw bags are worn horizontal on the rear waist of the rescuer and attach with an adjustable belt and quick release buckle. This style of bag keeps it immediately available for deployment. These smaller sized bags can contain 55 feet of ¼" polypropylene rope (tensile strength 950 pounds) or ¼" Dyneema® (tensile strength 2,608 pounds) line.

FIGURE W37. Waist Throw Bag features an internal throw rope in a bag that pulls completely free from the waist belt.

<u>THROW BAG ACCESSORIES</u>:

Wild Water Snag Plate- permits snagging and retrieving another line in the water with a standard throwbag. Snag Plate is installed in a throw bag by threading it on the rope and stowing it in the bottom of the bag before loading the loose rope in the bag.

FIGURE W38. Wild Water snag plate allows the user to snag and pull in a rope with a standard throw bag.

Crossline Reach System- includes a very small three-pronged machined grappling hook that can be deployed from a waist throw bag containing 60-75 feet of line with a strong Dyneema® core and polypropylene sheath for buoyancy. The design of the small grappling hook, which incorporates spring-loaded hook keepers, makes it effective at snagging other lines in the water.

Second Chance Ball- A floating rubber Kong dog retriever training toy that is attached to the proximal end of the throw bag rope, and provides a 10 oz. device to initiate a fast follow-up line cast to a victim.

Riverboards

Bodyboards - These were developed for the surface water sport of Bodyboarding, which is also referred to as Boogieboarding due to the invention of the "Boogie Board" by Tom Morey. Constructed 36- 42 inches in length with a EVA closed cell foam deck and a high density polystyrene core that is heat laminated. Bodyboards are equipped with channels that increase surface area in the critical parts of the board which, in turn, allow it to have varying hold and control on the wave. A wrist leash is a critical accessory for any bodyboard being used in the flood and swiftwater environment.

Carlson Riverboard The Carlson Riverboard is larger than a traditional bodyboard at 54 inches in

length and provides 165 lbs of flotation. The board has a second set of handles and enough flotation to handle two people, which makes it very useful when affecting a contact rescue. The riverboard weighs 10 lbs.

RiverX Rescue Board by Extractor

The RiverX Rescue Board is 55" x 24" x 6" at thickest point and weighs 18 lbs. The rotomolded polyethylene board provides 120 lbs. of flotation. It has a hollow core with vent/drain plug. The concaved deck with elbow wells offers stability and leverage so you feel like you are riding "in it" rather than "on it." Adequate rocker and channels on the bottom surface work like little surfboard fins, allowing the rider to have more control. They allow you to carve directional turns in order to go where you want. There are multiples holes in the hull (nose and tail) for rope attachments and the deck is padded with 3/8" thick PVC, which is very comfortable and has good traction. Multiple handgrips along the board perimeter are rated at 5,000 lbs. for pullout strength. This is an effective device for swiftwater rescue or ice rescue. Although the manufacturer produces PWC sleds, this product is not designed to be attached to a PWC.

FIGURE W39. River Rescue Board.

NRS Pro Rescue River Board

The NRS Pro Rescue River Board is an inflatable device designed for swiftwater rescue. The PVC coated drop-stitch material holds 10 psi of air pressure for rigidity. The board has two sets of webbing handles for handholds and two stainless-steel D-rings on the nose allow for towing, lining and lowering. The top deck is covered with a textured and grooved foam pad for a grippy, non-slip ride. It is constructed with a Leafield C7 inflation valve and a Leafield A6 pressure-relief valve, which protects the board from over-inflation. The board rolls up compactly for transport and storage.

Line Guns and Launchers

Line guns are used tool to establish a line across a river. They greatly reduce time and manpower requirements in spanning a gap with a rope. Line guns shoot projectiles and since they are firearms can be dangerous. Be certain to wear eye and hearing protection.

EZ Liner

The E-Z Liner is a light and compact line launcher with a plastic PVC stock. The lightweight unit incorporates a dog training retriever launcher with an extended stock. A line pack of string is put into the housing and the end is attached to either a hard or soft missile. The missile is put into flight with the discharge of a .22 caliber blank cartridge. The flying projectile pulls the line from the line pack up to 300' (91m). The entire unit and kit weighs 5 lbs.

Bridger Line Gun

The Bridger Line Gun is capable of throwing a line up to 850 feet (259m) or further depending on the cartridge and line used. The .45-70 caliber line throwing gun is used by the U.S. military, Coast Guard, and fire departments. Complete kits include a minimum of four nylon or Spectra® shot lines 600 ft. long and 140 lb. test strength. The manufacturer recommends that when firing with the wind or in calm wind conditions, the gun should be held at an upward angle of 30-35 degrees. When firing into the wind, the elevation should be reduced to 20-25 degrees.

FIGURE W40. The Bridger Line Gun.

Sherrill Big Shot®

The Big Shot® line launcher is an oversized slingshot on a fiberglass extension pole, which the Sherrill Tree Company patented in 1998. This normally used by arborists to launch a weighted bag over a tree's branch, however it may be used as a line launcher in a swiftwater application as well.

The unit can be assembled quickly and will throw a lightweight Spectra® line up to 120 ft. vertically or more than 300 ft. horizontally. The strong leader line may be used to pull a larger rope into place. The kit contains a Big Shot head, two 4 ft. pole sections to make an 8ft mounting pole, line rod and reel, 250 ft. of 200 lbs. test Spectra® line, and carrying case.

FIGURE W41. Sherrill Big Shot.

ResQmax™

The ResQmax™ line thrower is designed to throw a wide variety of lines up to 400 feet (122m). It is a non-pyrotechnic line thrower, powered by compressed air and the components can be reused. The projectile cylinder can be charged from a compressor, SCBA bottle, or SCUBA bottle. As a water rescue device, it can deliver an auto-inflating flotation harness and retrieval line to a victim in the water, over distances up to 300 feet. The swiftwater kit weight 33 lbs.

FIGURE W42A, B, C. ResQmax system setup and shown during deployment

Watercraft

The use of watercraft in flood and swiftwater rescue has excellent applications in initiating direct rescue efforts as well as conducting downstream safety support tasks. The selection of the right type of watercraft for the actual flood and swiftwater environment is paramount. No one single type of watercraft works effectively in every emergency situation. It sounds like common sense, however this tenet is repeatedly violated by rescue teams attempting rescue efforts with a watercraft that is completely unsuitable for the situation. After the vessel gets swamped, stuck, stalled, rolled, or pinned, the question will be asked, “what were they thinking? Remember to pick the right tool for the job!

Hard Shell Kayaks

A hard shell kayak is the more versatile watercraft in the broadest range of flood and swiftwater, which includes steep technical descents. A spray skirt prevents water from entering the cockpit of a kayak in turbulent whitewater conditions. A kayaker can affect a rescue of a conscious swimmer by towing them to shore or having the swimmer pull themselves up on to the rear deck in line with the hull. These boats are constructed of plastic or fiberglass and typically weigh 30-50 lbs. Plastic kayaks are rotomolded polyethylene and this material is incredibly durable and abuse- tolerant.

<u>The three primary types of whitewater kayaks include</u>:

Creek Boats - this is a high-volume kayak with the volume arranged equally around the cockpit. Thus, the larger deck shapes ensure that neither end will submerge easily with the whole boat designed to resurface quickly. The tip of a creek boat boats is designed to be stubby, which helps prevent vertical pins. Lengths of creek boats vary depending on the intended creeks, but they tend to be longer than either play boats or river runners.

Play Boats - useful for surfing waves and holes and performing freestyle tricks, play boats tend to have a lot less volume in the front and back decks. The depressed decks permit the ends to sink underwater, so paddlers can perform vertical play moves.

Downriver Boats - these boats are in between high-volume creekers and low-volume play kayaks. The overall design of a downriver boat is to cruise down the river in comfort and control, while still features that make some basic play moves possible. Downriver boats in general will have mid- to high-volume bow decks that shed water quickly, and mid- to low-volume stern decks. They tend to be longer than current freestyle designs. The added length adds to the tracking ability of the boat and permits it to move faster in a straight line.

The single biggest drawback with the use of hard shell kayaks for flood and swiftwater rescue is the level of proficiency that is required to operate these boats. A competent kayaker needs to be able to comfortably execute a roll. This permits a flipped boater to regain an upright position back to the surface. Being able to brace in turbulent water requires practice and plenty of time spent actively kayaking. Although a great tool, the lack of technical kayaking skill makes this type of boat less appropriate for flood and swiftwater rescue response by many teams.

Inflatable Kayaks

A high-performance inflatable kayak comes close to matching a hard shell kayak's quickness and performance in water. Like a hard shell, these watercraft can surf waves, edge in and out of eddies, punches through holes and are quick to maneuver in flood and swiftwater. The cockpit is outfitted with thigh straps that provide security for the operator, yet they are easily released in the event of capsizing. Unlike a hard shell, where the operator can roll back to the surface, once an inflatable kayak rolls over typically the operator simply bails out to the surface.

FIGURE W43. An inflatable kayak usually contains four air chambers.

The boat is constructed of an outer PVC Shell and, depending upon manufacturer, an air holding bladder layer is thermo-welded inside. The shell provides air retention protection. Inflation is quickly achieved with a barrel pump. Carry handles on the ends also serve as tow or grab handles for subjects in the water. Finally, the amount of time required to become proficient with an inflatable kayak is much less than a hard shell kayak.

Packraft

Packrafts, which are the smaller and lighter version of an inflatable kayak were developed for long distance trekking or extreme backpacking travel. This watercraft is less stable than a normal inflatable kayak in turbulent flood and swiftwater, however it can be a useful flood and swiftwater rescue tool in some applications. The micro-sized packraft is constructed with a 12-inch tube diameter and utilizes a single air chamber. The packraft shown has an outside dimension of 87 inches X 37 inches with an interior opening 44
inches X 14.5 inches. An optional spray

FIGURE W44. Packraft weighs five lbs.

skirt may be attached. This raft shown rolls down to the size of a small two-person tent and weighs 5 lbs. The raft packed in its stuff is 9 inches x 24 inches. These small all-purpose inflatables are used by small whitewater paddlers, adventure racers, and long-distance trekkers. As a watercraft for flood and swiftwater rescue, it could be a preferred tool of choice for carrying to a remote scene, where it can be quickly pumped up with its dedicated inflation bag.

Cataraft

The overall profile of a cataraft gives it excellent maneuverability. A typical cataraft is constructed of two 22" diameter tubes connected with a tubular aluminum frame. The boat operator sits on a tractor seat mounted in the center. The 14' cataraft shown is propelled by two sweep oars. The upturned tube design in the kick and rocker (Bow\Stern) provide the punch to get through large

FIGURE W45. 14-foot cataraft.

waves in flood and swiftwater. It weighs 70 lbs., however it has a carrying capacity: 876 lbs. The tubes are constructed of urethane with a multi-chamber air cell design, which increase strength, durability and safety. Rubberized handles make it easier to carry a cataraft to the water.

Paddle Rafts

Paddle rafts, which are typically 10-12 feet in length, have no metal rowing frame attached. These boats are powered by a team of paddlers all using T-paddles and directed by a paddle captain in the rear. Substantial propulsion can be generated by the coordinated efforts of an efficient team in a paddle raft. This watercraft is very useful for transporting personnel or gear and is employed during tethered boat techniques, which involve maneuvering a boat at a flood and swiftwater rescue scene with a rope from shore.

Hybrid Watercraft

Inflatable Victim Retrieval Device

The Inflatable Victim Retrieval Device (IVRD) manufactured by Applied Rescue Technique IVRD is a safe alternative for victim retrieval during incidents involving low-head dams and falls through ice. It provides flotation for several victims when multiple people need to be retrieved. The IVRD is made of yellow 1000 Denier PVC/Polyester woven fabric that inflates to 9.5 inches diameter by 10 feet in length. It can be inflated with a hand pump or compressed air. The exterior is fitted with a nylon webbing lanyard running the full length for victims to grab. The device weighs 9.5 lbs. and rolls into a 9.5" X 16" bundle for storage.

