LOS ANGELES POLICE DEPARTMENT

BOAT CREW

Los Angeles Police Department

Boat Crew Manual

Table of Contents

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Chapter 1: Boat Crew Duties and Responsibilities

Overview

The Los Angeles Police Department boat crew performs duties requiring both skill and knowledge. This chapter discusses general crew duties and related procedures for watchstanding necessary for the successful completion of any mission. The general duties for crew members (Deckhands) are outlined in this chapter. Assignments and procedures for specific tasks, such as towing or retrieving people from the water, are found in other chapters.

The Boat Crew

Introduction

There are two basic boat crew positions:

- Operator
- Crew member or Deckhand

Determining crew size

There are several factors in determining crew size:

- Boat type
- Operational need
- Minimum crew size prescribed by higher authority.
- Tactical obligations and considerations

Qualification and certification

Boat crew members and operators are qualified and certified in accordance with this Manual.

Boat Crew Duties

Introduction

The Boat Operator training program is based on the concept that officers must be trained on the waterway. This manual, and specifically this section, is designed to provide an outline of the duties typically performed by various members of boat crews and the skills and knowledge required to perform tasks assigned. For people seeking to be members of a boat crew, it is fundamental that they understand these duties and the importance of crew members working together as a team.

Crew Member (Deckhand)

General

Crew members safely perform their duties under the supervision of a boat operator. They stand:

- Helm
- Lookout
- Towing watches
- Anchor watch

They also:

- Rig towing and mooring lines
- Administer first aid
- Operate damage control equipment

Performance, skill, and knowledge requirements

To be effective boat crew members must execute orders quickly and must have the following knowledge and performance skills:

- Marlinespike seamanship and line handling
- Basic navigation (including radar) and boat handling
- Survival, safety, and damage control equipment
- Emergency and casualty control
- Watchstanding and communications
- First aid
- Preventive maintenance procedures for the boat in port

Risk management A keen knowledge of the boat's characteristics and limitations, the outfit equipment, and the stowage will be invaluable in times of crisis. Frequent drills practicing the procedures for different emergency circumstances will teach crew members how to react correctly to each situation. All crew members must continuously think about emergency situations and answer the hypothetical question, "What should I do if...?" so it can be instantly put into action when the question becomes, "What do I do now?"

Knowing the operating area Boat crew members must have knowledge of their local Operating Area. *See Chapter 21*

Boat Operator

General All LAPD boats underway shall have a **Boat Operator** on board who is certified by the Unit Commander to operate that particular type of boat. Boat Operators are in charge of the boat and crew. The Boat Operator's duty is unique. Great trust has been placed in the Boat Operator's ability to provide effective boat crew leadership, coordination, and risk management skills.

Responsibility and authority Boat Operators shall be responsible, in order of priority, for the following:

- Safety and conduct of passengers and crew
- Safe operation and navigation of the boat
- Completion of the operation(s) or mission(s)
- Perform pre-start, light off, and securing functions for propulsion machinery.
- Monitor, detect, and respond to machinery and electrical system casualties or failures.
- Preventive maintenance procedures for the boat in port

Boat Operators will respond to the following:

- Hazards to life or property
- Violations of law or regulations

Performance, skill, and knowledge requirements

The knowledge requirements and performance skills for Boat Operators are extensive. Boat Operators must apply good judgment, intelligence, and initiative. They must make decisions with the safety of their crew and boat in mind. In addition to basic crew member skills, a operator requires these additional knowledge and performance skills:

- Demonstrate leadership that effectively coordinates, directs, and guides the performance of the boat crew during watches and tasks (e.g., towing, fog navigation, man overboard, and tactical operations).
- Demonstrate correct application of regulations, policy, and guidance delineated by the unit commander or higher authority to the circumstances at hand (e.g., safe navigation, safe speed, law enforcement, and rendering assistance).
- Know the boat's and crew's limitations:
  - maximum sea conditions boat can operate in
  - maximum wind conditions boat can operate in
  - maximum size of boat that can be towed by your boat
- Navigate and pilot a boat.
- Know the local operating area with minimal reference to charts and publications.
- Demonstrate boat handling skills to safely and prudently control the movement of a boat while underway.
- Understand the principles of risk management and incorporate them into the decision making process. These principles include detection, identification, evaluation, and mitigation or control risk as part of making decisions (e.g., slow to safe speed in restricted visibility, cast off a tow because the assisted vessel is losing stability).
- Thorough understanding of currents, weather, and hydrodynamics. How they pertain to the local bar/inlet conditions.
- Boat handling skills and procedures while operating in surf.
- Boat crew safety and emergency procedures.

Boat Operator Certifications

Introduction

Certain additional certifications can be given to Boat Operators depending upon satisfactory completion of additional training. These certifications denote additional skills, duties, responsibilities and privileges as follows:

Certification Courses:

- Basic Maritime Officers Course-Maritime Law Enforcement Training Center
- Boating Officer Anti-Terrorist Training (B.O.A.T.) - Federal Law
- Enforcement Training Center.
- Commercial Vessel Boarding-Maritime Law Enforcement Training Center

  Advanced Maritime Officers Course-Maritime Law Enforcement Training Center

Offshore Certification:

A Boat Operator with an Offshore Certification issued by the Unit Commander is a Coast Guard Licensed Master and has completed the additional training needed to command an offshore vessel. This training is completed on the job through training check off certification forms, practical evaluations and written testing.

Watchstanding Responsibilities

Introduction

Under the direction of the Boat Operator, crew members are assigned various watches which are described in this section.

Crew member Watch

Requirement

The Navigation Rules state that "Every vessel shall at all times maintain a proper lookout by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision."

Assign and station

A proper lookout must be maintained in order to comply with the requirement noted above. Crew members must report to the Boat Operator everything seen, smelled, or heard while the boat is underway that may endanger the boat or may indicate a situation to investigate (e.g., distress, law enforcement, or pollution). Some examples are:

- Ships
- Land
- Obstructions
- Lights
- Buoys
- Beacons
- Discolored water
- Reefs
- Fog signals
- Anything that could affect safe navigation

It is important for the Boat Operator to consider the experience level and abilities of individual crew members (Deckhands).

Object identification

Crewmembers must report what they see, smell, or hear with as much detail as possible. **Object type** is immediately important (vessel, buoy, breaking waves), but additional details may help the Rescue Boat Operator in decision making. The following are some obvious characteristics of objects:

- Color
- Shape
- Size

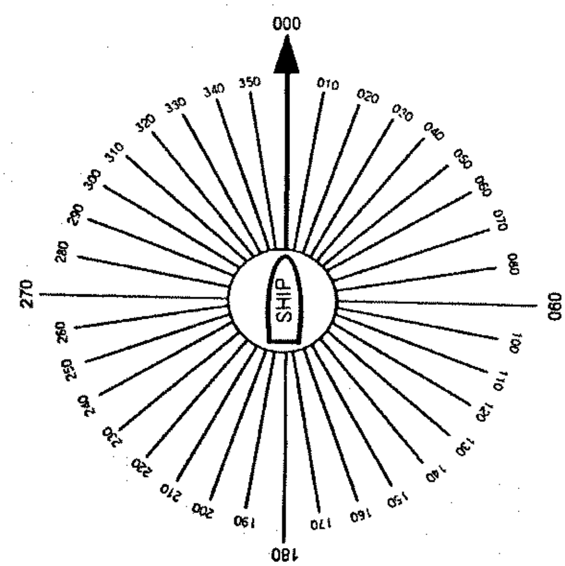
At night, Crew members must identify the color of all lights. This is the specific reason why all boat crew members must have normal color vision.

Relative bearing Crew members make reports using **relative bearings only**. This means the bearings are measured with reference to the vessel's heading, or to the fore and aft line of the boat's keel. These bearings run clockwise from zero degrees (000°) or dead ahead, through one-eight-zero degrees (180°) or dead astern, around to three-six-zero degrees (360°) or dead ahead again.

The following steps are important in reporting relative bearings:

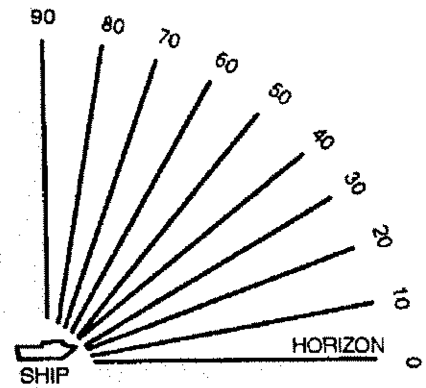
Procedure

Step 1. Study the diagram on major reference points of relative bearings. Picture in your mind the complete circle of relative bearings around your boat in 10 degree increments.



Position angle

Objects in the sky are located by their relative bearing **and position angle**. The position angle of an aircraft is its height in degrees above the horizon as seen from the boat. The horizon is 0° and directly overhead is 90°. The position angle can never be more than 90°. Position angles are reported in one or two digits and the word "Position Angle" is always spoken before the numerals



Position Angles

Distance

Report **distances** in yards. Knowing the distance to the horizon, land, or other reference point, will help estimate distance. By dividing the distance from you to your reference point, you can estimate the distance to another object. Ranges in yards are reported digit by digit, except when reporting yards in hundreds or thousands.

Making reports

When making reports, the crew member names or describes the object sighted, the direction (in relative degrees) and the range to the object (in yards). Give reports in the following format:

- Object name or description
- Bearing
- Range

For example:

> Discolored water on a bearing of 340° relative to the bow of the boat and at a distance of 2,000 yards.

Scanning

The crew member's method of eye search is called **scanning**. Scanning is a step-by-step method of visually searching for objects. Good scanning techniques will ensure that objects are not missed. Scanning also reduces eye fatigue. Development of a systematic scanning technique is important. There are two common scanning methods:

- Left to right and back again
- Top to bottom and bottom to top

In either case, move your eyes in increments. This creates overlaps in your field of vision and fewer objects will be missed.

Step	Procedure
1	When looking for an object, scan the sky, sea, and horizon slowly and regularly. Scan from left to right and back again or from top to bottom and bottom to top.
2	When scanning, do not look directly at the horizon; look above it. Move your head from side to side and keep your eyes fixed. This will give any stationary objects in your field of vision the appearance of moving and make them easier to see. One technique is to scan in small steps of about 10 degrees and have them slightly overlap as you move across your field of view.
3	Fatigue, boredom, and environmental conditions affect scanning. For example, after prolonged scanning, with little or no contrast, your eyes develop a tendency to focus short of where you think you are looking. To prevent this, periodically focus on a close object such as whitecaps or the bow of the boat.

Night Watch

General

Although the duties for day and **night lookout** watches are the same, safety and caution during night watches are especially important. Your eyes respond much more slowly at night and pick up moving objects more readily than fixed objects. It takes about 30 minutes for your eyes to become accustomed to the limited light available at night.

Guidelines

The guidelines for crew member watches also apply for night crew member watches.

Night vision is based on your eyes receiving and interpreting a different type of light than exists during daylight.

Dark adaptation

Dark adaptation is the improvement of vision in dim light. It is very difficult to see colors at night. Most objects are seen in various shades of gray. Although dark adaptation requires at least 30 minutes, a bright light will destroy night vision in a fraction of a second. In this brief period, the eyes readjust themselves to daylight conditions and the process of dark adaptation must begin all over again.

Avoid looking at bright lights during night-time operations. When a light must be used, use a red light.

Scanning

Scan the sky, waterway, and horizon slowly and regularly when looking for an object. Scan from left to right and back again or from top to bottom and from bottom to top.

Helm Watch

General

The **helm watch** or helmsman is responsible for the following:

- Safely steering the boat
- Maintaining a course
- Carrying out all helm commands given by the Boat Operator

The helm watch can be carried out by the Boat Operator or by a qualified crew member. Every crew member should learn to steer and control the boat.

Guidelines

There are several guidelines for the helm watch:

- Check with the Boat Operator for any special instructions and for the course you will steer.
- Repeat all commands given by the Boat Operator.
- Execute all commands given by the Boat Operator.
- Maintain a given course within 5°.
- Remain at the helm until relieved.
- Execute maneuvers only when expressly ordered, however, minor changes in heading to avoid debris, which could damage propeller or rudders, are essential.

Anchor Watch

General

When the boat is anchored, an **anchor watch** is set. The person on watch must ensure that the anchor line does not chafe and that the anchor does not drag. The individual on watch also looks for other vessels in the area. Even when the boat is anchored, there is the possibility that it can be hit by another boat.