FIGURE W46. Inflatable Victim Retrieval Device (IVRD) being deployed in low-head hydraulic.

Oceanid RDC

The Oceanid Rapid Deployment Craft (RDC) is an inflatable water rescue platform. The design of the 15 feet by 4 foot wide yellow RDC incorporates upturned open ends. These openings permit a rescuer to "drive" the boat's open end over the victim, while the victim's head remains above water at all times. The floor is open at each end, providing two entry points. The RDC inflates in one minute and weighs 50 lbs. It is constructed of 35 oz. polyurethane/PVC with three air chambers, two in the 12-inch diameter main tube and one in the inflatable floor. This hybrid watercraft may be used for water rescue, ice recue, and patient transport.

FIGURE W47. Oceanid Rapid Deployment Craft (RDC) is a hybrid watercraft that can be deployed in flood & swiftwater responses.

Motorized Watercraft

Outboards

FIGURE W48. Evinrude 55-hp two-stroke multi-fuel outboard engine with a shrouded impeller, which handles submerged obstacles and is safe to operate around swimmers.

An outboard engine with an exposed propeller, deployed in the flood and swiftwater environment, is dangerous to any personnel in the water and easily damaged by striking submerged obstacles. Specialized outboards typically employed for flood and swiftwater operations, which eliminate this hazard, include shrouded props, jet drives and impeller designs. A shrouded prop includes a large fixed circular ring, which surrounds the props spinning freely inside, that prevents contact with obstacles or swimmers. A conventional jet drive replaces the lower unit of the outboard with an assembly that includes an intake, impeller and a jet discharge that forces the water out creating thrust. Personal watercraft employ a inboard jet drive for propulsion. Finally an impeller-equipped jet pump is an upgraded design that provides increased thrust and performance when compared to conventional jet pumps.

Motorized Inflatables

Motorized inflatables provide a stable platform to transport rescuers, victims, and cargo. In higher volume flood and swiftwater this may a much safer choice than a swimming rescue. The portability of an inflatable permits it to be trailered to a rescue scene or transported by helicopter sling load (more secure than being flown inflated) and inflated at the scene with compressed air cylinders.

The very popular F470 Combat Rubber Raiding Craft (CRRC), also known as the "Combat Rubber Reconnaissance Craft," is a specially fabricated inflatable boat used by U.S. Navy SEALs and Marines. The length of the F470 is 4.7 meters (15'5"). A total of eight individual airtight chambers comprise the F470. The vessel is constructed of Hypalon® neoprene and has an empty weight of the vessel is 322 lbs.

FIGURE 49. Zodiac Inflatable.

Rigid-Hull Inflatables (RHIB)

The rigid-hulled inflatable boat, (RHIB) or rigid-inflatable boat (RIB) is a lightweight and high-performance boat constructed with a solid hull and inflatable flexible tube collar attached to the gunwale. The inflatable tube provides buoyancy to the vessel even if a large amount of water is taken on board due to rough conditions. The hull of a RIB is shaped to increase the performance of the boat in the water by increasing its hydroplaning characteristics. "Deep-V" hulls cut through rough water easier but require greater engine power to start planing than "shallow-V" hulls, which plane at lower speed but with a more uncomfortable ride. It is suitable to deploy these vessels in large volume flood and swiftwater conditions, which require a bigger watercraft with these capabilities. Common materials for the tubes are Hypalon and uPVC (Polyvinyl chloride), though some manufacturers use PU (Polyurethane).

FIGURE W50. WASH 23-foot boat for swiftwater.

Personal Watercraft

Personal watercraft have an inboard engine driving a pump jet that has a screw-shaped impeller to create thrust for propulsion and steering. The U.S. Coast Guard defines a personal watercraft, as a jet drive boat less than 13' in length. Prior to 1990, many PWC, along with marine outboards, were powered by two-stroke cycle engines. These are smaller and lighter than newer four-stroke cycle engine designs but more polluting.

The size, relative ease of use, and their propulsion system lacking an external propeller have made PWCs very popular for surf rescue. A PWC can be employed in the flood and swiftwater environment, but a significant shortcoming is the fiberglass hull, which is easily damaged if it strikes a rock.

FIGURE W51. Personal Watercraft (PWC) equipped with a rescue sled.

John boats

A john boat is a flat-bottomed vessel constructed of aluminum, fiberglass, or wood. John boats typically have a rear transom, where an outboard motor can be mounted. The flat hull causes the boat to ride over waves rather than cut through them like a V-hull, which limits the use of the boat to calmer waters. John boats are available commercially between 8 and 24 feet long. Numerous public safety agencies deploy john boats routinely for flood rescue operations. This boat hull design is very stable in areas of flooding inundation and exceptional for moving numerous floodwater victims. The same cannot be said of the use of a john boat in the flood and swiftwater environment. The low freeboard (height of the side of the boat above water) makes this type of watercraft dangerous in flood and swiftwater as they are easily swamped. Rescue organizations owning john boats have repeatedly made this mistake.

FIGURE W52. John boat.

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Chapter

Six

FLOOD & SWIFTWATER ROPES, LINES & ANCHORS

Knots, Hitches, Bends and Anchors in Flood & Swiftwater Rescue

Introduction to Knots

Knots, hitches, bends, and anchors are fundamental tools in flood and swiftwater rescue. These skills are crucial for creating strong and reliable systems that can withstand the dynamic forces encountered during flood and swiftwater operations. In this chapter, we will explore the types of knots, hitches, bends, and anchors commonly used in flood and swiftwater rescue and their practical applications.

Types of Knots

1. **Figure Eight Knot**: This knot creates a secure loop at the end of a rope, often used as a stopper knot or to tie into a harness.
2. **Bowline Knot**: A versatile knot used to create a non-slipping loop, ideal for attaching ropes to anchors or creating harnesses.
3. **Clove Hitch**: Useful for securing a rope to a post or other object, the clove hitch is quick to tie and untie.
4. **Double Fisherman's Knot**: This knot is excellent for joining two ropes of equal diameter, creating a strong and reliable connection.
5. **Prusik Knot**: Essential for ascending or descending ropes, the Prusik knot grips the rope under tension but can be easily adjusted when slack.

Types of Hitches

1. **Tensionless Hitch**: Also known as the trucker's hitch, this hitch is used to create a mechanical advantage for tightening or securing loads.
2. **Munter Hitch**: A versatile hitch used for belaying, rappelling, and creating a simple mechanical advantage system.
3. **Traverse Hitch**: Ideal for traversing a rope while maintaining tension, commonly used in high-angle rescues.

Types of Bends

1. **Double Fisherman's Bend**: Similar to the double fisherman's knot, this bend is used to join two ropes securely.
2. **Water Knot**: Used to join webbing or flat rope, the water knot is strong and easy to tie.

3. **Sheet Bend**: A reliable bend for joining two ropes of different diameters, commonly used in rescue situations.

Anchors in Swiftwater Rescue

Anchors play a crucial role in creating stable systems during flood and swiftwater rescue operations. Here are some common types of anchors and their applications:

1. **Natural Anchors**: Trees, rocks, and other natural features can be used as anchors in flood and swiftwater rescue. It's important to assess their strength and stability before use.
2. **Artificial Anchors**: Anchor plates, bolts, and specialized anchor systems are used when natural anchors are not available or suitable.
3. **Anchor Points**: Select strong and stable points for anchors, ensuring they can withstand the forces exerted during rescue operations.

Practical Applications

- **Tensioned Diagonal System**: Utilizes multiple anchors and a system of ropes and pulleys to create a stable and adjustable tensioned line for rescues across flood and swiftwater channels.
- **Floating Anchor System**: Involves deploying an anchor upstream to create a stable point for rescuers to work from, especially useful in dynamic water environments.
- **Litter Bridle System**: Uses knots, hitches, and bends to secure a litter or stretcher for safe extraction of victims from flood and swiftwater.

Conclusion

Mastering knots, hitches, bends, and anchors is essential for flood and swiftwater rescue personnel. Practice and proficiency in these skills enable rescuers to create reliable systems that enhance safety and effectiveness during flood and swiftwater operations. Regular training, simulation exercises, and real-world scenarios are crucial for maintaining and improving these essential skills.

World Academy of Safety & Health

Chapter

Seven

FLOOD & SWIFTWATER RESCUE TECHNIQUES

Swiftwater Rescue Techniques

Swiftwater Swimming

The ability to competently swim in flood and swiftwater is a personal survival skill for every flood and swiftwater rescuer. Although a rescuer may not intend to enter the water during a response it is possible for the dynamic nature of a river rescue to cause a change in the initial plan. Additionally, working within ten feet of the water's edge it is possible for an accident to occur and a rescuer suddenly finds themself in the water.

Entering and initially swimming in cold turbulent flood and swiftwater is stressful. It requires a swimmer to consciously regulate their breathing or they will unconsciously hyperventilate. Conserving energy where possible and using strong bursts of energy only when necessary will permit a swimmer to avoid exhaustion.

A swimmer is in a position of having their mouth close to the water surface, which can make breathing difficult. Swimming through big waves requires that you time your breathing in order to catch a breath in the low trough between waves. To avoid the shock of cold water to the face by catching a large wave head-on, turn your head to the rear as the wave approaches. This will significantly reduce your fatigue level when swimming in big waves.

If you enter the water from a rock or shore never dive head-first. The chance of injury is too great. In deep water perform a shallow water dive with your chest contacting the water first.

Defensive Swimming Technique

In shallow rocky flood and swiftwater (greater than knee deep), the best position is on your back facing downstream in the "defensive swimming position" watching where you heading. This involves having your feet downstream close to the surface, thereby reducing the risk of foot entrapment. Your feet are ready to fend off obstacles with legs bent. Do not permit your butt to ride too low in the water or it will impact shallow rocks. It is far better to strike a rock with your feet instead of your lower spine. Be aware of your profile in the water and make adjustments accordingly. Paddle with an aggressive backstroke toward shore using a good ferry angle. A sidestroke can also be used effectively for extra power or when in deeper water.

FIGURE W53. Defensive Swimming Position.

Aggressive Swimming Technique

In deep water, where foot entrapment hazard is minimal, it can be more effective to roll over on your stomach and perform a crawl stroke. This powerful stroke is very useful in catching an eddy by blasting through an eddy fence with plenty of momentum. Keep your head out of the water as much as possible to maintain your orientation.

Strainer

A strainer is an obstacle at or near the surface that allows water to pass through but pins solid objects (e.g., tree, fencing). These can be a deadly obstacle for a swimmer. The first choice would be to avoid a strainer. If confronted with an oncoming strainer, such as a large tree, a feet-first position may cause the current to push you under the object. Instead roll over into an aggressive swimming position and propel yourself downstream with a powerful crawl stroke directly toward the obstacle. As you reach the tree, use your momentum to crawl up on to the strainer.

Developing proficiency in this flood and swiftwater technique is achieved through training with a “strainer drill.” A training prop, such as a plastic pipe or inflatable tube, is secured in the current, to simulate a strainer at the water surface. Swimmers approach in a defensive swimming position. Once a decision is made to go over the strainer, they switch to an aggressive forward swimming stroke and launch themselves over the strainer prop.

FIGURE W54. Strainer drill. Rescuers employ a section of PVC pipe.

Entrapment

An entrapment is the process by which an extremity or a subject’s entire body is forced into a crack, crevice, or undercut and pinned there by the force of the current. Avoiding an entrapment means not attempting to walk in water deeper than your knees and keeping your feet up and downstream when swimming in shallow water. Once an entrapment occurs, it is difficult for a victim escape without assistance. If you experience a foot entrapment, the force of the water current will push you forward face down. Attempt to regain an upright stance and keep your head above the water surface.

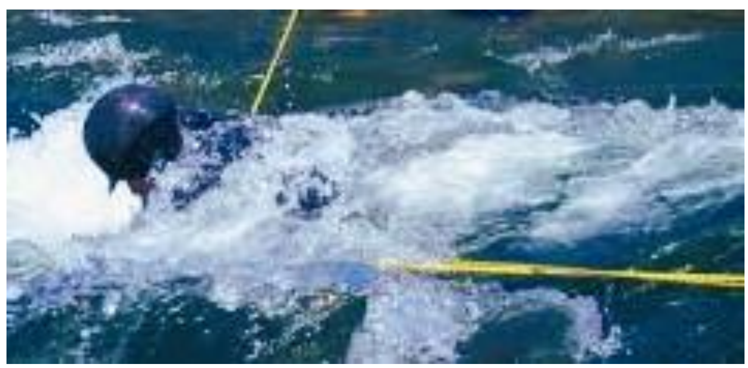


FIGURE W55. A stabilization line, immediately deployed to an entrapped person.

Rescuers need to provide immediate physical assistance by employing a shallow water crossing (wading) technique to reach the subject or establishing a stabilization line across the river with a rope.

Ferry Angle

When maneuvering or swimming across current, the rescuer maintains a body position that is 45° upstream to the current vector. The idea is that the force of the current will help to propel the rescuer in the direction rescuer is trying to go. If done correctly the flow will propel rescuer in the direction of the rescuer's head is pointed regardless of whether the rescuer is in defensive or offensive swim position

A swimmer or watercraft operator can use the power of the current to move them to a shoreline by establishing a good ferry angle. To reach a point on an opposite shore without excessively travelling downstream, a swimmer would enter the water slightly above their target and begin swimming upstream at a 45° angle. Although the swimmer is pointed aggressively upstream the current is overcoming their upward progress. The angle of their body in the water causes the current to push them toward the opposite shore.

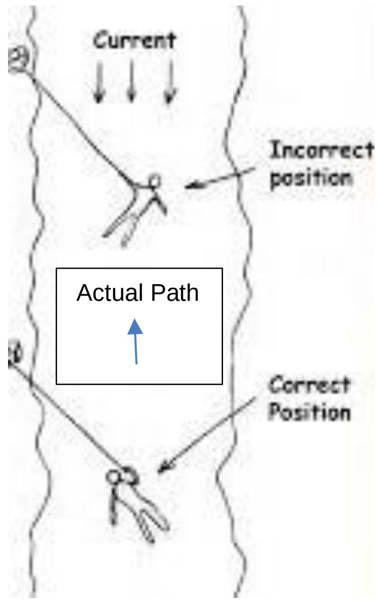


FIGURE W56. A correct upstream ferry angle allows rescuers to reach a point across river from them.

Rope Throw Bags

A throw bag rescue is conducted with the rescuer on shore deploying the rope with pinpoint accuracy directly to the subject. This is the ideal scenario and requires proficiency on the part of the rescuer. This can only happen with adequate bag throwing practice. It is a skill that requires mastery.

The rescuer positions themself downstream of the incident or hazard, not immediately across from it. If feasible, select a location where you can swing your "catch" into an eddy below. Consider deploying multiple rope throwers and, if applicable, use both shorelines. This is especially important in hazardous sections of flood and swiftwater. Coordinate and plan your actions with the other rescuers, so that a barrage of rope is not thrown simultaneously.

Get yourself in a good location. This means a secure position where you have good balance and can brace for the impact of the rescue rope suddenly becoming tensioned.

FIGURE W57. Rescue throw bag.

Prepare the rope bag itself. Loosen the drawstring opening so that rope will deploy without snagging on the bag. Inspect the bag to make certain the rope was stored ready for effective deployment. Remove any carabiners from the bag before deployment which could hurt the swimmer.

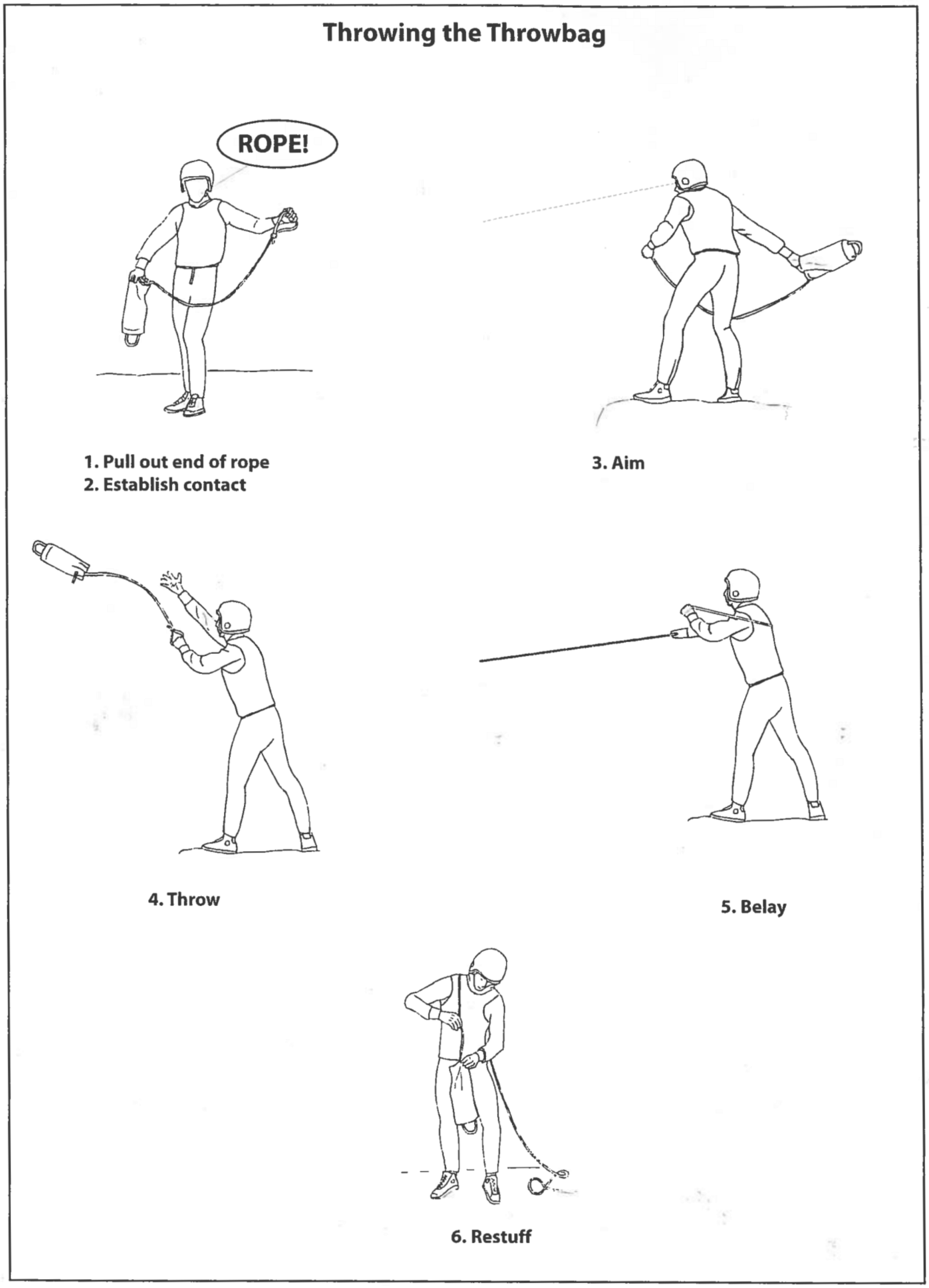


FIGURE W58. Procedure for correctly throwing a rescue throw bag.

FIGURE W76. Technique for deploying a rescue throw bag. Establish voice and eye contact with your target and time your throw to land the rope squarely on the subject.

FIGURE W59. Technique for deploying a rescue throw bag. Establish voice and eye contact with your target and time your throw to land the rope squarely on the subject.

Hold the wrist loop on the line coming out of the top of the bag, but do not place it your wrist inside it. You may need to abandon the line if it starts to pull you in the river and having it around your wrist could be a disaster.

Grasp the rope bag in the palm of your throwing hand. Some rescuers prefer to grasp and throw from the strap on the top of the bag, but physically throwing the bag itself provides much more thrust.

Throwing technique includes underhand, overhand, and side arm. The underhand technique permits putting an arc to the throw bag as it sails through the air. The overhand technique generates the greatest velocity for longer throws. Get the attention of the swimmer and yell "rope!" It may sound obvious, but hang on to the rope with your hand opposite from your throwing arm as you release. Many rescuers have sent the entire rope and bag into the air forgetting this essential step. Like a baseball pitcher use your entire body to make the throw with force being transmitted from your torso and out through your arm.

FIGURE W60. Grasping the entire throw bag to toss to victim.

Timing is everything! Use your best judgment to have the bag deploy in line with the head of the subject in the water. Only one rescuer should throw at a time. This will minimize the multiple ropes from entangling the victim.

Your goal is to have the rope land directly on their swimmer's head. A rope deployed slightly downstream of a subject will remain at that location. A rope placed outside the arm's reach of a subject will be difficult for them to see in churning flood and swiftwater and they may not be able to get to. Should the rope miss the victim the rescuer should be able to recoil the rope and attempt a second throw before the victim is out of reach,

Get ready for the rope to become tensioned by widening your stance and lowering your center of gravity. Having another rescuer grab your PFD at the shoulders will provide stabilization. In strong current, reposition the rope around your waist for a hip belay. Your brake hand needs to be upstream, which will put your body on the upstream side of the tensioned line and permit you to escape from the belay if that becomes necessary.

FIGURE W61. A team member provides a safety backup for a rescuer after deploying a throw bag as they pendulum a subject to shore.

Once the swimmer has grabbed the rope they should be directed to roll on to their back side and place the rope over their upstream shoulder. If possible pendulum the swimmer into calm water downstream.

If you miss your target on the first throw you may, depending upon site conditions, be able to initiate a second throw. The scenario of other subjects in the water may also require an immediate second throw. This can be accomplished by quickly pulling in the rope and flaking large loops over your non-throwing hand. As you reel in the bag filled with water, quickly split the coil into both hands with the rope bag half in your throwing hand. Make the second the throw immediately while the rope bag still has some water in it for added weight. This throw with a split coil will require strong effort, since you don't have the a rope filled rope bag for mass. As the first half of the coil is deployed from your throwing hand, open your non-throwing hand to permit the second half of the coil to pay out. This technique is not easy and requires fluid motions combined with practice.

FIGURE W62. A second throw with a rescue throw bag being initiated using the split coil technique.

FIGURE W63. Making a quick second throw count with the split coil technique requires practice.

Following a throw, stuff the rope back in the bag so that the equipment will be response-ready. Stuffing a rope rapidly into a throw bag requires efficient motions. Draping the rope over your shoulder directs it into the bag easier. One method is to grasp the bag lip with one hand and repeatedly stuff rope with the other hand. Another method, best applied with the bag resting on the ground or clipped to something for support, is to have one hand working slightly above the other hand. Grasp the rope with fingers of the upper hand and feed it to the lower hand in a continuous manner that completes the stuffing action.

FIGURE W64 Recoil the line of the throw bag after use.

Wading Rescue (Shallow Water Crossing) Techniques

These methods may be employed to cross a river as well as wading rescues to reach a subject in the flood and swiftwater environment. This direct rescue does place a rescuer at risk with an in-water approach, however it is simple and quick to deploy. A pinned kayaker or victim of an entrapment can be reached quickly and provided with physical assistance.

All of these techniques focus on creating increased stability. One person is a bi-ped and structurally unstable against the massive force of raging current. Combined with a pole or other rescuers their stability is increased permitting travel in much stronger currents than before.

Single Rescuer

A single rescuer can form a tripod position utilizing a pole or paddle. A T-paddle works very well. Place the handle end in the water and the blade against a shoulder. If the blade is placed down in the water, it can be difficult to control in stronger deep water. Face upstream and lean against the current. It is crucial to create a highly exaggerated tripod stance, with legs kicked out and in a very wide stance. Effectiveness of method requires the rescuer to move one leg of the tripod at a time as they move across strong current.

Figure W65. Tripod position for a shallow water crossing.