Guidelines

Use the following guidelines when standing anchor watch:

- Check the strain on the anchor line frequently.
- Check that the anchor line is not chafing.
- Confirm the position of the boat at least every 15 minutes, or at shorter intervals as directed by the Boat Operator.
- Report bearing or range (distance) changes to the Boat Captain immediately.
- Report approaching vessels to the Boat Captain immediately.
- Report major changes in wind velocity or direction.
- Check for current or tidal changes.
- Report any unusual conditions.

Chafing

Once the anchor is set, apply **chafing** gear to the anchor line. It is the job of the anchor watch to ensure chafing gear stays in place and the anchor line

Dragging

There are two methods to determine if your anchor is **dragging**.

- Check for tension on the anchor line
- Check the boat's position

If the anchor is dragging over the bottom, you can sometimes feel vibration in the line. Periodically check your position by taking a navigational fix. Always use both methods.

Position Check

It is important to routinely **check your position** to ensure you are not drifting or dragging anchor:

- Take compass bearings to three separate objects spread at least 45° apart. Any bearing changes may indicate that you are beginning to drift.
- On a boat equipped with radar, determine the distance (range) to three points of land on your radar screen. Any change in the ranges may indicate anchor drag.
- On a Loran or GPS equipped boat, mark your position with your equipment. Periodically check your LAT/LONG readout. Any change would show your position is changing.
- Make a note of each time you check your bearings or ranges. Also note your position and the depth of water regularly. A small note pad is acceptable for this purpose. If the water depth or position changes, the anchor may be dragging.

As the wind or water current changes direction, your boat will swing about its anchor. This is a **swing circle** centered around the position of the anchor, with a radius equal to the boat's length plus the horizontal component of the length of anchor line in use; simply stated **horizontal component + boat length = radius of swing circle at its greatest length**. (The horizontal component decreases as the water depth increases.) Ensure your swing circle is clear of other vessels and underwater obstructions. When checking your position, it should fall inside the swing circle.

Towing Watch

General

A towing watch is normally performed aft on the boat. The primary duty of the towing watch is to keep the towline and the boat being towed under constant observation. (For more information on towing procedures, see Chapter 17 - *Towing*.)

Guidelines

The guidelines for standing this watch are as follows:

- Observe how the tow is riding (e.g., in step, listing, or veering).
- Report any unusual conditions to the Boat Operator.
- Ensure chafing gear is riding in place.
- Adjust the scope of the towline upon command of the Boat Operator.
- Report any equipment failure or problems observed to the Boat Operator immediately.
- Keep deck space area clear of unnecessary gear and people.
- Stay clear of the immediate area around the towline due to possible line snap back.
- Know when and how to do an emergency breakaway.

Observed danger

The towing watch must be aware of and report any signs of danger. Many of the signs of danger include:

- Yawing - Tow veers from one side to the other which may cause one or both boats to capsize.
- List increasing on towed boat.
- In Step - the proper distance between the towed boat and the towing boat to maintain control and prevent breaking the tow line.
- Towed boat taking on water.
- Deck hardware failure due to stress, no backing plates, etc.
- Towline about to part due to stress, chafing, or other damage.
- Towed vessel overtaking your boat due to sudden reduction in speed.
- Positioning of tow's crew.

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Chapter 2: Boating Law & Boarding

Boating Law

Boating law is an important tool for the maritime law enforcement officer. The boating officer must be familiar with Federal regulations, State statutes, and local ordinances. This section will only give an overview of the various rules and regulations. The following publications should be used as references and for further information.

- U.S. Coast Guard Navigation Rules
- California Harbors and Navigation Code
- California Department of Fish & Game
- California Code of Regulations, Title 13 & 14
- Local Ordinances and Regulations

Navigation Rules of the Road

The Navigation Rules are much like the rules of the road on the highway. They establish a consistent way to navigate safely and avoid collisions when two boats are crossing paths, are on course to meet head-on, or when one boat wishes to overtake another. Being familiar with the Navigation Rules of the Road are also useful for the following:

- Correct maneuvering of ***Your*** Patrol Boat
- Provides Probable Cause for a stop
- To Determine Causation of Boating Accidents

All mariners are required to know and responsibly apply these navigation rules when operating their vessels.

Rules of the Road apply to vessels in sight of one another where there is a risk of collision. Other navigation rules apply in or near areas of restricted visibility such as fog, rain, or snow. You must know two critical definitions of "Give-way vessel" and "Stand-on vessel". Depending on the situation, a vessel will be either the "stand-on vessel" or the "give-way vessel".

Give-way vessel

The vessel that is required to take early and substantial action to keep well away from other vessels by stopping, slowing down, or changing course.

Stand-on vessel

The vessel that must maintain its course and speed unless it becomes apparent that the give way vessel is not taking appropriate action. If you must take action to avoid a collision do not turn toward the give way vessel or cross in front of it.

Rule 2 ***Responsibility***, requires that due regard shall he given to all dangers of navigation and collision. This rule allows the mariner to depart from the rules as necessary to avoid the immediate danger of collision. This rule is often applied when the risk of collision between three or more vessels may occur. It is the mariner's responsibility to take the necessary actions to avoid a collision.

Rule 5 Requires that every vessel shall at all times ***maintain a proper lookout*** using sight and hearing as well as by all available means appropriate in the prevailing circumstances so as to make a full appraisal of the situation and of the possible risk of collision.

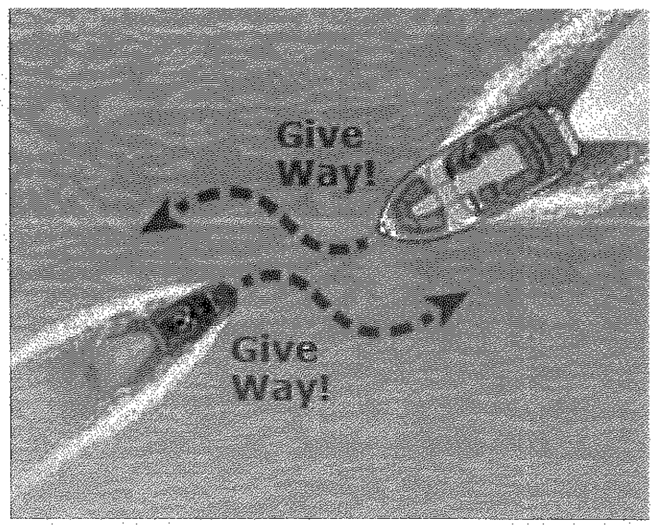
Rule 6 Requires that every vessel shall at all times ***proceed at a safe speed*** so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions. In determining safe speed the following factors shall be among those taken into account: the visibility, traffic density, maneuverability of the vessel with special reference to stopping distance and turning ability, at night the presence of background light such as from shore lights, the state of the wind, sea, current, proximity of navigational hazards, and the draft in relation to the available depth of water. Additionally, vessels with operational radar must use that radar to its fullest extent to determine the risk of collision.

Rule 7 ***Risk of Collision***, states that every vessel shall use all available means to determine if risk of collision exists; if there is any doubt, assume that it does exist. Risk of collision shall be deemed to exist if the compass bearing from your vessel to an approaching vessel does not change. Constant bearing decreasing range (CBDR) is the term we use to describe this situation. Collision risk may sometimes exist even when appreciable bearing change is evident, particularly when approaching a very large vessel or a vessel towing or when approaching a vessel at very close ranges

Rule 8 ***Action to Avoid Collision***, provides specific guidance on how to maneuver your vessel so as to avoid a collision. Changes in course and speed shall be large enough so as to be readily apparent to the other vessel. If there is sufficient sea room, alteration of course alone may be the most effective action to avoid a close quarters situation provided that it is made in good time, is substantial and does not result in another close quarters situation. If necessary to avoid collision or allow more time to assess the situation, a vessel shall slacken her speed or take all way off by stopping or reversing her propulsion. A vessel which is required not to impede the passage of another vessel shall take early and substantial action to allow sufficient sea room for the passage of the other vessel.

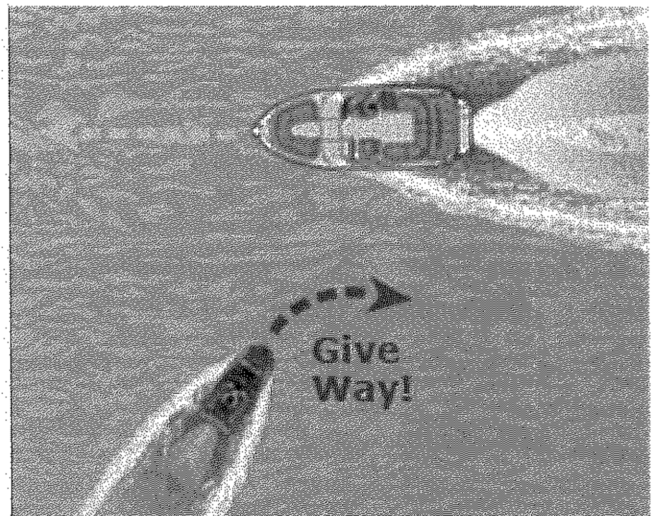
Rule 9 ***Narrow Channels***, states that a vessel proceeding along the course of a narrow channel or fairway shall keep as near to the outer limit of the channel which lies on her starboard (right) side as is safe and practicable, A vessel less than 20 meters in length or sailing vessel shall not impede the passage of a vessel, which can safely navigate only within the narrow channel.

Rule 14 ***Head-On Situation***, states that vessels which are approaching head-on shall alter course to starboard so each will pass port to port. (See Figure 2-1)



Head-on Situation
Figure 2-1

Rule 15 *Crossing Situation*, states that when two power driven vessels are crossing so as to involve risk of collision, the vessel which has the other vessel on her starboard side shall keep out of the way, and shall, if the circumstances of the case admit, avoid crossing ahead of the other vessel. (See Figure 2-2)



Crossing Situation
Figure 2-2

In addition to the rules listed, there are other rules which apply to vessels operating in restricted visibility, rules which prescribe the types of navigation lights and sound signals required by vessels.

Rule 18 - Responsibilities between vessels

Rule 18 lists the various classes of vessels in a "pecking order" of privilege. Vessel classes perceived to be more maneuverable are directed to keep out of the way of classes thought to be less maneuverable. Naturally, there are exceptions in the Rule because perceptions do not necessarily hold true in reality. Remember that this Rule applies only to vessels in sight of each other.

Highest Priority

Overtaken	Vessels being overtaken are privileged over all others.
Not Under Command	A vessel "not under command" is usually one that has suffered a loss of propulsion or steering control.
Restricted in Ability to Maneuver	A vessel "restricted in her ability to maneuver" would typically be a dredge, one laying an underwater cable, conducting SCUBA operations, etc.

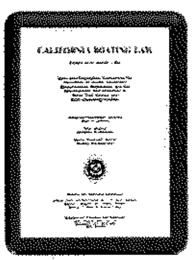
	Constrained by Draft	International Rules only.
	Engaged in **Fishing**	A sport-fishing boat with trolling lines out is not a "vessel engaged in fishing."
	Vessels under **Sail**	A vessel under sail does not have the privileges of that category if she is also being propelled by machinery.
	Power Driven vessels	Your patrol boat.
	Seaplane	In practical terms, apply to a seaplane taxiing on the water. Such aircraft, when taking off and landing are unable to maneuver to keep clear of vessels.
Lowest Priority	**Overtaking**	A vessel that is overtaking any of the above, must keep clear.

Memory Minder

Use the following Memory Minder to help remember the order of priority:

Only **N**ew **R**eels **C**atch **F**ish **S**o **P**urchase **S**ome **O**ften *Overtaken – Not Under Command – Restricted in ability to Maneuver Constrained by Draft – Fishing – Sail – Power – Seaplane - Overtaking - WIG*

California Boating Law



The California Boating Law publication contains laws and regulations concerning the operation of vessels, equipment requirements and registration. This publication includes excerpts the following:

- Harbors and Navigation Code
- California Code of Regulations, Title 13 & 14
- Vehicle Code
- Fish and Game Code
- Penal Code

Harbors and Navigation Code

663 H&N **Authority to Stop and Board** -Every peace officer shall enforce any regulations pursuant to this chapter and in the exercise of that duty shall have the authority to stop and board any vessel subject to this chapter, where the peace officer has **probable cause to believe** that a violation of state law or regulations or local ordinance exists.