Line Abreast

Three or more rescuers form a line adjacent to one another facing their intended direction of travel. They link arms for stability and can use a pole or paddle to increase their structural strength. It is best to place the largest rescuer on the upstream end to counter the force of the water. One rescuer serves as the team leader and coordinates the movement of the team. All team members should be directed to move one foot at the same time to create fluid travel.

FIGURE W66. Line abreast crossing technique.

Line Astern

Three or more rescuers form a line facing upstream against the current. The largest rescuer should be placed at the upstream end to counter the force of the water. All rescuers grasp the shoulder portion of the PFD in front of them and pull downward. In very strong current, have the number one position turn around and face downstream leaning downstream on the number two position, who is leaning upstream. All movements of the team are coordinated together.

Tripod (aka triangle or people pivot)

A group of three rescuers can form a triangle of stability with the three individuals forming a tripod, which permits them to successfully enter strong current. The largest rescuer should be placed at the upstream corner of the tripod to counter the force of the water. The area inside the triangle creates an eddy of calmer water. Upon reaching a victim they can be encircled with the tripod formation, immediately creating relief and support.

Wedge

A larger group of rescuers can form a wedge or V-shaped formation with the point facing upstream. Of all of the wading rescue formations this is the most stable for deep and swift-moving water. As with the other formations, the largest rescuer should be placed at the upstream position to counter the force of the water. Have all remaining rescuers in descending order of size on both sides of the wedge. Have the rescuer at the point of the V face downstream and grab the PFD of the number two position on either side of the wedge. All other rescuers grasp the PFD of the rescuer in front of them and pull downward. All movements of the team are coordinated together by the rescuer in the number one position.

FIGURE W67. Wedge formation wading rescue technique.

Contact Rescues

Making a direct contact rescue of a subject involves significant risk to the rescuer. The progression involves approaching the victim, making contact, and ultimately moving them to safety. This could involve providing physical assistance to an immobile entrapment victim in a river channel or capturing a mobile subject being swept downriver. These situations may require immediate and precise action to resolve. To make contact with a mobile subject it is more efficient to deploy downriver and have the

FIGURE W68. A contact rescue.

subject come toward you than to be in a position of having to chase after a subject. A rescuer can swim upstream against the current and stall as the subject moves downstream to them.

During the approach to a subject assess their level of panic and fatigue. Since their actions may be difficult to predict and you should be mentally prepared in the event they lunge toward you or try to climb on top of you for safety. Upon reaching victim in the water position yourself behind them and place them on their back for transport to shore. A cross-chest grip of the subject's PFD or grasping the shoulder of their PFD is preferred. Keeping you head above water and the subject's, kick toward shore on your side. This is a very exhausting task. If possible, encourage the subject to assist by swimming or kicking as well.

A rescuer can either directly swim the subject to shore with a proper ferry angle or be pulled by a tether line from shore-based rescuers. They can pendulum rescuer and subject to the shoreline.

When making a contact rescue of a stranded subject, who does not have a PFD, it should be a priority to get a PFD (minimum PPE) on the subject, before you attempt to move them. If your rescue plan does not go smoothly, they have some means of flotation if they head downstream.

FIGURE W69. Contact rescue sequence

An important initial action should include getting a PFD to the subject.

FIGURE W70. Rescue swimming techniques for contact rescues.

Figure W71. Riverboard employed for contact rescue.

Riverboard Rescues

The added flotation of a riverboard or Boogie Board when making a physical rescue in the water adds security to the situation. An exhausted subject rests on the board rather than upon a rescuer comprising their safety. Upon reaching the subject, the nose of the board is first presented to the subject. This initially creates a physical barrier from the rescuer. If the subject is cooperative, the board surface can then be pivoted around and presented to the subject and have them lay upon the board. The rescuer grasps the board from behind the subject sandwiching them to the board. Alternatively the rescuers can then reposition to the nose of the board and tow the subject to shore. The later technique permits the rescuer to kick harder as they swim and the subject less impairs their movements.

FIGURE W72. Using a riverboard to tow a subject to shore creates flotation support for the subject and a barrier limiting contact with the rescuer.

Tethered Swimmer

As discussed previously, ***don't directly tie a rope to a rescuer***. A tethered swimmer rescue or "live bait" technique involves a rescue swimmer employing the quick release feature of their flood and swiftwater PFD. The rescuer can clip directly into the ring on the back of the quick release harness or employ a cow's tail as an intermediate link. The drag against a rope line in the water limits the useful distance this technique can be employed from shore. The length of a rescue throw bag (75 ft) should be considered the maximum length or a tether line.

Don't directly tie a rope to a rescuer

FIGURE W73 Tethered swimmer technique.

After reaching an exhausted subject, the rescuer can use both hands to maintain contact of the subject and be reeled in by shore-based personnel. A disadvantage of this technique is the possible entanglement that can occur with a line in the water being snagged on a surface obstacle.

Tensioned Diagonal

A tensioned diagonal involves establishing a secured line between two points (e.g., shore-to-shore or mid-river to shore) at an angle of at least 45 degrees or greater to the current vector. The downstream end of the tensioned diagonal is the direction that a subject or rescuer needs to travel. A mechanical advantage system is used to tension the line so that a swimmer, sliding along the line, will have momentum to reach their destination at the downstream end. Although a carabiner and Prusik loop could be solely employed for the connection link to slide along the line, a pulley should also be incorporated for efficiency during movement.

FIGURE W74. Using a tensioned diagonal, also referred to as a "zip line."

It should be recognized that this technique involves placing subjects into the water and relying upon them to physically hang on for a connection point during a tensioned diagonal crossing. The reality is that utilizing this technique with untrained lay persons who have unknown swimming abilities may not be recommended except in highly controlled situations. (e.g., lower flows, short distances, downstream free of obstacles, etc.).Using a tensioned diagonal has inherent risks. Consider the possible consequences of using this technique before taking action.

Continuous Loop System

Another rope movement technique between points is the continuous loop technique. The line is not physically anchored and is simply held in position by rescuers. The loop is continuously in motion and can like the tensioned diagonal requires a user who can be relied upon to physically maintain their connection point during a traversing movement.

A rope loop is configured that is well over twice the distance from the shore to target. The loop is first positioned by a rescuer who starts upstream on the shoreline from the intended target. The rescuer wades or swims the line, which can also be tossed, out to the target. Rescuers on the shore simply run the rope through their hands for stability. They do not anchor the line or employ a body belay which could endanger them. Upon reaching the target, two rescuers on shore reposition with one well downstream of the target. Moving the loop, with a subject being transported from the target to safety on the shoreline.

Ferrying a Line

A line gun or deployment system can be used to send a messenger coprd (smaller diameter cord) or rope to an opposite shoreline or other target. If this equipment is not available or not appropriate to employ, then it may be possible to ferry a line to the target. This can be accomplished by a kayak or riverboard equipped swimmer. The line may be attached to the ring on their PFD quick release harness so their hands are free. On longer distances, keep the line supported out of the water as much as possible to reduce in-water drag that impairs the rope bearer.

Rope-Based Techniques

Swiftwater rescue operations frequently involved ropes based systems to accomplish rigging, salvage operations, body recoveries, etc.

Swiftwater rescuers should develop and maintain proficiency with their personal rope skills in the following techniques;

- Knots, bends and hitches
- Anchors
- Mechanical advantage systems
- Tethered Boat Techniques

The forces generated in salvage operations and tensioned lines in swiftwater rescue require that personnel maintain vigilance in their actions.

Don't stand inside the rope bight or on downstream side of a tensioned line

The forces generated with mechanical systems during a boat salvage (unpinning) are drastically higher than those generated with life-safety loads. Anticipate that rigging could suddenly fail without warning.

Do not rig to single D-rings on a pinned boat as an anchor point. These can easily fail with enough force. Employ a load distributing anchor system that incorporates several full strength anchor points (e.g., rig around a rowing frame or entire inflatable tube).

Haul lines under severe tension may snap back and injure personnel. Maintain discipline with PPE in the work zone including PFD, helmets, and eye protection for exposed personnel. Employ a tarp draped over a line to reduce the kick back potential. Minimize the number of personnel in any associated danger zones.

Think and plan ahead. Anticipate that if a pinned boat is pulled free, it will move downstream and the haul line attached to it will move along with the boat sweeping downstream and colliding with any object in its path.

FIGURE W75. Rescuers remain outside the bight formed by a mechanical advantage system and on the upstream side of the line. This practice protects rescuers in the event equipment failure and the sudden forces that could be dissipated.

Boat Pins and Salvages

A pinned boat is typically held in place by the force of the water upon finding an equilibrium point. Upsetting this balance by initiating a small amount of movement can get a boat under enormous pressure released successfully.

FIGURE W76. Pinned craft.

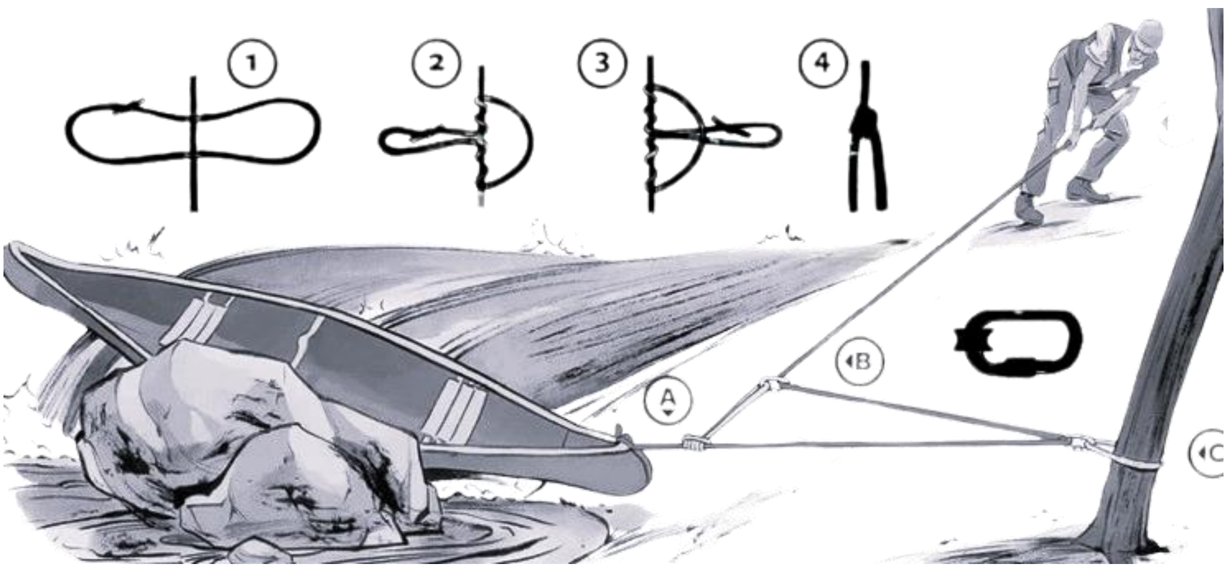


FIGURE W77. It may necessary to rig more than one line to facilitate the removal of a pinned boat.

Analyze the situation in detail before you take action. There is nothing more frustrating than spending considerable time rigging a haul line and anchor system only to find out the angle of pull is all wrong. As carpenters say, "measure twice, cut once." Avoid setbacks with a good plan the first time. This will require an experienced eye to determine how to best overcome the problem.

Stranded Vehicle Rescue Operations

- ***Half of all swiftwater fatalities are vehicle related.***
- ***As little as six inches of water will cause you to lose control of your car.***
- ***Two feet of water will carry most cars away.*** [10]

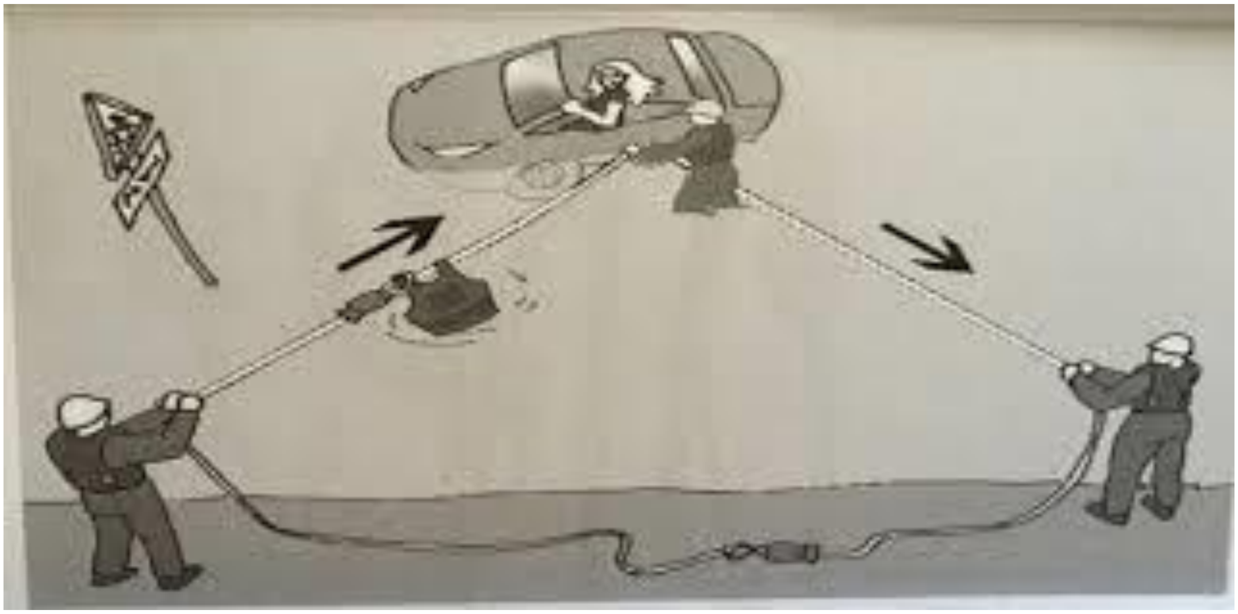
The standard sedan type vehicle will have approximately 600 lbs. of water pressure against it in a surface current as slow as 6 mph. Each foot of water depth will displace approximately 1500 lbs. of vehicle weight. So, only a few feet of water can float a vehicle downstream.

Quick assessment of the situation and rescue site is imperative. The vehicles' stability may depend on the type of surface it is sitting on. Concrete, sand, or a rock surface will affect the vehicles' stability differently. If a vehicle tumbles, escape may become impossible and is hazardous to the rescuers, weather the victim is still inside or has escaped to the roof, the weight of the passenger may be all that is keeping the vehicle from being swept away. A shallow water crossing, continuous loop technique, or a simple two or four point boat tether may, be all that is necessary to recover the victim. Whichever rescue technique is used, the rescuers should be aware of the following; Never approach a vehicle from the upstream side to perform a rescue, you could be pinned against the vehicle or worse yet sucked underneath the vehicle and become pinned to the undercarriage.

Approach from the downstream side of the vehicle, there is usually an eddy created by the vehicle. Be aware though that the eddy on a vehicle rescue is not the safest place it normally is out in the river, although it is the calmest and safest place to be in a vehicle rescue. The rescuers in the water and on the shore should be aware that the vehicle could be swept downstream or tumble, also remember the victims weight maybe all that is keeping the vehicle stationary.

FIGURE W78 Rescue of vehicle driver in flood waters.

FIGURE W79. Continuous Loop Technique



The **Continuous Loop Technique** is best employed for distances not exceeding 75 feet and in conditions where a wading rescue can be safely affected.

Connect up to three throw bag lines together or employ a single long section of water rescue rope. One rescuer wades out to the subject while belayed by two rescuers on shore, with the rope running through their hands only (no body belay). Upon reaching the subject, the initial rescuer remains in place, and all three rescuers now form a triangle. The rescuers belay the line through their hands. If the subject is capable, they wade back to shore supported by the moving line.

Alternatively, an additional rescuer can be employed to assist a subject to shore. Once the rescue is complete, the rescuer off-shore wades back, being belayed by the rescuers on shore.

If the passengers are still inside the vehicle and there is a substantial cushion of water on the upstream side of the vehicle, DON'T punch the window on the downstream side since drastic decompression can blow all the glass explosively and you may lose the victims as well.

Vehicles that are facing straight on to the current are more stable than those that are sideways in the current. Again when removing victims from the vehicle, be aware that their weight may be all that is keeping the vehicle from floating.

FIGURE W80. Anticipate that a vehicle oriented across the current vector will likely roll over.

Helicopter Swiftwater Operations

Helicopters can, with adequate training and proficiency be deployed effectively for swiftwater responses. Hoist and short-haul techniques can be employed to insert rescuers and extract subjects stranded by swiftwater. Limitations include available daylight, wind conditions, and pilot proficiency. Preplanning and prior training are a necessity to make this occur without operational deficiencies. Aircraft accidents account for the largest category of SAR related fatalities within the WASH. Effective decision-making and planning can avoid an accident.

AVIATION RISK MANAGEMENT

Within the limits of safety, weather, and performance capability, the helicopter can be a valuable resource in SAR operations. It is vital that this resource be applied appropriately during swiftwater emergencies. Discipline is required of rescuers to not let the urgency of the

All personnel aboard DOI-AM carded aircraft will wear personal protective equipment per existing park and Departmental Manual policy. Low-level flights over water beyond glide distance to shore expose a flight crew to added risk. Prior to initiating such a flight, consideration will be given to the need for flight crew personnel to don an approved helicopter crew flotation vest and receive a water-ditching briefing. The need for this action is at the discretion of the incident commander and helicopter manager based on the actual mission and exposure of the flight. Crew flotation vests may be required for low-level searches over large rivers. It is recommended that personnel involved in such flights complete Water Ditching and Survival Training (A-312).

The concept of *Crew Resource Management* (CRM), where each member of the aviation operation assumes a pro-active and responsible role in the safety of the mission, needs to be promoted and adhered to.

The Four M's of Aviation Risk Assessment:

METHOD - Appropriate method for the task?
MEDIUM - Safe working environment for the aircraft?
MAN - Adequate trained personnel to manage the aircraft? Pilot carded?
MACHINE - Aircraft carded? Task within performance limitations of the aircraft?

FIGURE W81. Hoist-equipped rescue helicopter.

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Chapter

Eight

FLOOD & SWIFTWATER MEDICAL CONSIDERATIONS

Medical Considerations

Submersion Injuries

Submersion refers to a patient's head being underwater, as opposed to an immersion injury, where their head remains above the water surface.[11] "Near drowning" means a person almost died from not being able to breathe (suffocating) under water. Once a subject is rescued from a near-drowning situation, immediate medical assistance is critical.

A reduced concentration of oxygen in the blood (hypoxemia) is common to all near-drownings. Human life, of course, depends on a constant supply of oxygen-laden air reaching the blood by way of the lungs. When drowning begins, the larynx (vocal cords) closes involuntarily, preventing both air and water from entering the lungs. In 10-15% of cases, hypoxemia results because the larynx stays closed. This is called "dry drowning." Hypoxemia also occurs in "wet drowning," the 85-90% of cases where the larynx relaxes and water enters the lungs. Typically within three minutes of submersion most people are unconscious, and within five minutes the brain begins to suffer from lack of oxygen. Abnormal heart rhythms (cardiac dysrhythmias) often occur in near-drowning cases, and the heart may stop pumping (cardiac arrest).

An increase in blood acidity (acidosis) is another consequence of near-drowning, and under some circumstances near-drowning can cause a substantial increase or decrease in the volume of circulating blood. Many victims experience a severe drop in body temperature (hypothermia).

Treatment begins with removing the victim from the water and performing cardiopulmonary resuscitation (CPR). The victim is also checked for head, neck, and other injuries, and fluids are given intravenously. Hypothermia cases require careful handling to protect the heart.

Patients can be discharged from the emergency department after four to six hours if their blood oxygen level is normal and no signs or symptoms of near-drowning are present. Because lung problems can arise 12 or more hours after submersion, the medical staff must first be satisfied that the patients are willing and able to seek further medical help if necessary. Admission to a hospital for at least 24 hours for further observation and treatment is a must for patients who do not appear to recover fully in the emergency department.

Early rescue of near-drowning victims (within five minutes of submersion) and prompt CPR (within less than 10 minutes of submersion) appear to be the best guarantees of a complete recovery.[12] If a person has been under water for LESS than one hour, full resuscitative efforts should be employed. If a person has been under water for MORE than one hour, resuscitation efforts are usually unsuccessful, and should not be started.[13]

Hypothermia

Hypothermia involves a drop in body temperature below the point of normal metabolism and bodily functions to occur.

Hypothermia Symptom and Treatment Chart

The following general procedures assume a rescuer has no special medical training or equipment:

<table>
<tr><th>Symptoms</th><th>Treatment</th></tr>
<tr><td colspan="2">Mild Case: Body temperature is 97 - 93° F (36.1 - 33.9° C)</td></tr>
<tr><td>Shivering
Cold hands and feet
Still alert and able to help self
Numbness in limbs, loss of dexterity, clumsiness
Pain from cold</td><td>Prevent further heat loss.
Allow body to re-warm itself.
Warm, sweet drinks - no alcohol.
Apply gentle heat source.
Help victim exercise.
Keep victim warm for several hours, with head and neck covered.</td></tr>
<tr><td colspan="2">Moderate Case: Body temperature is 93 – 90° F (33.9 – 32.2° C)</td></tr>
<tr><td>Shivering may decrease or stop</td><td>Same as above, EXCEPT:
Limit exercise.
Offer warm, sweet liquids only if victim is fully conscious, begins to re-warm, and is able to swallow – no alcohol.</td></tr>
<tr><td colspan="2">Severe Case: Body temperature is 90 – 82° F (32.2 – 27.8° C)</td></tr>
<tr><td>Shivering decreases or stops
Confusion, abnormal behavior, i.e, loss of reasoning and recall
Clumsiness
Slurred speech
Denies problem, may resist help
Semiconscious or unconscious
Muscular rigidity increases</td><td>Obtain medical advice/help as soon as possible.
Avoid jarring victim - rough handling may cause cardiac arrest or ventricular fibrillation of heart.
No food or drink - no alcohol.
Ignore pleas of "Leave me alone." Victim is in serious trouble.
Treat as for shock – lay down in bunk, wedge in place, elevate feet.
Apply external mild heat to head, neck, chest, and groin - keep temperature from dropping, while avoiding too rapid a temperature rise.
Transport to hospital.</td></tr>
<tr><td colspan="2">Critical Case: Body temperature is less than 82° (< 27.8° C)</td></tr>
</table>

Symptoms	Treatment
• Unconscious, may appear dead • Little or no apparent breathing • Pulse slow and weak, or no pulse found • Skin cold, may be bluish-gray color • Pupils may be dilated • Rigid body	• Assume patient is revivable; don't give up. • Handle with extreme care. • Tilt the head back to open the airway – look, listen and feel for breathing and pulse for one to two minutes. • If there is breathing or pulse no matter how faint or slow, do not give CPR, but keep a close watch for changes in vital signs. • If no breathing or pulse is detected for one to two minutes, begin CPR immediately. Medical help is imperative – hospitalization is needed. • Stabilize temperature with external heat sources, and/or use rescuer's breath exhaled in victim's face in unison with victim's breathing.

Treating Hypothermia[14]

First aid goals include:

- preventing further heat loss.
- re-warming the victim.
- quickly getting professional medical help as needed.

Minimize the victim's physical exertion when removing her or him from cold water. Rescuers may have to enter the water to get the victim. Once out of the water, gently **remove wet clothing** and **cover the person with dry clothing or blankets. Protect the victim from wind, especially around the head and neck.** Move them to a warm environment if possible and avoid re-exposure to the cold. Warm compresses and warm (not hot) liquids that are non-alcoholic and non-caffeinated also help to restore heat.