663.6 H&N **Vessel must Stop** - Every vessel if under way and lawfully ordered to stop and lie to, shall stop immediately and lie to, or shall maneuver in such a way as to permit the peace officer or harbor police to come alongside.

652.5(d) H&N **Vessel Shall Yield** - Any vessel approaching, overtaking, being approached, or being overtaken by a moving law enforcement vessel operating with a siren or an illuminated blue light, or any vessel approaching a stationary law enforcement vessel displaying an illuminated blue light, shall immediately slow to a speed sufficient to maintain steerage only, shall alter its course, within its ability, so as not to inhibit or interfere with the operation of the law enforcement vessel, and shall proceed, unless otherwise directed by the operator of the law enforcement vessel, at the reduced speed until beyond the area of operation of the law enforcement vessel.

658.5 H&N **Age Restriction** - No person under 16 years of age may operate a motorboat of more than 15 horsepower, except for a sailboat that does not exceed 30 feet in length or a dinghy used directly between a moored boat and the shore, or be- tween two moored boats. The law allows persons 12-15 years of age to operate motorboats of more than 15 horsepower or sailboats over 30 feet if supervised on board by a person at least 18 years of age. A violation of these provisions is an infraction.

655.2(a) H&N **Speed** - Speed is limited by law for certain conditions and areas. The maximum speed for motorboats within 100 feet of a bather (but not a water skier) and within 200 feet of a bathing beach, swimming float, diving platform or life line, passenger landing being used, or landing where boats are tied up is five miles per hour.

A safe speed should be maintained at all times so that: a) action can be taken to avoid collision and b) the boat can stop within a distance appropriate to the prevailing circumstances and conditions.

In restricted visibility, motorboats should have the engines ready for immediate maneuvering. An operator should be prepared to stop the vessel within the space of half the distance of forward visibility.

Alcohol is a factor in 49 percent of all fatal motorboat accidents in California. State law specifies that:

655(b) H&N No person shall operate any vessel, water skis or similar device while under the influence of intoxicating liquor or drugs. No person who is addicted to any drug shall operate any vessel, water skis or similar device.

655(c) H&N No person shall operate any recreational vessel or manipulate any water skis, aquaplane, or similar device if the person has an alcohol concentration of 0.08 percent or more in his or her blood.

California Code of Regulations, Title 14

CCR, Title 14 incorporates several carriage and safety requirements, such as P.F.D., fire extinguishers, etc. The Marine enforcement officers should be familiar with its contents as it relates to boating safety. Below are just some excerpts from the Code.

T14, sec. 6697(a) Negligent Operation - Riding on the bow, gunwale or transom of a vessel propelled by machinery underway when such position is not protected by railing or other reasonable deterrent to falling overboard.

T14, sec. 6600.1(a) Federal Inland Navigation Rules of the Road are incorporated into state law under this section.

*Title 14, California Code of Regulations, Section 6600.1(a), provides the reference to applicable federal law, and should be included when citing a violation of Federal Inland Rules of the Road.

For Example: Violation cited for not displaying required lights, cite :
Title 14, CCR, Sec. 6600.1(a), Rule 20.

T14, sec. 6550.5(d) **Termination Authority** - Any peace officer authorized to enforce the Harbors & Navigation Code may order the operator of an ***unsafe vessel*** to remove such vessel to the shore or to a safe moorage or anchorage in accordance with the requirements of this subsection. An officer may order an unsafe vessel so removed where it is being operated with ***one or more*** of the following hazardous conditions, ***where such conditions cannot be corrected on the spot***, and where, in the judgment of the officer, ***continued operation of the vessel would create an immediate danger*** to life, limb, or property.

- Insufficient PFD's
- No Lights at night
- Accumulation if fuel in the bilge
- Improper backflame control
- Insufficient fire extinguishers
- Fuel Leakage
- Improper ventilation
- Overloaded

Probable Cause, Reasonable Suspicion, and Searches

The Ninth and Tenth Circuits have ruled that a houseboat also qualifies for warrantless searches under the probable cause, vehicle exception. Therefore, assuming you have probable cause, you may search a houseboat without a warrant, at least where the boat is "in public waters, obviously mobile." The court noted, however, that it might rule otherwise if the houseboat were "permanently moored." In general, if a boat is permanently tied up to a dock, it is like a house. If it is "underway," it is like a car.

Coast Guard Searches (Source: California Legal Sourcebook)

The U.S. Coast Guard may "make inquiries, examinations, inspections, searches, seizures, and arrests upon . . . waters over which the United States has jurisdiction, for the prevention, detection, and suppression of violations of laws of the United States." (14 U.S.C. § 89(a).)

Example: The Coast Guard boarded a disabled sailboat to render medical aid to a passenger. After towing the boat to safety, officers conducted a post-search-and-rescue (SAR) boarding to ensure that the vessel was in compliance with federal regulations. The officers found tar heroin in plain view during the search. HELD: The administrative search of the boat was lawful. "Coast Guard boardings are an effective means for policing compliance with safety and documentation regulations and as a practical matter there are no feasible, less intrusive alternatives." The court noted that the post-SAR search was conducted pursuant to standard procedure, not pursuant to an individual officer's discretion. (Eng (2001) 94 Cal.App.4th 1184.)

Be aware, however, that according the Ninth Circuit, "reasonable suspicion" is necessary to justify any continued detention after a search and rescue operation is completed. (Thompson (9th Cir. 2002) 282 F.3d 673, 677-678.)

It is also important to note that if your initial contact is based upon a safety inspection, you must follow through, complete the inspection, and document your findings.

As with all police work, it's not just what you do, but also how well you document it. It also a continuous challenge to keep up with the law, policies, and procedures associated with your assignment. You must immerse yourself in the subject matter if you hope to gain a professional degree knowledge and skills.

Pullover, Approach and Pursuit

Introduction

A vessel pullover and approach is the first step in apprehension and seizure. The safety of the officer and their crew is the primary concern during any pullover and approach of a suspect vessel. The officer on the street faces many hazards when making traffic stops. The marine enforcement officer must not only face the same dangers, but also a number of other hazards unique to the marine environment:

- Weather and sea conditions
- Submerged objects
- Exposure to hostilities due to inadequate cover.

"There is no such thing as a routine traffic stop." Yet an average of 12 percent of all officers killed in the line of duty lost their lives during vehicle stops. Likewise, in marine law enforcement, there are no "routine" vessel stops or boardings.

Pursuit is "maintaining visual or radar contact" while following a suspect vessel. Pursuits begin after an attempt to stop suspect vessels in order to identify, investigate, arrest or seize. In any pursuit, the degree of danger is heightened. There is the distinct possibility that either of the vessels involved in the pursuit may exceed its design limitations.

As with proper vehicle pursuits, much of the danger involved in vessel pursuits can be kept under control. The marine enforcement officer must be thoroughly familiar with boat handling theory. The operator must know exactly what the boat can and cannot do when pushed toward its performance limits. Remember, the object is to maintain a visual or radar contact of the suspect during the pursuit. If the suspect vessel refuses to stop, even after the patrol boat is alongside, there is little that can be done to make the vessel stop. This chapter will explain several recommended techniques for pursuing and approaching a vessel. The primary objective is always officer safety.

Pullover

Even if no hostile action is perceived, the pullover or stop must be viewed as a "tactical evolution." Because of the inconvenience of an enforcement boarding on the water, a non-hostile stop may turn into a hostile stop in a short period of time. If this should occur, the enforcement personnel must be mentally alert and physically prepared to react. The open-minded enforcement officer will not focus total attention to one particular area or one person, but will be alert to any actions from all persons on board. Officers have been killed during vehicle stops because their attention was focused on the person being talked to and accomplices of the suspect surprise the officer from behind. In the marine environment there are countless numbers of places of concealment where a person can hide.

Repetition of safe tactics builds good tactical habits.

In the marine environment, the effects of outside noise such as engine, radio, and wind noise, is a constant problem, not only for the officer, but also for the operator of the vessel that is being stopped. The enforcement personnel must keep this in mind when a vessel does not stop. Do not confuse this with a person that obviously has no intentions of stopping his vessel. The action of "pulling over" another vessel will usually be of short duration. Normally the operator will comply when made aware of the signal to stop.

Vessel stops should not be viewed as routine; nothing in law enforcement can be considered routine. Always keep in mind that even during a non-hostile vessel boarding that the persons on board could have a criminal background, or may be currently involved in criminal activity. Do not become complacent.

Hostile actions

The marine law enforcement officer must be able to recognize the differences and the dangers between a hostile and non-hostile "stop". A "stop" is considered hostile after observing or receiving hostile actions from persons aboard the suspect vessel. Learn to recognize these actions and define them as intended or unintended.

Examples of hostile actions are:

- The person/persons on board the suspect vessel continues to be aggressive after you have identified yourself as a law enforcement officer.
- The suspect vessel does not stop after the operator is made aware of the signal to stop.
- Persons on board are observed with weapons.

These are just a few examples that may be observed that signal potential hostilities. Be aware and prepared to deal with hostile actions if they arise.

Failure to Yield

The preparation for a pursuit begins before the enforcement vessel leaves the dock, the vessel should be checked off to ensure it is properly equipped and operational for day and night operations. All equipment must be stored to avoid becoming flying objects while the vessel is maneuvering at high speeds. The crew should be briefed on specific assignments if a pursuit should occur. A crew member that does not know, or will not perform assigned tasks, is a hindrance and danger to other crew members.

80% Rule There are a number of factors that affect crew and vessel safety, which increase during a pursuit. This requires the operator to maintain composure while operating at accelerated speeds that require additional control measures.

It is during pursuit situations that the degree of danger to enforcement personnel, as well as to innocent bystanders, is not only present, but will start to increase at a very substantial rate. This danger not only exists from hostile action(s) from the suspect, but also from the risks of loss of control of both the enforcement vessel and the suspect vessel. During a pursuit situation the operator of the suspect vessel will be maximizing his efforts to avoid apprehension. In most cases this will mean that the suspect will be operating at ONE HUNDRED PERCENT of both his capabilities and also of his vessel's capabilities.

The enforcement officer operating a pursuit vessel must be aware of the potential for loss of control and/or mechanical failure. The prudent officer will use this knowledge as an advantage during a pursuit and will operate the pursuit vessel at no more than EIGHTY PERCENT of its capabilities. The officer must not allow the "heat of the chase" to influence decisions. During a high-speed pursuit, it becomes very easy to get tunnel vision. When this occurs, real possibilities and dangers can be mentally blocked out. Vision will increase dramatically, but at the same time, peripheral vision will start to narrow. The faster the speed, the more narrow the vision.

Other officers on board, must serve as extra sets of eyes to scan 360° and alert the operator of any dangers in the area. This communication between vessel commander and crew must work both ways. Once information is given, it should be acknowledged that it was received and the vessel commander should in turn relay his intentions to the crew.

Pursuit Initiation A pursuit is generally initiated when the operator of the vessel refuses to stop after the recognition of law enforcement presence. At this point, the pursuit may advance from "non-aggressive" to "aggressive or hostile." Actions by the suspect vessel should cause the enforcement officer to prepare for defensive actions, if needed. For instance, the enforcement officer wishes to stop a vessel for investigative purposes and the suspect vessel does not come to an immediate stop after activating the blue light and siren. At this point, there could be several logical reasons for the vessel captain not stopping, i.e. he did not see the blue light, or could not hear the siren because of wind or engine noise.

If at any time during the pursuit hostile actions are observed be prepared both mentally and physically to respond. Some of the hostile actions that may be observed include:

- Crewmembers running from one area of the boat to other areas.
- Visible weapons.
- Items being thrown off of the vessel.

These actions articulate facts that not only give the legal right to stop the vessel, but to also board and possibly search. Aggressive behavior by suspects should be considered a threat and handled in such a way that minimizes the possibility of danger to the officer or any third party.

Non-aggressive behavior should not be a signal that hostilities will not develop later in the boarding process.

NOTHING IS ROUTINE ABOUT ANY ENFORCEMENT STOP!

The marine enforcement officer must be able to relate to the law abiding citizen that they are not there as an inconvenience, but to protect the waterways. In most cases the boarding is, at best, an inconvenience to the operator, and without precautions could be a violation of their constitutional rights. The citizen is a valuable source of information.