Other recommendations include applying hot water bottles (maximum temperature of 115° F (46° C)) or hot, damp cloths to the victim's head, neck, trunk, and groin (change the water periodically to ensure a constant temperature). Exhale into the victim's face as s/he inhales. Immerse the victim's trunk but keep the arms and legs out of a warm bath (maximum temperature of 115° F (46° C)).

If you are helping a hypothermic person, be gentle; internal organs are sensitive to physical shocks. The victim should remain as inactive as possible so blood from their cold extremities won't reach their core too quickly. A cold heart is particularly susceptible to ventricular fibrillation. During all first aid efforts, watch for changes in the victim's temperature and vital signs. **"After drop" is a danger when re-warming hypothermia victims because cold blood in the extremities returns to the body core, lowering the core temperature further.**

Hypothermia victims with moderate to critical symptoms should see a medical professional as soon as possible.

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[14] Minnesota Sea Grant Hypothermia Prevention: Survival in Cold Water. University of Minnesota. 31 West College Street. Duluth, MN 55812. (218) 726-8106. Posted April 2012. http://www.seagrant.umn.edu/coastal_communities/hypothermia#time. Accessed 08-25-2012

The body-to-body rewarming controversy

Some medical professionals and rescue personnel recommend rewarming mildly hypothermic victims in the field with body-to-body contact (in other words, by sharing body heat). However, research suggests that this technique may not be beneficial. The rationale comes from the fact that the person offering up their body heat is giving about as much heat as they are taking away by restricting the victim's shivering response. And, the heat donor becomes colder in the process.

In a study[15] evaluating whether body-to-body rewarming would enhance the recovery of a mildly hypothermic subject, researchers found that sharing body heat was approximately as effective as letting a person rewarm from their own shivering.

In a different study[16], researchers simulated severe hypothermia by suppressing a victim's shivering response. In cases where a person cannot shiver themselves back to normal, they report that body-to-body rewarming yields a faster recovery than letting a victim passively rewarm but it is significantly less effective than applying a heater and a rigid cover to the victim's chest.

Alcohol consumption increases the odds of developing hypothermia

Alcohol consumption can speed the onset and progression of hypothermia. Alcohol impairs motor skills, magnifies the torso reflex, and affects clear thinking. As the alcohol level in a person's body increases, coordination abilities decrease. At high doses, alcohol damages thermoregulation, which lowers the body's resistance to cold water.

What is the mammalian diving reflex?

The *mammalian diving reflex* is an innate response to cold water exhibited by mammals – including humans. Cold water contacting the face triggers the reflex, which shunts blood and available oxygen to the heart and brain. **It lowers the heart rate and limits blood circulation to all but the body's core.** Water warmer than 70° F does not cause the reflex, and neither does plunging non-facial body parts into cold water. Children younger than 3 years old exhibit the reflex more dramatically than adults. The diving reflex enables some children to survive for an unusually long time in frigid water.

Because of the diving reflex, near-drowning victims have been revived after as long as one hour under cold water. The chances for surviving depend on water temperature (colder is better), length of time under water, age of the person (younger is better), and rescue efforts.

World Academy of Safety & Health

Chapter

Nine

FLOOD & SWIFTWATER SPECIAL SCENARIOS

Special Scenarios

Large Volume Rivers

Many swiftwater rescue techniques that work effectively on smaller rivers, such as wading rescues, tethered swimmer and rescue throw bags have significant limitations on wider rivers with larger volumes of water. Deploying a downstream safety with a throw bag may be useless in some situations. In high volume scenarios a motorized boat, kayaker, or a swimmer with a riverboard is a much better plan.

Recognize the limitations of certain techniques during training in order to develop the knowledge to judge when it won't work during a rescue. Use this knowledge to develop a workable pre-pan that causes you to reach for the right technique(s) in the heat of the moment.

Recovery Operations

Once it is clear that a subject has not and the incident has shifted to a recovery phase, the urgency of the mission is reduced. Take your time to develop a thorough plan for any continued operational efforts. Strategize on how further efforts can be successful and develop a sound recovery plan that makes sense. Look at effective timing, techniques, and risk management. Be certain to ask "how can the plan fail" and develop numerous contingencies to combat potential deficiencies.

When executing the recovery plan brief all involved agencies and personnel thoroughly. If the initial plan is not successful, be prepared to adapt your strategy. Don't press on with an ineffective plan that eventually gets someone hurt.

FIGURE W82A & B. Rescue efforts involving complex rigging.

Night Operations

Swiftwater rescue operations conducted at night involve significantly increased risk due to the inability to see hazards and the difficulty with maintaining accountability of personnel. A mission may start during the day and progress into darkness. This is an important reminder of the need for all rescuers to be responsible for their own personal preparedness. Having personal lighting, strobes, gear with retro-reflective material, hydration fluids, snacks, etc., all enhance operational effectiveness.

The increased hazard of working at night requires important considerations including:

- Personal lights and strobes
- Scene lighting
- Communications
- Identified or marked hazards
- Personal accountability

Scene lights illuminating the area should be deployed for rescuer safety. The sound of generators or emergency apparatus idling to power scene lights combined with the noise of the swiftwater will easily degrade scene communications.

Consider the following:

- Are you working toward a viable subject?

- Can the mission be suspended and resumed in the morning?

- Does it make sense to proceed in the dark?

Conclusion

This text provides a foundation for your knowledge base as a swiftwater rescuer. Develop proficiency and then mastery in the field through repeated training sessions. Train in different environments and conditions. When you are called upon to perform a swiftwater rescue, you will be ready.

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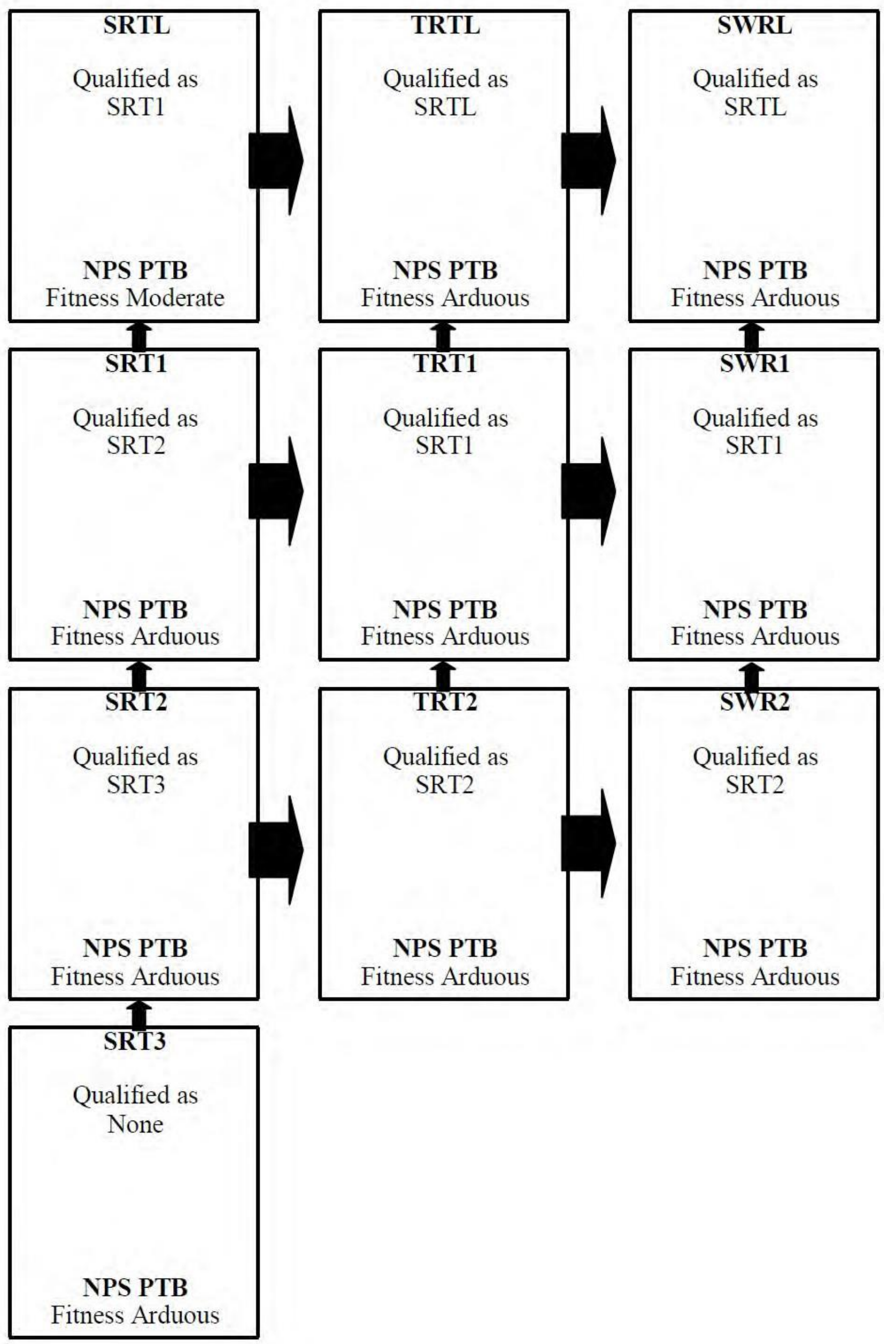
Appendix A- Flood & Swiftwater Terminology

- **Boil Line**- point downstream of hydraulic the where recirculated water meets with downstream flow unaffected by hydraulic.
- **Bottom Load**- debris in the waterway, which is negatively buoyant. This creates a hidden danger below the surface.
- **Boulder Sieve**- collection of boulders in the river channel that acts as a strainer.
- **Chute**- clear tongue of water flowing between two obstacles.
- **Cold Reflex**- (*also known as the gasp reflex or inhalation response*) is a physiological reaction – an involuntarily gasp – that happens when a person suddenly enters cold water. The reflexive sucking in of air is a way for the body to rapidly increase oxygen intake into the lungs as a means of increasing survival.
- **Confluence**- junction of two or more water features.
- **Current Vector**- Strongest laminar flow in a channel may not be parallel to shoreline (e.g., bend in the channel). Ability to identify is an essential skill for a swiftwater rescuer.
- **Cushion**- see "pillow."
- **Downstream**- direction water is travelling.
- **Downstream V**- point of V (tongue) is downstream. Formed by flow between two obstacles. Indicates deepest, cleanest route.
- **Eddy**- horizontal reversal of water flow where the differential between the current's pressure on the upstream and downstream sides of an obstacle in a channel causes the water behind the obstacle to flow upstream. Serves as an excellent area to rest or scout.
- **Eddy Fence**- dividing line between laminar flow and the eddy.
- **Eddy Line**- obvious line or demarcation in the river, where the current moves in opposite directions on either side.
- **Eddy Turn**- Maneuver employed by a boat to leave the main current and enter an eddy.
- **Entrapment**- The process by which an extremity or a subject's entire body is forced into a crack, crevice, or undercut and pinned there by the force of the current.
- **Ferry Angle**- 45 degree angle to current vector. Using the proper ferry angle allows you to efficiently have the river work for you.
- **Flood Control Channel**- man-made watercourse constructed for the purpose of moving floodwaters out of urban areas. This steep sloping wall of concrete channels adds difficulty to a basic shoreline rescue. Anyone operating near this type of channel must be secured with at minimum a belay line with a quick release harness.
- **Frowning Hole**- strongest reversal is side to side. Trying to exit to the side results in being pushed back to the center. Exit is down.
- **Gradient**- amount of elevation loss between two points on a river. Typically expressed as feet per mile or percent of slope.
- **Haystack or Standing Waves**- remain stationary in the channel.
- **Helical Flow**- The corkscrew flow of the water between the shoreline and main current.
- **High Side**- Shifting the weight of a boat crew to the high (i.e., downstream) side of a boat to prevent flipping. This is done when a boat washes up against an obstacle, hits a large breaking wave, crosses a eddy line, or caught in a hole.
- **Hole**- A river wave, usually caused by an underwater obstacle that breaks back upstream. A hole is a surface phenomenon; it may flip or hold a buoyant object like a watercraft but it will not recirculate a swimmer.
- **Horizon Line**- appearance of a horizon downstream on a river formed by the steep gradient. This is an indicator for an on-shore scout.

- **Humps**- indication of an obstacle beneath the surface. Avoid these features when observing this visual cue.
- **Hydraulic**- formed by water pouring over an obstruction. A low pressure area is formed on the back side of the object. Water is drawn from downstream to fill this void. The recirculation of water frequently traps victims and debris. Known affectionately as “keeper,” “stopper,” or “maytag”.
- **Laminar Flow**- layered downstream flow of the river’s main current. The layer in the center just below the surface moves the fastest, while the side and bottom layers are slowed somewhat by friction.
- **Low Head Dam**- man-made obstruction with a sustained reversal that extends from one side of channel to the other. When a low head dam has sufficient water flow, a continuous "hole" may extend across the downstream side of the feature. If a subject is trapped in the recirculating hydraulic, they will quickly drown and unless they can escape the recirculating motion.
- **Pillow**- found at upstream side of obstacles. Water pushes up into a higher mound on the upstream side of the obstacle, which forms a cushion pushing away objects like boats from it. These are also known as “cushions.”
- **River Right**- right shoreline looking downstream.
- **River Left**- left shoreline looking downstream.
- **Smiling Hole**- appearance from upstream. Strong reversal in center with downstream current on either side. Exit to the sides.
- **Strainer**- Any river obstacle that allows water but not solid objects to pass through it. This is extremely dangerous for swimmers who may be pinned against the object by the force of the water running through it. Strainers are most commonly formed by trees, brush, or other debris.
- **Surface Load**- debris that is positively buoyant.
- **Suspended Load**- neutrally buoyant debris (e.g., silt).
- **Swiftwater**- water over two feet deep that is flowing at a rate greater than one knot (1.15 mph) occurring in a natural water course, flood control channel, or flood-related incident.
- **Upstream**- the direction water is coming from.
- **Upstream V**- hydraulic effect creating a V, which points upstream. It is caused by caused by an obstruction that is just beneath the surface. Avoid.
- **Volume**- amount of water in a river, which is determined by the measurement of water flowing past a given point in one second and expressed as cubic feet per second (cfs) of cubic meters per second (cms).
- **Waves**- flow affected by obstacles or constrictions.
- **Whitewater**- collective term referring to “aerated water.”

Appendix B- DOI All-Hazard SAR Position Qualifications

Operations Positions – Search and Rescue



Final Exam – Flood & Swiftwater Rescue Course

Directions:

- **The final exam must be proctored by a World Academy of Safety & Health (WASH) Authorized Instructor in good standing, authorized to deliver this WASH training program/course, and working under the direction of a current Authorized Training Center (ATC).**
- **To successfully complete this final exam, a minimum score of 80% must be earned.**
- **This final exam is a closed book exam.**
- **The signatures of both the WASH Authorized Instructor S.1, S.2, S.3 and the participant must be present on the last page of the final exam booklet along with the date signed/completed.**

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Flood & Swiftwater Rescue – Final Exam Name: ___________________________

1.	What does LARU stand for in swiftwater rescue?
	A) Large Animal Rescue Unit B) Low Angle Rescue Unit C) Long Arm Reach Unit D) Land and River Unit Answer: B) Low Angle Rescue Unit
2.	Which of the following is NOT a primary role of a swiftwater rescue technician?
	A) Perform self-rescue techniques B) Conduct water-based searches C) Assist in helicopter operations D) Handle hazardous materials Answer: D) Handle hazardous materials
3.	What is the primary objective of a shore-based swiftwater rescue operation?
	A) Provide medical care to victims B) Maintain communication with the incident commander C) Secure the rescue scene D) Deploy watercraft for rescue Answer: C) Secure the rescue scene
4.	What is the purpose of a throw bag in swiftwater rescue?
	A) To provide flotation to the rescuer B) To anchor a rope across the river C) To throw to a victim for self-rescue D) To inflate a rescue raft Answer: C) To throw to a victim for self-rescue
5.	What is the recommended technique for crossing swiftwater on foot?
	A) Walk upstream at a diagonal angle B) Swim aggressively to reach the other side quickly C) Use a rescue harness for stability D) Dive and swim underwater Answer: A) Walk upstream at a diagonal angle
6.	Which type of knot is commonly used in swiftwater rescue for creating anchor points?
	A) Bowline knot B) Square knot C) Clove hitch D) Figure-eight knot Answer: D) Figure-eight knot
7.	In swiftwater rescue terminology, what does "strainer" refer to?
	A) A type of rescue boat B) An obstruction that allows water to pass through but not objects C) A rope used for throwing to victims D) A rescue technique for entangled victims Answer: B) An obstruction that allows water to pass through but not objects
8.	What is the purpose of a personal flotation device (PFD) in swiftwater rescue?
	A) To provide warmth to the rescuer B) To improve visibility in the water C) To keep the rescuer buoyant D) To carry rescue equipment Answer: C) To keep the rescuer buoyant
9.	What is the role of a safety officer in a swiftwater rescue operation?
	A) Lead the rescue team B) Provide medical assistance to victims C) Ensure safety protocols are followed D) Coordinate helicopter evacuations Answer: C) Ensure safety protocols are followed
10.	What is the primary hazard associated with strainers in swiftwater?

A) Drowning B) Hypothermia C) Entrapment D) Collisions with rocks Answer: C) Entrapment

11. What does "reach, throw, row, and go" refer to in swiftwater rescue?

    A) The order of operations in a rescue scenario B) Communication protocols between rescuers C) Types of rescue equipment D) Navigation techniques in swiftwater Answer: A) The order of operations in a rescue scenario

12. Which of the following is NOT a category of swiftwater rescue equipment?

    A) Personal protective gear B) Communication devices C) Watercraft for transportation D) Food supplies for victims Answer: D) Food supplies for victims

13. What is the primary purpose of conducting a risk assessment before a swiftwater rescue operation?

    A) Determine the number of rescuers needed B) Identify potential hazards and safety concerns C) Establish communication with local authorities D) Plan the evacuation route for victims Answer: B) Identify potential hazards and safety concerns

14. Which of the following is a common technique for stabilizing a victim in swiftwater?

    A) Using a rescue sled for transportation B) Applying a tourniquet to control bleeding C) Creating a human chain to support the victim D) Administering oxygen therapy Answer: C) Creating a human chain to support the victim

15. What is the purpose of using a throw bag with a floating rope in swiftwater rescue?

    A) To mark the location of a victim B) To create a temporary anchor point C) To provide buoyancy to the rescuer D) To tow rescue equipment across the river Answer: B) To create a temporary anchor point

16. What does "reach" refer to in the "reach, throw, row, and go" sequence?

    A) Reaching out to grab a victim B) Assessing the reachability of the victim C) Using a reach pole or extended arm to assist a victim D) Moving swiftly to the rescue scene Answer: C) Using a reach pole or extended arm to assist a victim

17. In swiftwater rescue, what is the primary purpose of setting up a perimeter?

    A) Restricting access to the rescue scene B) Providing shade for victims C) Marking the location of rescue equipment D) Establishing a landing zone for helicopters Answer: A) Restricting access to the rescue scene

18. Which of the following is a common hazard associated with swiftwater rescue operations?

    A) Sunburn B) Electrical shock C) Dehydration D) Foot entrapment Answer: D) Foot entrapment

19. What is the recommended procedure for approaching a victim in swiftwater?

    A) Swim directly toward the victim B) Approach from downstream to avoid being swept past the victim C) Use a watercraft for approach D) Yell loudly to get the victim's attention Answer: B) Approach from downstream to avoid being swept past the victim

20. What does the acronym "SAR" stand for in the context of swiftwater rescue?

    A) Swift Assistance Response B) Search and Rescue C) Safety at Riverbanks D) Swiftwater Assistance Request Answer: B) Search and Rescue

21. Which of the following is NOT a recommended action during a swiftwater rescue operation?

A) Use alcohol-based hand sanitizers frequently B) Wear appropriate personal protective equipment C) Communicate clearly with team members D) Maintain situational awareness Answer: A) Use alcohol-based hand sanitizers frequently

22. What is the purpose of conducting a post-rescue debriefing session?

A) Evaluate the performance of rescue equipment B) Celebrate successful rescues C) Identify lessons learned and areas for improvement D) Plan future rescue operations Answer: C) Identify lessons learned and areas for improvement

23. Which of the following is an example of a swiftwater rescue hazard assessment tool?

A) Incident action plan B) Job safety analysis C) Incident response checklist D) Watercraft inspection form Answer: B) Job safety analysis

24. What is the primary responsibility of a shore-based lookout in swiftwater rescue?

A) Perform water-based rescues B) Monitor and report hazards and changes in conditions C) Coordinate communication between rescue teams D) Provide first aid to victims Answer: B) Monitor and report hazards and changes in conditions

25. What does the acronym "PPE" stand for in swiftwater rescue?

A) Personal Protective Equipment B) Primary Prevention Effort C) Public Participation Engagement D) Personal Preparedness Exercise Answer: A) Personal Protective Equipment

26. Which of the following is a recommended communication protocol in swiftwater rescue operations?

A) Use of hand signals only B) Use of radios with secure channels C) Yelling loudly to communicate across distances D) Sending text messages via smartphones Answer: B) Use of radios with secure channels

27. What is the primary objective of establishing a command structure in swiftwater rescue?

A) Assigning tasks to rescuers B) Ensuring effective communication and coordination C) Documenting rescue operations D) Evaluating rescue equipment Answer: B) Ensuring effective communication and coordination

28. What is the purpose of conducting pre-incident planning for swiftwater rescue scenarios?

A) Create a timeline for rescue operations B) Assign specific roles to rescuers C) Identify potential hazards and resources D) Schedule regular training exercises Answer: C) Identify potential hazards and resources

29. Which of the following is a common sign of hypothermia in a victim during swiftwater rescue?

A) Increased heart rate B) Profuse sweating C) Pale skin color D) Rapid breathing Answer: C) Pale skin color

30. What is the primary role of an incident commander in swiftwater rescue operations?

A) Perform technical rescue maneuvers B) Coordinate overall rescue efforts C) Provide medical care to victims D) Assist in helicopter operations Answer: B) Coordinate overall rescue efforts

31. What is the purpose of conducting a scene size-up in swiftwater rescue?

A) Estimate the number of victims B) Assess the size of the water body C) Evaluate potential hazards and risks D) Determine the location of rescue equipment Answer: C) Evaluate potential hazards and risks

32. Which of the following is a common method for rescuing a victim trapped in fast-moving water?

    A) Deploying a rescue raft B) Using a helicopter hoist C) Conducting a shore-based rescue D) Performing a rapid extrication Answer: D) Performing a rapid extrication

33. What is the recommended procedure for removing a victim from swiftwater using a rescue sling?

    A) Secure the victim's head first B) Lift the victim directly out of the water C) Place the sling under the victim's arms D) Use the sling as a flotation device Answer: A) Secure the victim's head first

34. Which of the following is a common hazard associated with swiftwater rescue boats?

    A) High water visibility B) Low maneuverability in fast currents C) Ability to navigate shallow waters D) Use of inflatable materials for buoyancy Answer: B) Low maneuverability in fast currents

35. What does "straddle" refer to in swiftwater rescue techniques?

    A) Crossing a river using a straddle position B) Using a straddle stance for stability C) Creating a straddle raft for rescue D) Employing a straddle lift for extrication Answer: B) Using a straddle stance for stability

36. Which of the following is a common hazard associated with floodwaters in swiftwater rescue?

    A) Reduced water flow B) Decreased water depth C) Debris and contaminants D) Absence of swift currents Answer: C) Debris and contaminants

37. What is the purpose of conducting regular equipment checks in swiftwater rescue operations?

    A) Ensure proper storage of equipment B) Identify damaged or malfunctioning equipment C) Coordinate equipment rental for rescue teams D) Document equipment usage for reporting Answer: B) Identify damaged or malfunctioning equipment