Vessel Pursuit Operation

The effective operation of a vessel in a pursuit situation requires an understanding of several essential criteria:

The knowledge of the pursued vessel's handling characteristics is helpful to the pursuing officer's tactics. Understand that no one can be familiar with the handling ability of every vessel, the level of operator skill, and modifications to hull designs. A broad base of vessel familiarization will greatly enhance the officer's ability to pursue another vessel safely.

Another criterion for an effective pursuit is recognizing limitations. Weather and sea conditions can make the difference between successful vessel pursuits and dangerous results. Knowing the design capabilities of the vessels being operated will enhance the ability to safely complete a pursuit in rough seas, or will make the decision to terminate the pursuit easier. Knowing personal limitations will enhance the ability to safely complete a pursuit or justify the termination of a dangerous pursuit. Remember not all pursuits will result with successful apprehension.

A sensitive and very real limitation is that of the operator's ability. There is no room for the "ego" here. Confidence based on knowledge and "real-time" experiences will lay a safe foundation for this potentially dangerous task. Familiarization with the vessel, decision-making ability and reaction time will affect the outcome of a pursuit situation. Preparation for the possibility of a stressful pursuit is built upon experience gained every time the boat is under way.

Pursuit Skills

Monitor the vessel's movements closely, watch for speed and direction changes. When possible, observe the operators hands "telegraphing" the next vessel change. A change in the angle of the bow of the pursued vessel should indicate that a change in speed or direction is about to take place. The pursuit vessel should compensate for all changes made by the suspect vessel to prevent overrunning the suspect vessel, or to prevent the suspect vessel from getting its bow on the pursuit vessel creating a danger of collision or ramming.

During a pursuit, there is a tendency to try and close the distance on the suspect vessel to a very close and dangerous distance. What must be remembered is that when you observe the actions of the suspect operator, it will take 1.5 to 2.0 seconds to react. The enforcement vessel will travel 42 feet per second when in pursuit of a suspect traveling at 25 knots. So in 2.0 seconds the enforcement vessel has traveled 82 feet. If the suspect vessel should suddenly decelerate and the patrol boat is following at 100 feet, in the time that it takes to react to the actions of the suspect vessel, the pursuit vessel will collide with transom of the suspect vessel. Remember that a boat has no brakes.

The time that it takes to look down at the VHF radio to check or change the channel, could result in a collision situation with the suspect vessel or with another vessel that has entered the path of the pursuit.

Keeping a safe distance behind and just a little offset of the suspect vessel will provide an escape route should the suspect vessel stop suddenly, or throw objects overboard to try to foul propellers on the pursuit vessel.

Remember that the above actions will take only a second to accomplish; first interpret the action and then react. The key to a successful pursuit is to keep focused on the suspect vessel at all times.

All pursuits must be in compliance with current Department policy regarding vessels!

Suspect Observation – Y Maneuver

Slowly approach the stern to allow the crew to gather intelligence while closing the distance on the suspect vessel.

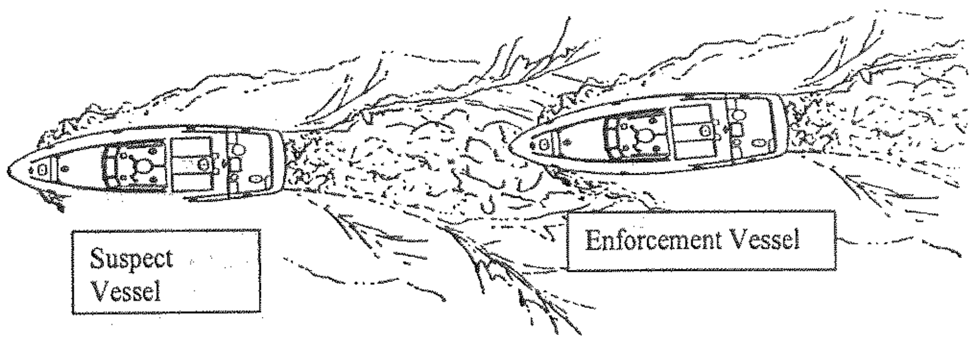
All figures used in this handout are not to scale. Most figures depict the vessels much closer together than should be in an actual pursuit.

Astern Position

Information available from an Astern position:

- Name and hailing port
- Number of persons onboard
- Brand of outboard motors
- Brand of boat
- Unusual activity

(See Figure 2-3)

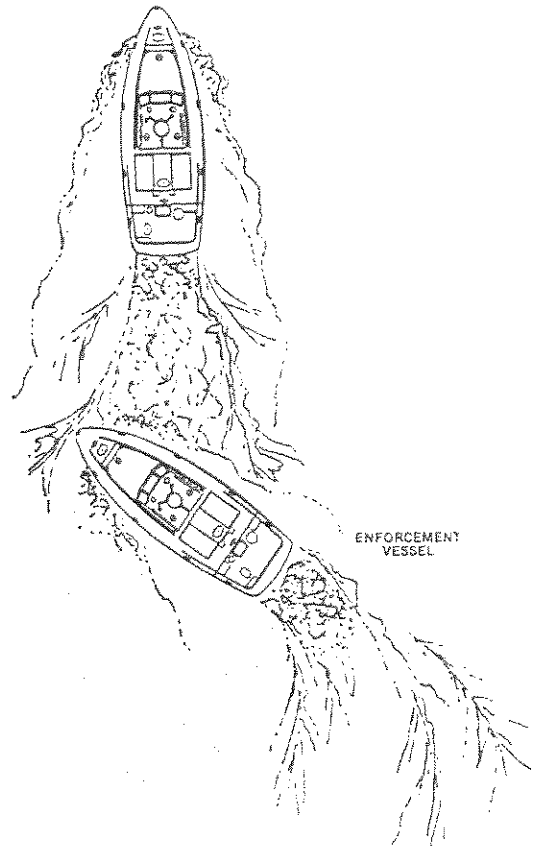


Astern Position
Figure 2-3

Crossing wake to port or starboard

Cross out and over the suspect vessel's wake. At the moment of making contact with the suspect vessel's wake, apply additional throttle to cross the wake rather than surf along the ridge of the wave.

Reduce throttle to original settings quickly, after breaking the wake open. This prevents overtaking the vessel. See Figure 2-4.



Crossing the Wake
Figure 2-4

This position also allows officers to observe any contraband that may be thrown overboard and a clear view of the cockpit and cabin area of the vessel. Things to note about the vessel are:

- Name and hailing port of vessel.
- Description of vessel.
- Number of persons visible.

Never get in a position forward of the vessel's beam. Upon gathering pertinent facts, drop back, and cross over to the other side for a similar position alongside.

Crossing from one side to the other

After completing intelligence gathering on one side, drop back astern of the suspect vessel and cross its wake to opposite side.

Initiating Stop

Return to the astern position. After gather all information possible, when ready activate emergency equipment and attempt to stop the vessel.

Evasive Maneuvering

If the suspect vessel uses evasive maneuvers, maintain a position astern. If in a turn, remain on the outside of the turn to avoid a bow-on situation. Remaining on the outside of the turn will also allow an escape route if the suspect vessel proves highly maneuverable and doubles back in a turn. In this event, move well off the scene and begin a new approach. Use only enough speed to close on the suspect vessel. Monitor the vessel's operator closely to be able to anticipate and "mimic" the suspect vessel's changes. An inherent amount of delay between operator input and vessel reaction exists to varying degrees, making this "shadowing" effort a very difficult task.

Avoid closing to the inside of the turn. This desire to close on the suspect vessel is normal human nature. However, if the suspect vessel continues to tighten the radius of the turn, the law enforcement vessel will find itself unable to stay on plane and will lose speed. If this should happen, break off of the pursuit and clear the area. The ability to realize when the suspect vessel has the upper hand is a result of training. Failure to evaluate and react accordingly in this situation can place the law enforcement vessel and crew in harm's way.

If the pursuit becomes a close quarter maneuver, always maintain a bow-on attitude to the suspect vessel. If a collision appears imminent, try to make contact with the vessel's bow. The bow is the strongest part of the vessel and this position provides the most protection for the engines and/or lower units. The engines are highly susceptible to damage from a strike from the suspect vessel. A bow-to-bow collision is preferred which will usually result in a glancing action versus a T-bone or bow to stern collision.

Sudden deceleration can be an effective tactic against the law enforcement vessel operator if reaction time is slow. If at any time during a pursuit, the suspect vessel slows down, reduce speed immediately. Any hesitation could cause the law enforcement vessel to pass the suspect vessel and thereby expose the stern and crew to the suspect, or, the failure to react could cause a collision.

Remember:

- Use only enough speed to close on a suspect vessel.
- Monitor the vessel operator closely to anticipate and mimic the suspect's changes.
- Never allow suspect's vessel to get a bow-on position to the enforcement vessel.

Determination to terminate a pursuit

The decision to terminate a high-speed pursuit is one of the most difficult and must be made by the operator of the law enforcement vessel or from a supervisory person and relayed to the vessel. Do not let the heat of the chase influence decision making abilities. The safety of not only your vessel, crew and innocent parties but also the suspect's vessel should be of primary concern. The vessel commander of the law enforcement vessel should base decisions on:

- Probable cause to initiate the pursuit.
- Patrol vessel's capabilities in relation to sea and weather conditions.
- Depth of water and hazards to navigation in the pursuit venue.
- Density of civilian boat traffic. Even though the pursuit is with blue lights and siren, due regard must be exercised for other boats.

The operator will be held responsible for any injury or damage as a result of the pursuit. The officer is not in an accident-proof capsule because of the blue light and badge. Remember that a suspect that is trying to avoid apprehension is probably operating at 100% of his ability and the vessel's capabilities. Eventually there will either be a loss of control, or the vessel will mechanically malfunction and stop. As long as the enforcement vessel and the operator maintain the 80% rule there is that additional 20% reserve as back up.

The decision to pursue is not irreversible. Officers must continuously re-evaluate whether the pursuit should continue. Pursuit should be terminated under the following conditions:

- Agency or departmental procedures.
- Clear and unreasonable danger to officers or third party.
- Sea or weather conditions indicate the futility or danger of continued pursuit.
- The suspect vessel's location is no longer known.

Vessel stop and approach

When the suspect vessel is stopped, maintain the enforcement vessels position at a safe distance astern of the suspect vessel. During this time the crew gathers further intelligence, properly identifies themselves and maintains visual contact of the suspect crew. The law enforcement vessel operator should verify position-using electronics, if available, and if not, by using a visual fix. This information should be passed along to the communications center prior to boarding.

Consider the use of Cover or Concealment when conducting your initial communications. The unknowns still warrant a precautionary approach until circumstances dictate otherwise.

Documentation

The law enforcement crew should document all information available about the suspect vessel such as:

- Type of vessel.
- Color of vessel and its trim.
- Approximate length of vessel.
- Name and hailing port.
- Any identifying numbers; hull number, state registration number, commercial fishing license number, documentation, hailing port, etc.
- Flag flown, if any.
- Vessels overall condition (how it is riding in the water and hull's condition).
- Any damage observed on the vessel's hull.
- Number of persons on board and their descriptions.
- Any features that make the vessel stand out i.e. number of antennas and types, GPS receivers, satellite dishes, outriggers, etc.

The same information should be recorded on other vessels in the area, including their distance, course and speed from the suspect vessel.

During this information gathering process, the law enforcement operator should regain composure and allow the "adrenaline dump" to subside. Also, this time should be used to evaluate the area where the vessels are located and determine the best action for an approach to the suspect vessel. Possible actions of the suspect vessel are:

Have the suspect vessel operator shut down the engines and go dead in the water (DIW). This allows the operator to be removed from the controls of the suspect vessel and be placed in a position of disadvantage to minimize a threat to the boarding team. The disadvantages are that the suspect vessel is at the mercy of any wind and sea conditions. It should be noted that no matter what aspect the suspect vessel stops, once DIW, it will generally turn sideways to the wind and seas. The law enforcement operator should plan on this movement and approach accordingly.

If wind and sea conditions are a factor, an easier approach may be made possible by having the suspect operator bring the vessel to idle speed and place the vessel on a prescribed course or heading. If the suspect vessel is a multi-engine vessel, have the suspect operator shut down all other engines and use only what is necessary. This action prevents the suspect operator from trying to flee again as the approach is being made. The disadvantage is that the suspect operator is still at the helm.

Whether to place the suspect vessel headed into or running with the seas is a case-by-case call. Generally, if the wind and seas are not severe, into the wind is preferable. Heavier wind and seas may dictate that the approach be made down wind which allows the two vessels to ride more in step with each other.

Remember that the enforcement officer has assumed responsibility for the suspect vessel and crew and must ensure that the wind, seas and/or current will not take it into dangerous waters.

After stopping the vessel, communication between the suspect vessel and the enforcement vessel must be established. This can be accomplished by one of several means:

- Intercom or loud hailer.
- Direct voice from personnel on the enforcement vessel to persons on the suspect vessel.
- VHF radio. This should be used as a last alternative and used only if communications cannot be established by other means. The use of VHF radio will alert other suspect vessels that enforcement operations are in the area. If the VHF radio is used, switch to low power to minimize the distance of the transmission.

After communications have been established, instruct the suspect crew and passengers to assemble in a visible area on the vessel, usually the stern. Have them move to the far side of the vessel to provide a safe area for the team to board. If the captain was instructed to maintain steerage of the vessel have him stay at the helm of the vessel until the boarding crew is on the vessel.

During the interview with the captain, ask some of the following questions and record the responses. These responses could be used later as probable cause to conduct a thorough search of the vessel. Each passenger should be asked the same questions to check for conflicting responses.

- *How many persons besides you are on board?*
- *Where have you been and where are you going?*
- *Are you the owner of the vessel?* If not, who is the owner and is he/she on board?
- *Do you have the documents on board the vessel as required by the State or Coast Guard?* If yes, ask where they are located; this could give you authority to come aboard and examine and verify.
- *Without reaching or going to them, Captain, are there any weapons on board?* If yes, ask where the weapon(s) are located. During the safety/security sweep, locate the weapon(s) and run the serial numbers.

Rigging Fenders

Before starting the final approach and while still at a safe distance, member(s) of the boarding crew should be rigging fenders on the enforcement vessel to prevent damage to either vessel during the boarding process. When rigging fenders, special attention should be made to the free board of the enforcement vessel versus the suspect vessel. Placing the fenders too low will allow the rub rail of the enforcement vessel to make contact with the suspect vessel. It might not cause damage but it will most likely leave a mark on the hull of the suspect vessel. Remember that some of the vessels that are boarded cost hundreds of thousands of dollars and some, even in the millions. These people don't like having scuff marks on the sides of the vessel, especially if put there by someone who has caused them an inconvenience.

Personal Flotation

Crew members should be wearing personal flotation devices and ballistic protection during any pullover and approach. The flotation devices should be equipped with rescue lights. The risk of injury during a boarding, whether accidental or through hostile intent, is high. The chance of survival if thrown overboard is greatly increased if wearing a flotation device, especially if knocked unconscious.

Transferring from one vessel to another is a very dangerous procedure. The officers are stepping from one unsteady platform to another. Most decks of modern boats have what is known as nonskid surface paint. Do not be led astray by this. The combination of water and a little oil or gas can cause this surface to be slick and even the best pair of deck shoes cannot overcome the slick surface. When boarding a vessel, try to pre-arrange all personal gear, such as flashlights, documents, hand-held radios, and other equipment that may be needed during the boarding. These items can be secured in a tote bag or back pack leaving both hands free to use when boarding.

Boarding a vessel with weapons drawn is not recommended unless it is felt that there may be a need to have it immediately accessible. A drawn weapon will increase the danger of accidental injury when transferring from one vessel to another. Fellow boarding officers should provide cover for transferring personnel. In the evolution of boarding another vessel, avoid tunnel vision. Normally, an officer's attention is focused on where they will be stepping aboard the vessel, and not seeing objects that could cause injuries such as T-tops, outriggers, etc.

Types of approaches

Determine the best approach under existing circumstances. In addition to the actions of the stopped boat and its crew, things to consider are sea and wind conditions, visibility, time (day/night), the type of vessel to be boarded, and the presence of nets or other obstructions in the water that can damage or disable a vessel.

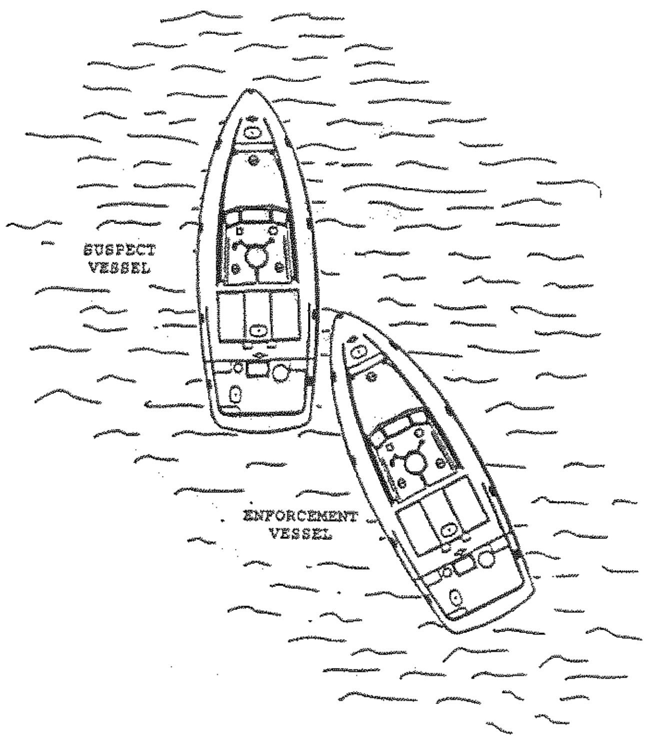
Quarter bow to quarter stern

The safest approach and the most preferred type of vessel boarding is the "quarter bow to quarter stern" approach. This is accomplished by placing the quarter bow of the patrol vessel to the quarter stern of the suspect vessel. This position allows the crew of the patrol vessel cover from hostile fire and also allows for intelligence gathering from different angles during the approach. The captain of the patrol vessel usually does not board the suspect vessel but maintains the patrol vessel at a safe distance while still having access to communications. The patrol vessel should be positioned so the crew can maintain a visual contact with some of the boarding party. See Figure 2-5.

During the approach, the boarding team should remain behind cover or concealment until the time that the operator directs them to go forward and board. Once the boarding team is on the suspect vessel, the law enforcement operator should move astern of the suspect vessel at a safe distance and maintain a watch for the boarding team. Another responsibility of the law enforcement operator is to maintain both vessels in safe water.

Quarter bow to quarter stern allows for the boarding team to transfer from the law enforcement vessel's bow to the cockpit of suspect vessel.

Should hostilities arise, this position allows for an easy exit.



Quarter bow to Stern quarter
Figure 2-5

Bow-on to amidships

The "Bow-on" or "90 Degree" boarding may be necessary due to sea and wind conditions. In heavy seas it may be necessary to place the boarding team on the bow of the patrol boat where they ride a swell toward the suspect boat. The law enforcement vessel operator will have to reverse the engines as the distance closes. For example: Upon approaching a suspect vessel with the seas astern, position the bow to a point that would allow the seas to propel the vessel to the port or starboard beam of the suspect vessel.

Maintain control and distance by placing the engines in reverse upon getting close to the suspect boat. In this type of boarding, one officer usually boards on each approach. The Boarding officer must concentrate totally on the transfer to the other boat. Each member of the crew must be able to depend upon the others for protection during the transfer.

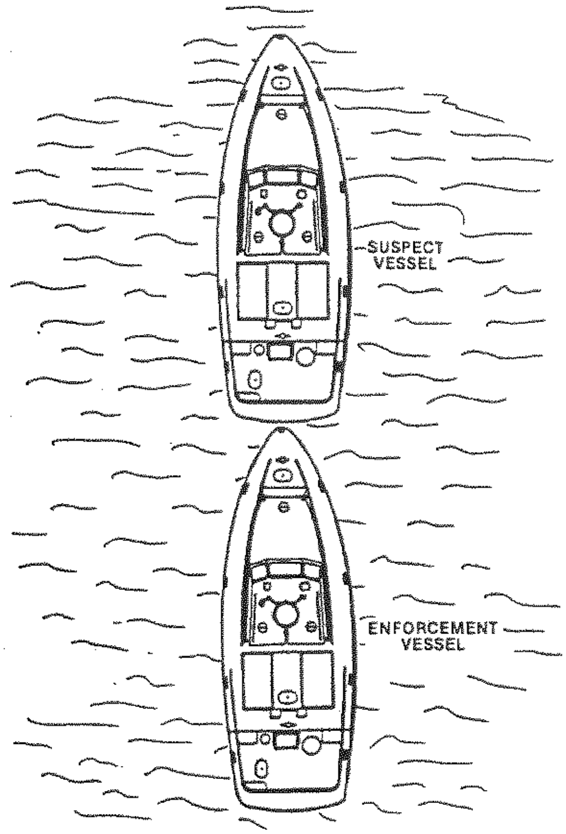
This approach is not recommended unless no other approach can be safely made.

Bow to transom

"Bow to Stern" boarding may be used when there is fishing or other gear obstructing other approach angles. Vessels such as trawlers and most net boats often present this problem. This approach is also used during single officer boarding, and should be avoided if possible. The approach is made from directly astern of the suspect vessel, the captain of the patrol vessel must be aware of any gear that may still be in or under the water. Place the bow of the patrol vessel to the stern of the suspect vessel and have the boarding party transfer across the stern of the vessel. This position puts the crew in a vulnerable position as they must climb up across the stern, and lose sight of the persons on board the suspect vessel. Also, possibilities exist that the suspect vessel may reverse the engines and ram the patrol vessel. See Figure 2-6.

The boarding party is transferred from the bow of the enforcement vessel over the stern of the suspect vessel.

This approach may be necessary when approaching vessels with gear in the water, such as trawlers, longliners or vessels with outriggers.



Bow to Stern
Figure 2-6

Side to Side

The "Side to Side" approach is the most common and most dangerous. Often used during the single officer boarding. This type of approach places the entire enforcement vessel in a position alongside the suspect vessel. This position exposes the crew to hostile action by leaving the enforcement officer with little cover. It is not a recommended practice.

Whenever a boarding of this type is performed, it is advisable that the officer perform their duties from their own vessel as much as possible.

If tying the two vessels together is necessary, the officer should perform this task and do not allow the suspects to do it.

Summary

The pursuit, stop, and approach of a vessel require more demanding physical and psychological skills than any other task performed by a marine law enforcement operator. It is important to remember that the vessel pursuing another vessel will always have to work harder than the lead vessel due to the reaction time.

Human nature and ego cannot take over in a pursuit situation. The desire to "close the gap" in a turn and not realizing when the suspect gains the upper hand must be avoided at all costs. The marine law enforcement operator must exhibit patience and common sense during a pursuit in order to be successful and safe. Even when the suspect vessel stops, due diligence to the entire surroundings of the marine enforcement officer must be maintained for officer safety and a successful boarding.

Vessel Boardings

The most critical tactic of marine enforcement is the vessel boarding. The marine enforcement team will in most cases put themselves on board the suspect vessel. While performing a boarding the boarding team will maintain a position of advantage.

The marine enforcement officer often conducts a vessel boarding with minimal backup. The tight quarters on a vessel increases the hazard to the officer. With these hazards in mind, the marine enforcement officer will identify and assess potential threats and determine a proper response.

The officer's response is based on the assessment of the situation. Unfortunately, a suspect vessel cannot be stopped and the occupants ordered to exit the vessel and lay prone on the ground as is done in high-risk felony car stops.

When the marine enforcement officer must board the vessel, it requires the officer to enter the "home turf' of the suspect. The suspect has the advantage of being thoroughly at home on the vessel while the officer is at a disadvantage. Finally the boarding team evaluates the vessel boarding and determines if further action is required.

The courts have held that because of the exigent circumstances of most vessel boarding, obtaining a warrant prior to conducting a search is not practical. Most searches in the marine environment will not require a warrant but if time allows one should be obtained.

If marine enforcement officers do not exercise proper legal authority and professional demeanor in the conduct of a boarding, the courts could impose tighter restraints.

Remember, jurisdiction, authority and use of force policies are agency specific; this section covers vessel boardings from a broad perspective. Whether enforcing boating safety laws or interdicting narcotics, regardless of the purpose of the boarding, the techniques are basically the same.