38. What does "downstream safety" refer to in swiftwater rescue operations?

    A) Safety measures for downstream communities B) Techniques for navigating downstream currents C) Procedures for ensuring rescuer safety in the water D) Mitigating hazards for downstream personnel Answer: D) Mitigating hazards for downstream personnel

39. Which of the following is a common technique for managing a swiftwater rescue scene?

    A) Use of barricades to control access B) Allowing untrained volunteers to assist C) Ignoring bystanders' input D) Delaying medical assessment of victims Answer: A) Use of barricades to control access

40. What is the recommended procedure for communicating with victims during a swiftwater rescue?

    A) Use technical jargon to maintain professionalism B) Speak loudly and assertively to command attention C) Use clear and reassuring language D) Avoid direct eye contact with victims Answer: C) Use clear and reassuring language

41. What does "RPM" stand for in swiftwater rescue operations?

    A) Rescuer Performance Measure B) Riverine Patrol Mode C) Revolutions Per Minute D) Rapid Progression Maneuver Answer: D) Rapid Progression Maneuver

42. Which of the following is a common hazard associated with swiftwater rescue helicopters?

A) Limited maneuverability in tight spaces B) High visibility in adverse weather conditions C) Ability to land directly on water D) Use of floatation devices for stability Answer: A) Limited maneuverability in tight spaces

43. What is the primary purpose of establishing escape routes during a swiftwater rescue operation?

A) Ensure rescuer safety in case of emergencies B) Provide alternative access points for victims C) Coordinate evacuation of bystanders D) Secure perimeter boundaries Answer: A) Ensure rescuer safety in case of emergencies

44. Which of the following is a recommended action for swiftwater rescue personnel during thunderstorms?

A) Continue rescue operations as usual B) Seek shelter immediately C) Use metal equipment for better conductivity D) Increase water-based activities Answer: B) Seek shelter immediately

45. What is the purpose of conducting pre-dive checks for swiftwater rescue divers?

A) Evaluate water temperature for diving suitability B) Ensure proper functioning of diving equipment C) Coordinate dive team assignments D) Schedule dive training sessions Answer: B) Ensure proper functioning of diving equipment

46. Which of the following is a common technique for stabilizing a victim on a rescue board in swiftwater?

A) Using ropes to secure the victim's limbs B) Positioning the victim face-down for better visibility C) Performing CPR while on the rescue board D) Keeping the victim's head elevated Answer: D) Keeping the victim's head elevated

47. What is the recommended procedure for securing a swiftwater rescue boat during rescue operations?

A) Anchor the boat to a stationary object B) Use the boat's engine to maintain position C) Tie the boat to a rescue sling D) Inflate the boat's pontoons for stability Answer: A) Anchor the boat to a stationary object

48. What does "dynamic risk assessment" refer to in swiftwater rescue operations?

A) Assessing risks based on historical data B) Continuously evaluating and adapting to changing conditions C) Conducting risk assessments during nighttime operations D) Risk assessment conducted by external agencies Answer: B) Continuously evaluating and adapting to changing conditions

49. Which of the following is a common technique for managing multiple victims in swiftwater rescue?

A) Assigning one rescuer per victim B) Conducting triage to prioritize rescue efforts C) Using loudspeakers for communication D) Ignoring minor injuries to focus on critical cases Answer: B) Conducting triage to prioritize rescue efforts

50. What is the purpose of conducting swiftwater rescue simulations and drills?

A) Practice coordination with other emergency services B) Test the effectiveness of rescue equipment C) Simulate real-life rescue scenarios for training purposes D) Improve communication with bystanders Answer: C) Simulate real-life rescue scenarios for training purposes

Final Exam Score: __________________%

Instructor Name: __________________

Instructor ID #: ______________

Instructor Signature: ___________________

Date: _________________

Instructor Training Center Affiliation:

____

Print Form

Appendix D

World Academy of Safety & Health

WASH INTERNATIONAL ANNUAL 'WATERMAN' TEST

Parameters
There are five exercises that evaluate stamina and comfort in the water, each rated by points.
The diver must successfully complete all stations and score a minimum of 12 points to pass the test.
The test should be completed with not more than 15 minutes between exercises.

Exercise 1: 500 Yard Swim
Participant must swim 500 yards without stopping using a forward stroke and without using any swim aids such as a mask, fins, snorkel, or flotation device. Stopping or standing up in the shallow end of the pool at any point will result in a score of 0/DNF/Incomplete.

Criteria	Points
Less than 10 Minutes	5
10-12 Minutes	4
13-15 Minutes	3
16-18 Minutes	2
19 Minutes or More	1
Stopped	0/DNF/Incomplete

Exercise 2: 15 Minute Tread
Using no swim aids and wearing only a swimsuit the participant shall tread water, bob or float for 15 minutes with hands out of the water during the final two (2) minutes.

Criteria	Points
Remained afloat with hands out of water for final 2 minutes	5
Remained afloat - did not keep hands out of water for final 2 minutes	3
Supported oneself on bottom and/or side at least 1 time	1
Supported oneself on bottom and/or side 2 or more times	0/DNF/Incomplete

Exercise 3: 800 Yard Snorkel Swim
Using mask and snorkel as well as fins (no BCD or other flotation aid), the participant must swim 800 yards non-stop with his/her face in the water. At no time may the participant use his/her arms to swim.

Criteria	Points
Less than 15 minutes	5
16-17 Minutes	4
18-19 Minutes	3
20-21 Minutes	2
Greater than 21 Minutes	1
Stopped	0/DNF/Incomplete

Exercise 4: 100 Yard Rescue Tow

The swimmer must push or tow a victim wearing appropriate PPE on the surface 100 yards non-stop and without assistance.

Criteria	Points
Less than 2 minutes	5
3-4 minutes	4
5-6 minutes	3
7-8 minutes	2
Greater than 5 minutes	1
Stopped	0/DNF/Incomplete

Exercise 5: Free Dive to a depth of nine feet and retrieve a 10-pound object

Criteria	Points
Retrieved object and returned to surface with object	Pass/Complete
Failed to retrieve object and/or return to the surface with the object	0/DNF/Incomplete

Appendix E – Flood & Swiftwater Skills Assessment Form (FSWSAF)

World Academy of Safety & Health

P.O. Box 311 Riderwood, MD 21139 U.S.A. Ph: 1-800-484-0419 E: admin@lifeguardcertifications.com Web: lifeguardcertifications.com

Skills Assessment Form (FSWSAF) – Flood & Swiftwater Rescue

STUDENT NAME: ______________________________ **DATE:** ____________________

Section/Chapter	Skill	Met Standard	Did Not Meet Standard	Notes:
I.	**Course Pre-Requisites**			
A.	Age Verification – 18 years of age			
B.	WASH 'Waterman' Test			
II.	**Water Rescues:**			
A.	**Entries:**			
1.	Swiftwater Entry			
B.	**Swimmer Skills:**			
1.	Defensive Swimming			
2.	Aggressive Swimming			
3.	Barrel Roll			
4.	Strainer Drill			
C.	**Water Crossings:**			
1.	Tripod Shallow Crossing			
2.	2-Person Wading			
3.	4-Person Huddle			
4.	Pyramid			
5.	In-Line Shallow Crossing			
D.	**Other Crossing Techniques:**			
1.	Line Crossing			
2.	Diagonal Traverse			
D.	**Miscellaneous Rescues:**			
1.	Throw Bag			
2.	Belays & Back-Ups			
3.	Pendulum			
4.	Stabilization Lines			
5.	Snag Lines			
6.	Simple Rope Tether			
7.	Live Bait			
8.	V-Lower			
9.	Simple Cinch			
10.	Knots			
11.	Anchor Systems			
12.	Mechanical Advantage Systems			
13.	Universal River Signals			

IV.	**CPR/AED**				
V.	**First Aid**				
VI.Final Skills	**Final Skills Assessments**				
A.					
B.					
C.					
VII.Exam	Written Exam				

Instructor Name: ___________________________________ Date: ____________________________

Instructor Signature: ________________________________ Instructor Certification ID: ___________

Instructor Training Center Affiliation: ____

Student Name: ____________________________________ Date: ____________________________

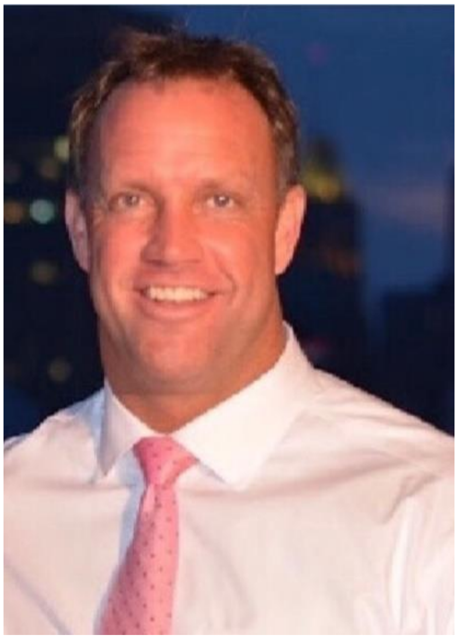
Student Signature: _________________________________

Appendix F - Ten Codes

10-1	Receiving you poorly	10-41	Moved to different channel
10-2	Receiving you well	10-42	Traffic accident located at……
10-3	This channel in use	10-43	Traffic congestion located at……
10-4	Okay, Roger, Yes, I understand	10-44	I have a message for……
10-5	Relay the message	10-45	Stations on this channel identify yourself
10-6	Busy, Not able to talk now	10-50	Break
10-7	Out of service	10-60	What is the next message number
10-8	In service	10-62	Unable to copy your transmission. Use telephone
10-9	Please repeat your last message/transmission	10-63	Net directed to…….
10-10	Was 10-6. Now on call	10-64	Net clear
10-11	Talking to fast	10-65	Awaiting your next message
10-12	Visitors are present	10-67	All units comply
10-13	Advise weather conditions	10-70	Fire at…..
10-16	Make a pick up at	10-71	Proceed with your transmission in code
10-17	Important business	10-73	Ending conversation on radio
10-18	Anything for me/us?	10-77	Not receiving you
10-19	Return to headquarters/base	10-81	Reserve hotel for……
10-20	What is your present location?	10-82	Reserve room for…….
10-21	Contact by telephone	10-84	Telephone number is……
10-22	Make in-person contact with	10-85	Address is……..
10-23	Stand-by	10-89	Radio repairman needed
10-24	Assignment is complete	10-91	Talk closer to the radio mic
10-25	Contact another station by radio	10-92	Adjust your transmitter
10-26	Disregard last message/transmission	10-93	Check my frequency on this channel
10-27	I am changing to channel…….	10-94	Give me a long count
10-28	Proper station identification	10-99	All units
10-29	Time is up for contact	10-100	Rest stop
10-30	Violates regulations	10-200	Police needed at……..
10-31	No longer violating regulations		
10-32	Will advise readability of signal		
10-33	Emergency traffic only on this station		
10-34	In trouble, require assistance		
10-35	Urgent matter cannot discuss via radio		
10-36	Time check		

10-37	Send tow truck		
10-38	Injuries, ambulance required		
10-39	Your message has been delivered		

Biography of President



Jeff Dudley founded World Academy of Safety & Health (WASH) in 2012 in an effort to reduce water-related accidents by providing affordable and accessible training options to all populations. He has worked in aquatics since 1990. During this time, he served as Aquatics Director for Seapointe Village; Training Officer, Medic and Ocean Rescue Lieutenant for the Borough of Cape May Point; Official for the United States Lifesaving Association (USLA) National Lifeguard Championships; and has delivered lifeguard and lifesaving training and in-services across the world to pool and ocean lifeguards; police departments; 911 operators; and fire and EMS departments.

He holds both a bachelor's and master's degree as well as certifications across multiple states in special education, teacher of sciences, administrator I and II. He has worked as an educational professional since 1998 and has held positions of Teacher, Director of Athletics, Dean, Principal, and Head of School in both public and private settings. Dudley has been selected to serve on several school accreditation review committees.

Dudley lives in Baltimore County, Maryland.

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