Responsibilities and Duty

A vessel boarding is a systematic process used to ensure compliance with law enforcement laws and regulations (fisheries, immigration, customs laws, counter terrorism, marine safety and State Law). The boarding team should have a plan constructed before initiating a vessel boarding. The boarding team must assess the situation and determine a proper course of action.

A "fisheries boarding" requires different tactics than boarding a vessel that is suspected of smuggling or boarding a vessel after a pursuit. All vessel boardings involve a level of risk. A safe tactical boarding starts with observing and analyzing the crew, the vessel to be boarded and the totality of the circumstances.

Information is determined by making radio communications and asking pre-boarding questions, gathering intelligence on the vessel and crew, and visually identifying risks while on scene (weather, and sea conditions).

Information is determined by communicating with suspect vessel and law enforcement information sources.

This recognized information will determine the level of risk involved (risk or high risk boarding.)

Marine law enforcement officers must be prepared for the unexpected. Officers must be mentally and physically prepared for risk and high-risk boardings.

- This tactical approach to any boarding maintains consistency and prevents disorganization and confusion.
- Certain boardings involve unique procedures by virtue of the status, type, or activity of the vessel.

Positive Impression

The marine enforcement team promotes a positive impression by appearance, professional conduct and competence.

All officers should conduct a vessel boarding in a polite and professional manner.

- A professional appearance can be obtained by wearing a PFD when underway, due to the hazards posed in the marine environment, as well as the positive reinforcement to the public about the importance of wearing their PFD.

- During the boarding, utilize effective communications, task direction and good officer presence.
  - Only one officer should communicate with the (suspect) vessel's master.
  - If the crew makes requests, they should be brought to the attention of the senior boarding officer.

- Be prepared to state the purpose and authority for the boarding. Be cautious not to limit the scope of the boarding by indicating a lesser level of boarding authority.

- Confirm any information obtained during the stop and approach to the vessel (i.e. number of persons on board, presence of weapons and location of any valuables on board).
  - Ask for the vessel's official document or registration certificate.
  - Record all the pertinent information; time, geographical location, other vessels and their position in the area, weather and sea conditions, last departure point, destination, activity and what the vessel was engaged in before the boarding and other pertinent information made available during the boarding.
  - Maintain a professional demeanor at all times to minimize the potential of antagonizing the people on board and escalating the risk to the boarding team.

Boarding Team

The recommended number of officers on a boarding team is **two at a minimum.**

- Three or more officers may be required on larger vessels or on a "high risk" boarding.

With a two officer boarding, one officer maintains crew control while the second officer completes the boarding. A larger boarding team allows for increased safety and sharing of the workload.

- Generally, the law enforcement vessel commander is not included in the boarding team.

- By remaining on the enforcement vessel, the vessel commander fills the role of safety lookout and backup.

The senior boarding officer should state name, agency and reason for boarding in a professional manner to the vessel's operator or master prior to boarding.

Determine the identity of the person in charge. If that person is unidentifiable, record the duties of all the persons on board.

Vessel Security Sweep

The purpose of a vessel Security Sweep is for the safety of the marine enforcement team. In addition, it insures the seaworthiness of the vessel.

A vessel is an inherently dangerous environment and a security sweep locates hazards and hidden persons who may be on board a vessel.

- Gas or other toxic fumes
- Taking on water
- Any hazardous conditions

A two person team is recommended to maximize officer safety.

- One officer may do a security sweep if necessary
- However, officers should exercise due caution and be mindful of the lack of available backup

Security sweep methodology

A security sweep of a vessel is executed similar to clearing a building, with one exception, clear the vessel outside to inside and top to bottom (a building is cleared outside to inside and bottom to top).

The clearing of the vessel compartments should proceed away from a security team guarding suspects.

The boarding team should inspect all man-size compartments voids, including private spaces, accounting for all persons and possible hazards on board the suspect vessel.

Agency statutory authority provides for warrant-less inspections and procedures that are exempt from Fourth Amendment requirements. They are provided for under Administrative Inspections.

Outside vessel

Before entering the cabin check any deck hatches, covers, or doors large enough for a person to fit through.

Avoid the "fatal funnel" at every opening. Open hatches, covers and doors from a protected position with something in hand (i.e., flashlight or, if circumstances warrant, a handgun).

Deck hatches may require the officer to lay low and lift the hatch towards them providing a screen while the backup observes from a different angle.

- Check all man-sized compartments including:
- Engine compartments
- After steering voids
- Fish wells
- Dry storage compartments
- Large coolers
- Freezers
- Deck boxes

If the vessel is equipped with a flying bridge do not overlook that area.

- Larger flying bridges usually have ample space to conceal one or two people.
- The foredeck may include; a seating area, deck boxes for storage, a small dinghy, or other locations for concealing suspects.

Inside Vessel

Before entering the cabin officers should avoid the fatal funnel. The weather deck door should remain open. This will allow for communication between the inspection team and the officers outside.

Begin high, working to the deck and inspecting the compartment. Mentally account for all space and access hatches.

If access to the bilges exists in the compartment check them before going further. Keep alert to all occurrences on board.

Remain alert to all surroundings and conditions to avoid developing "tunnel vision."

Totality of the circumstance may dictate a high risk entry or SWAT/ Tactical Waterborne (TWB).

The officer will distinguish between open and plain view when contraband is found.

Open View

Open view is finding evidence in an area which is open to the public, or where there is no reasonable expectation of privacy.

Plain View

Plain view is finding evidence while legally in a space which is normally not open to public view.

- The marine enforcement boarding officer must be legally present in that space.
- The objects must be immediately apparent as evidence.

Security sweeps are not searches. It is an exception to The Fourth Amendment, protecting U.S. citizens from unreasonable searches or seizures.

Controlling others vessels crew and vessel during boarding

Control of the crew and vessel begins before the vessel security sweep. In fact, the vessel and crew response to an attempt to establish control will affect judgment on how to proceed with the boarding. Maintain control over the crew for the sake of officer safety.

Security Sweep

Everyone may be controlled before the security sweep.

- Gather all persons on board the vessel into one area so they can be controlled.
- This may be out on deck or in a common area inside the cabin.
- Before the crew is assembled in the area selected, the location must be cleared for potential weapons.
- Establish control over the crew. Look for any bulges under clothing or other indications of a concealed weapon.
- If the circumstances warrant, a Terry Frisk of the crew may be conducted.
- The names and identification papers of each person on board should be obtained.

The marine enforcement officer must remember that detaining a person is the temporary limitation of that person's freedom of movement. To be lawful, a detention must be reasonable in duration, method and location.

Evidence Collection

During a security sweep, when an officer discovers evidence of a crime that warrants an arrest or seizure. The officer should continue conducting the security sweep and pass the word to all other officers discreetly.

The evidence can be addressed after the security sweep is complete.

- With the element of surprise intact, a safe arrest can be made at this point.
- A complete search can be delayed until arrival at the dock as long as the security sweep is completed and the vessel is secure.

Single Officer Boarding

For safety reasons, a single officer boarding is not recommended. Some agencies, however, operate one man patrol boats due to budgetary or man power constraints.

A single officer should never board a vessel suspected of carrying a large amount of narcotics. However, the authority and responsibility of deciding upon a course of action ultimately rests with the on-scene officer.

IF AT ALL POSSIBLE WAIT FOR BACK-UP TO ARRIVE.

If there is any suspicion the vessel might be engaged in a felony, the marine officer should not engage the vessel but **request and wait for backup.**

If no other marine enforcement unit is available as backup, follow or direct the suspect vessel to a dock and have a land based law enforcement unit provide backup.

If a single officer boarding must be performed, the totality of the circumstance should be taken into consideration.

The officer should conduct as much of the boarding as possible from the law enforcement vessel for officer safety reasons.

- Commercial fishing vessels and large recreational vessels, usually, have two or more persons on board.
- Many of these vessels also routinely have firearms on board.

Both of these facts make a single officer boarding extremely risky.

The officer should minimize risk by attempting to account for all persons on board before initiating the boarding. Have the crew assemble in full view on deck.

It is impossible for one officer to watch all the crew members and conduct the boarding at the same time.

- The officer must be alert at all times.
- The master should accompany the boarding officer to ensure safety.

Vessel Search

A marine enforcement officer must have reasonable suspicion that evidence of a crime may be found aboard the vessel.

A marine enforcement officer must remember while searching that certain areas possess immediate threats. These threats include;

- Doors or hatches (open or closed) could hide people or hazards.
- Crates or containers, and other large areas on a vessel could also hide people or hazards.
- The enforcement officer should be aware of dangerous items/compartments that are readily accessible to captain and crew.

A marine enforcement officer should conduct a search using the same techniques applied in the security sweep. Search the vessel outside to inside, top to bottom. If possible, the search team should consist of two officers.

- The second officer is an extra set of eyes.
- Marine enforcement officers should never enter closed voids or confined spaces. Toxic fumes or lack of oxygen could overcome and cause death in seconds.
- Search the vessel systematically.
- Check all built in storage spaces (drawers, closets, etc.)
- If necessary, remove the stowed equipment in the space to ensure a thorough search.
- Follow the decks through bulkheads to check for false floors or overheads. Remember, people involved in smuggling are not lazy.

Hidden Compartments

The key to detecting hidden compartments is perseverance and the ability to think outside the box.

To determine if hidden compartments are on a vessel, carefully measure the exterior of the vessel.

- Next begin deducting measurements of interior compartments.
- Unaccounted for space, may be cause for suspecting a hidden compartment.

In hidden compartment cases, things are not always what they seem to be. Fuel and water tanks, decks, overheads, bulkheads, even the interior "skin" of the vessel may be false.

Look closely for signs of fresh paint, fresh welds, new gasket material, bright threads on bolts, or lifting pad eyes in unusual locations. Do not fail to consider the exterior of the hull. Contraband has been hidden in waterproof containers affixed to the hull. (Parasite compartments)

Vessels with hidden compartments are often extremely clean.

- They may use a variety of aromatics to mask the smell of narcotics (especially marijuana).
- These aromatics include cloth impregnated fabric softeners (Bounce), pine oil based cleansers, etc.

All voids that can't be visually inspected and all fuel/water tanks should be sounded. These spaces can also be tested by tapping on the exterior with a small hammer. If necessary, tanks can be pumped out to insure they contain only fuel or water. Be suspicious of full tanks, especially when the crew claims to have been at sea for some time. Tanks are usually kept equally ballasted to maintain the trim of the vessel.

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Chapter 3: Environmental Stress

Overview

The crew's physiological well-being plays an important role in the safe and successful accomplishment of each boating safety and enforcement mission. Boat crew members will assist people in a variety of conditions and at times may feel like they have reached the limits of their physical and mental endurance.

Crew Fatigue

Mental and physical fatigue is among the greatest dangers during rough weather operations. The hazards of fatigue dramatically reduce the powers of observation, concentration, and judgment. This reduces the ability to exert the effort necessary, and increases the probability that chances will be taken and prescribed safety precautions to be disregarded. The following are examples of situations that may cause fatigue:

- Operating in extreme hot or cold weather conditions
- Eye strain from hours of looking through sea-spray blurred windshields
- The effort of holding on and maintaining balance
- Stress
- Exposure to noise
- Exposure to the sun
- Poor physical conditioning
- Lack of sleep
- Boredom

At times like these, crew members should not be tempted to take chances, such as towing too fast or crossing a shoal under dangerous conditions. Always keep the safety of the crew and other passengers as the foremost concern.

Crew responsibility

The crew's safety and welfare are the Boat Operator's primary responsibility. A Boat Operator must be constantly aware of stress signs evident in their crew, learn to recognize fatigue, and take corrective action. Crew members must watch each other's condition to prevent excessive fatigue from taking its toll. Note the ability of each member to respond to normal conversation and to complete routine tasks.

Symptoms

The primary symptoms of fatigue are:

- Inability to focus or concentrate/ narrowed attention span
- Mental confusion or judgment error
- Decreased coordination of motor skills and sensory ability (hearing, seeing)
- Increased irritability
- Decreased performance
- Decreased concern for safety

Any one of these symptoms can cause mistakes in judgment or cause a crew member to take shortcuts that could threaten the safety of the mission and crew. It is important to ward off the effects of fatigue before it gets too great. Fatigue can lead to faulty decisions and a "don't care" type of attitude.

Prevention

Boat Operators must be aware of the dangers that exist when crew members push themselves beyond reasonable limits of performance. They should help eliminate mistakes caused by fatigue. Boat Operators must not hesitate to call for assistance when fatigue begins to impair the efficiency of their crew.

Some preventive measures are:

- Adequate crew rest
- Dress appropriate for weather
- Rotate crew duties
- Provide food and refreshments suitable for conditions
- Observe other crew members for signs of fatigue

Environmental conditions

Despite the normal operating climate in a particular area, all crew members must dress (or have clothing available) for unexpected weather. Keeping warm in cold weather and cool in hot weather helps prevent fatigue. Some other environmental conditions that also promote fatigue are:

- Motion sickness
- Glare from the sun
- Wind and rough sea conditions
- Rain
- Vibration (boat engine)

Motion Sickness

Causes of motion sickness

Motion sickness (seasickness) occurs when there is an imbalance between visual images and the portion of the middle ear which senses motion. Mental and physical stresses, as well as the rolling or pitching motion of a boat, contribute to motion sickness. Reading chart work, or other tasks that require close attention, will aggravate motion sickness.

Symptoms

The motion of the boat, especially when the boat's heading produces a wallowing or rolling motion, can cause the typical symptoms of nausea and vomiting. The primary symptoms of seasickness are:

- Nausea and vomiting
- Increased salivation
- Unusual paleness
- Sweating
- Drowsiness
- Overall weakness
- Stomach discomfort

Prevention / medication

Motion sickness can often be prevented or made less severe with different kinds of anti-motion medication, including the use of Scopolamine patches. Crew members who are especially susceptible to motion discomfort should take medication when weather and sea conditions are such that motion sickness is likely to occur. Note that the medications work best when taken approximately 1 hour prior to the anticipated trip. Antihistamines such as Dramamine (generic name is dimenhydrinate) or Antivert (generic name is meclizine) are effective. Dramamine has rapid onset of action and therefore may also work reasonably well if taken soon after symptoms start. The effect of Dramamine lasts about 4 hours, while that of meclizine about 12-24 hours. Note that a major side effect of this medication is drowsiness.

CAUTION!

Some anti-motion medications may cause drowsiness. Consult a medical professional to determine if other alternatives are available.

Besides taking medication, there are other things that can be done to help prevent seasickness.

- Stay out of confined spaces
- Stay above deck in the fresh air
- Avoid concentrating on the movement of the boat by looking out over the water toward the horizon or shoreline
- Avoid prolonged concentration on text or tasks such as NavNet, charts, intricate repair or equipment manipulation.

Lethal Fumes

Introduction

Every year, people are at risk of injury or death from exposure to lethal fumes. Carbon monoxide (CO) is a colorless and odorless gas. It is the most common lethal gas encountered during boat operations.

Conditions where CO may be present

The following conditions are associated with CO poisoning:

- Fuel-burning devices
- Enclosed areas
- Underway
- Fires

Fuel-burning devices

Operating any fuel-burning devices such as gasoline or diesel engines, salvage pumps, propane or alcohol stoves, acetylene torches and kerosene heaters, produces CO fumes.

Enclosed areas

Personnel can be quickly affected by CO fumes in areas such as closed cockpits.

- A defective exhaust system can allow fumes to accumulate in a confined space on board a vessel.

Underway

The boat does not need to be stationary for a problem with CO fumes to occur. For example, a following wind can circulate exhaust gases throughout the cockpit of a slow-moving boat.

The construction of some cockpits or cabins can cause the eddies from a wind current to draw fumes back onboard.

Fires

Breathing the by-products of a fire is another source of dangerous fumes. Even a recently extinguished fire is still dangerous. Fires can also create other highly lethal fumes such as cyanide gases. This happens when different types of plastics, upholstery, cushions, or electronics insulation burn.

Symptoms

Symptoms of lethal fume poisoning can include one or more of the following:

- Throbbing temples
- Dizziness
- Ears ringing
- Watering and itching eyes
- Headache
- Cherry pink skin color

Prevention

- Always ensure adequate circulation of fresh air throughout the vessel.
- Try to minimize the effect of exhaust fumes on the vessel. This may be as simple as making a minor course change, increasing speed, opening a window or cracking open a door, etc.

Response to victims

The first senses affected by poison gases are those that control a person's judgment and decision-making ability. Once a person is affected by dangerous fumes, they may not be able to help themselves.
If carbon monoxide or any other type of poisoning is suspected, get the victim to fresh air and get medical help immediately.

Noise

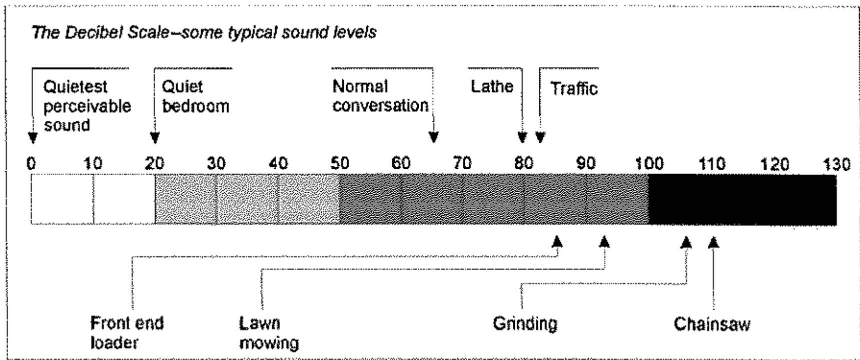
Noise as a fatigue factor

Any continual noise at the same pitch can distract, lull, or aggravate to the point where it adversely affects temperament and the ability to perform properly. Moreover, loud noise can cause hearing loss and contribute to excessive fatigue. Boat Operators should be aware of the effect noise may be having on the crew.

Noise management

These are a few measures to help manage noise:

- Make minor changes to engine speed
- Adjust radio controls so they produce a minimum amount of static
- Use ear protection whenever noise levels exceed 85 decibels.



Weather Related Factors

Introduction

The purpose of this section is to briefly describe the precautions to take while operating in both cold and hot weather. Cold rain, high winds and high temperatures can develop with very little warning. Preparation before encountering these kinds of conditions and understanding their effects on personnel safety is vital.

Effects of Cold Weather

General

Operating in a cold climate presents the challenge of keeping warm enough to tolerate the weather and yet effective enough to carry out the mission. As the temperature drops or you become wet and tired, more insulation is required to keep the body from losing its heat.

Excessive loss of body heat, which can occur even in mild weather conditions, may lead to hypothermia.

Wind

Wind affects body temperature. Those parts of the body exposed directly to the wind will lose heat quickly, a condition commonly referred to as "wind chill." On bare skin, wind will significantly reduce skin temperature, through evaporation, to below the actual air temperature.

Prolonged exposure to the wind may lead to hypothermia.

Crew fatigue

The combination of rough seas, cold temperatures and wet conditions can quickly cause the crew to become less effective. Crew fatigue will occur more quickly when these conditions are present. Many accidents occur when cold induced fatigue sets in because the mind loses attentiveness and physical coordination diminishes. Even a crew which is moderately cold and damp will exhibit a decrease in reaction time which is also a symptom to the onset of hypothermia.

Hypothermia

Hypothermia is the loss of internal body temperature. Normal internal body temperature is 98.6° F (39 ° C) and is automatically regulated by our bodies to remain very close to this temperature at all times. A minor deviation either up or down interferes with the bodily processes. Being too cold will adversely affect the body. Even a minor loss of internal body temperature may cause incapacitation.

Observable signs

Signs that a person may be suffering from hypothermia include:

- Pale appearance
- Skin cold to the touch
- Pupils are dilated and will not adjust properly when exposed to light
- Poor coordination
- Slurred speech / appears to be intoxicated
- Incoherent thinking
- Unconsciousness
- Muscle rigidity
- Weak pulse
- Very slow and labored breathing
- Irregular heart beat

Expect a hypothermic person to tremble and shiver, however, these symptoms may not always be present. When a person stops shivering, their hypothermia may have advanced beyond the initial stages.

Prevention

Never give hypothermia victims anything by mouth.

Cold and hypothermia affect crew safety and mission performance, and prevention must be a top priority. Proper personal protective equipment must be carried onboard.

Heat Related Illnesses

Long hours underway often include exposure to many natural elements. Unexpected changes in the weather, or simply poor planning, can result in exposure problems which can range anywhere from mild discomfort to genuine life threatening emergencies. In addition to one's own health and safety, the Marine Deputy could come upon others' who may be suffering ill effects due to heat overexposure. The prepared deputy should have sufficient knowledge to cope with these emergencies. Many do not consider heat-related emergencies to be serious. Victims of heat cramp and heat exhaustion should be treated and discouraged from returning to their previous activities until fully recovered. Otherwise the conditions will likely worsen.

Heat Cramps

Heat cramps are typically the first symptoms of injury from excessive heat. They can result from simple overexertion on a warm day, or they can be the first signs of a more perilous inability to cope with environmental heat. Signs and symptoms include severe muscle cramps (generally leg and/or abdominal cramps) exhaustion, and occasionally dizziness and/or loss of consciousness.

Emergency Care Procedures

When treating heat cramps one must realize that symptoms can he the first signs of a more serious problem and treat accordingly.

1. Move victim to a cool place.
2. Place the patient in a supine position with legs elevated.
3. Give fluids, preferably with electrolytes (Gatorade, Sports Drinks).
4. Apply moist towels to forehead and cramped muscles.
5. *Do Not* take Salt tablets or Salt water.

Out on the open water the rescuer will have to improvise. Hopefully, shade is available. In a maritime environment there is a ready source of water for wetting clothing or cloths to use as cool compresses. Immersing the victim in water is not recommended since the sudden change in temperature could have harmful effects.

Heat Exhaustion

Heat exhaustion is a more serious result of heat exposure. Signs and symptoms include rapid, shallow breathing, cold, clammy skin, heavy perspiration, general weakness, and possible loss of consciousness. Heat exhaustion can rapidly progress to heat stroke if the victim remains exposed and does not replenish lost fluids.

Emergency Care Procedures

1. Activate EMS system.
2. Move victim to a cool place.
3. Rest victim.
4. Remove enough clothing to cool but don't chill.
5. Give fluids (To conscious / non-vomiting victims only).
6. Treat for shock.
7. Provide victim high concentration of oxygen if available.

Heat Stroke

Heat stroke is a serious life threatening emergency wherein the victim's cooling system has failed. The prolonged high body temperature associated with this condition will likely result in brain damage or death. Signs and symptoms can include difficulty breathing, rapid pulse, dry hot skin, dilated pupils, loss of consciousness, and seizures. Behavioral symptoms may include irritability, confusion, apathy, belligerence, or emotional instability.

Emergency Care Procedures

1. Activate EMS system.
2. Get victim out of the sun into a cooler area (Run air conditioner if available).
3. Place the patient in a supine position with legs elevated.
4. Remove clothing and wrap with wet towels or sheets if possible.
5. Apply water with a sponge or wet towel to keep the skin wet.
6. Rapidly cool the victim in any manner possible (Fan patient aggressively).
7. If cold packs or ice bags are available, pack one under each armpit, behind each knee, one on the groin, one on each wrist and one on each side of the neck.
8. Treat for shock.
9. Provide victim high concentration of oxygen.
10. Victim must be transported to definitive care as soon as possible.

Prevention

You can take some steps to avoid experiencing these kinds of emergencies.

- Condition yourself adequately before engaging in heavy exercise in the heat.
- Drink plenty of liquids before the activity and stay adequately hydrated.
- Consume electrolyte rich beverages prior to the activity.
- Pace yourself.
- Cool off as frequently as possible, particularly when high temperatures and high humidity combine.
- If you start to feel weak – stop, rest and rehydrate.

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Chapter 4: Risk Management

Overview

This section addresses human error and risk decision-making. Both greatly affect the safety of boat operations. Human error has been and continues to be a significant cause of boat mishaps. Ineffective risk decisions have placed the boat and crew at greater risk than necessary. Technical knowledge and skill alone cannot prevent mishaps. It takes teamwork that minimizes, recognizes, and corrects human errors and a systematic process to continuously assess and manage safety risks.

Prudent seamen have exhibited, and human factors researchers have described, critical skills that reduce the potential for human error-induced mishaps. Within these skills are important processes that serve to control safety risks and improve team performance. These critical skills are collectively titled "Team Coordination". The processes are risk management, crew briefing, and crew debrief.

This section mandates the use of team coordination and risk management as part of standard boat operations. It describes the skills and performance standards for each Boat Operator's responsibilities and training requirements. It also describes the risk management, crew briefing and crew debrief processes. (See Risk Calculation Worksheet GAR pg. 4-9)

A team is a collection of people that uses the technical abilities of its members to achieve a common mission. This chapter discusses how team coordination can control:

- Human error.
- Safety Risk Management.
- Continuous improvement in team performance.

Team Relationship

The larger team

A boat consisting of the Boat Operator and crew is a team. But it also is a part of a larger team. Boats seldom perform missions without interacting with other people. Members of this larger team are:

- The Station command (Watch deputy, Watch commander, etc.)
- Other assigned Sheriff's assets (aircraft, boats and patrol units), other government, commercial and private parties (federal, state and local officials)
- Commercial salvagers and Good Samaritans
- The public

In this case the victim is the person or vessel which is the focus of the mission. The mission is the reason for getting the boat underway.

Boat Operator

The Boat Operator wears two hats:

1. The person in charge of the boat team.
2. As the member of the larger team.

Because the majority of boat missions have inherent safety risks, effective coordination of the boat team and the larger team is a cornerstone for mishap prevention.

Risk Management

General

Team coordination is like having a set of tools that, if properly used, can:

- Control human error
- Manage safety risks
- Provide direction for continuous improvement in team performance.

Proper use requires team members, the Boat Operator and the boat crew to routinely use team coordination skills all the time. The skills are the good habits of exemplary leaders. They have been tested within complex missions under ever-changing conditions, and when crew stress and safety risks were high. Like the navigational rules of the road, when team coordination and risk management is properly used an adequate safety margin for mission operations can be maintained.

Leadership Standard

Standards of leadership

The standards of leadership are:

- The boat crew respects each other. The climate is an open one, the crew is free to talk and ask questions about the mission.
- Regardless of assigned duties, the individual with the most information about the situation-at-hand is allowed to participate in mission decisions.
- When disagreements arise, the Boat Operator and crew directly confront the issues over which the disagreements began.
- The primary focus is on solutions to problems. The solutions are generally seen as reasonable. Problem resolution ends on a positive note with very little grumbling among the Boat Operator and crew.

Boat Operator responsibilities

The Boat Operator shall:

- Be in charge and give clear and understandable direction to the boat crew members.
- Monitor crew safety and progress.
- Monitor crew workload and manage crew stress.
- Remain approachable and open to ideas and suggestions.
- Update the crew on significant mission changes.
- Provide to the crew timely, constructive feedback on performance.
- Provide Station with timely updates on boat status.
- Understand level of risk that the mission has and how much risk the Boat Operator is authorized to take.
- Take no unnecessary risks and have contingencies to deal with unacceptable risks.
- Brief the crew on mission objectives and the plan. Permit open discussion to ensure that tasks are understood and crew ideas are considered.
- Update plans based on changes in the situation and/or mission objectives.
- Debrief the crew on mission performance and identify areas for improvement

Boat Operator responsibilities

The Boat Operator shall:

- Not get underway without an understanding of the mission objective, the known risks, and a plan of action.
- Ensure the crew understands the mission plan and assigned tasks.
- Remain alert to mistakes in planning and crew errors. Likewise empower the crew to double check Boat Operator decisions and actions.
- Remain vigilant to changes in the situation. Remain alert to conflicting or ambiguous information that may indicate that the perceived situation is different than the actual one.
- Periodically update the mission coordinator and the crew as to the perceived situation.

Decision-Making Standard

General

The following points reflect the standards of decision-making:

- Boat Operator decisions reflect a willingness to use available information from all sources.
- Most decisions are timely, but may be affected by stress.
- Most decisions are appropriate for the situation; however, the crew may overlook options or discount risk.
- The boat crew does not exhibit hazardous thought patterns (e.g., anti-authority, invincibility, impulsiveness, machismo, or resignation).
- Before the Boat Operator decides and implements a change in objective, the situation may worsen. However, mission accomplishment is not affected and no loss occurs.

Boat Operator responsibilities

The Boat Operator shall:

- Assess current situation and available information to determine ability to meet mission objectives.
- Make use of available time to develop contingencies or alternative courses of actions.
- Consciously weigh the risks versus the gain. Implement the best contingency or action to address the situation.
- Monitor the situation to ensure that the decision produced the desired outcome.

Boat Operator responsibilities

The Boat Operator shall:

- Use standard terminology in giving commands to the crew and in conducting external communications.
- Ensure information and orders conveyed to the crew are acknowledged by the intended receiver.
- Communicate intentions associated with risks to the mission coordinator and the crew.

Assertiveness Standard

General

The following standards reflect the assertiveness necessary for each member of the boat crew team.

- The Supervision, Boat Operator and/or crew occasionally raise questions about the plan or actions when they are in doubt or when they believe the boat is standing into danger. Most of these questions are relevant to risk decision-making.
- The Boat Operator alerts the crew when input is needed to make risk decisions.
- The crew or supervision responds to the Boat Operator's request with pertinent, brief, and timely information. Everyone remains open to questions about the mission.
- Suggestions are listened to without criticism.
- Requests for task assistance are made when overloaded.

Boat Operator responsibilities

The Boat Operator shall:

- Speak up when an error or poor judgment is perceived.
- Notify the station command when the Boat Operator perceives either: the level of risk has changed, the mission is beyond the capabilities of the boat, or the crew has become overloaded or overly fatigued.
- Encourage input and feedback from the crew.
- Treat questions and concerns of the crew with respect.

Four Rules of Risk Management

General

To use the risk management process correctly the team must follow these four rules:

Rule #1 Integrate risk management into mission planning and execution.

- Risk management is an iterative and continuous process.
- Risk management is most effective when it is proactive. It requires that when new information on risks is received, the ability to control those risks is reviewed. It requires the Boat Operator and crew to remain vigilant and safe until the boat is secured and the mission is over.

Rule #2 Do not accept unnecessary risks.

- Unnecessary risk does not contribute to the safe accomplishment of the mission. It is operating beyond the known capabilities of the crew and/or boat without considering other alternatives.
- Unnecessary risks are often taken when decision makers rationalize that the boat is the only alternative or that urgency is more important than safety.
- Unnecessary risk taking constitutes endangering lives, government, and private property.

Rule #3 Make risk decisions at the appropriate level. Many times mishaps occur because the level of risk is not perceived by an individual.

- Understanding of risk is highly dependent upon technical knowledge and expertise; therefore, risk decisions must be made by clear-thinking, technically competent people with an understanding of the situation.
- The mission coordinator and Boat Operator should work as a team in making risk decisions.

Rule #4 Accept risks if benefits outweigh costs. Eliminating unnecessary risk leaves a level of risk that is either acceptable or unacceptable for the accomplishment of a mission.

- "Who owns the mission owns the risk."
- In some cases mission directives outline what is acceptable (i.e. sustaining personnel injury and equipment damage to save lives). However, in high stress situations, the line between acceptable and unacceptable may be unclear.
- Clear-thinking, technically competent people with an understanding of the situation must be involved in the risk decision.
- The mission coordinator and Boat Operator should work as a team in making risk vs. gain decisions.

Risk Management Process

Identifying hazards

Identifying possible hazards to the boat and the crew. Hazards include anything that could go wrong with equipment, in the environment, or with the team.

- Equipment: Is the equipment functioning properly and can it be expected to function properly throughout the mission?
- Environment: How will the weather, water conditions, proximity to hazards, vessel traffic, and available light affect the mission?
- People: Is the team properly trained and capable of handling the demands of the mission? Are they fatigued, complacent, or suffering from physical or mental stress?

Assessing the risks

Risk is a function of the severity, probability and exposure.

- Severity describes the potential loss. Should something go wrong, what would be the injury or equipment damage?
- Probability is the likelihood the consequences described above will happen.
- Exposure is the amount of time, people or equipment exposed to the hazard.

Risk Calculation Worksheet – Calculating Risk Using GAR Model (GREEN-AMBER-RED)

To compute the total level of risk for each hazard identified below, assign a risk code of 0 (For No Risk) through 10 (For Maximum Risk) to each of the six elements. This is your personal estimate of the risk. Add the risk scores to come up with a Total Risk Score for each hazard.

SUPERVISION
Supervisory Control considers how qualified the supervisor is and whether effective supervision is taking place. Even if a person is qualified to perform a task, supervision acts as a control to minimize risk. This may simply be someone checking what is being done to ensure it is being done correctly. The higher the risk, the more the supervisor needs to be focused on observing and checking. A supervisor who is actively involved in a task (doing something) is easily distracted and should not be considered an effective safety observer in moderate to high-risk conditions.

PLANNING
Planning and preparation should consider how much information you have, how clear it is, and how much time you have to plan the evolution or evaluate the situation.

TEAM SELECTION
Team selection should consider the qualifications and experience level of the individuals used for the specific event/evolution. Individuals may need to be replaced during the event/evolution and the experience level of the new team members should be assessed.

TEAM FITNESS
Team fitness should consider the physical and mental state of the crew. This is a function of the amount and quality of rest a crewmember has had. Quality of rest should consider how the ship rides, its habitability, potential sleep length, and any interruptions. Fatigue normally becomes a factor after 18 hours without rest; however, lack of quality sleep builds a deficit that worsens the effects of fatigue.

ENVIRONMENT
Environment should consider factors affecting personnel performance as well as the performance of the asset or resource. This includes, but is not limited to, time of day, temperature, humidity, precipitation, wind and sea conditions, proximity of aerial/navigational hazards and other exposures (e.g., oxygen deficiency, toxic chemicals, and/or injury from falls and sharp objects).

EVENT or EVOLUTION COMPLEXITY
Event/Evolution complexity should consider both the required time and the situation. Generally, the longer one is exposed to a hazard, the greater are the risks. However, each circumstance is unique. For example, more iterations of an evolution can increase the opportunity for a loss to occur, but may have the positive effect of improving the proficiency of the team, thus possibly decreasing the chance of error. This would depend upon the experience level of the team. The situation includes considering how long the environmental conditions will remain stable and the complexity of the work.

Assign a risk code of 0 (For No Risk) through 10 (For Maximum Risk) to each of the six elements below.

Supervision	____________
Planning	____________
Team Selection	____________
Team Fitness	____________
Environment	____________
Event/Evolution Complexity	____________
Total Risk Score	____________

The mission risk can be visualized using the colors of a traffic light. If the total risk value falls in the GREEN ZONE (1-23), risk is rated as low. If the total risk value falls in the AMBER ZONE (24-44), risk is moderate and you should consider adopting procedures to minimize the risk. If the total value falls in the RED ZONE (45-60), you should implement measures to reduce the risk prior to starting the event or evolution.

GAR Evaluation Scale
Color Coding the Level Of Risk

0 – 23	23 – 44	44 – 60
10 20	**30 40**	**50**
GREEN (Low Risk)	**AMBER (Caution)**	**RED (High Risk)**

The ability to assign numerical values or "color codes" to hazards using the GAR Model is not the most important part of risk assessment. Team discussions leading to an understanding of the risks and how they will be managed is critical.

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Chapter 5: Medical Emergencies

Overview

This section provides basic first aid and patient transport information for injuries encountered in the marine environment. This chapter provides basic first aid and transporting information for injuries encountered in the marine environment. First aid can be described as doing what must be done before advanced life support care is available. It may include:

- Providing immediate and temporary care
- Saving life
- Preventing further injury or unfavorable progression
- Preserving vitality and resistance to infection
- Delivering victim if necessary

Proper knowledge and skill in first aid is essential for boat crew members. A well trained crew that responds effectively and professionally to an emergency situation may be the difference between life and death or temporary injury and disability of the victim.

Crew Responsibilities

Crew Members

Crew members should render first aid, consistent with their training, in their role as an emergency first responder regardless of their first aid qualifications. Crew members must request immediate medical assistance for serious injury cases so that appropriate medical resources can be contacted. Crew members providing first aid must do the following:

- Evaluate the scene
- Consider whether or not rescuers are trained and equipped to safely render assistance
- Protect themselves from injury or infection
- Keep calm
- Act quickly
- Activate the Emergency Medical Services (EMS) Response System if necessary

Scene Assessment

When responding, make a quick survey of the scene. Do not enter an unsafe scene until fully prepared and protected against hazards such as exposed electrical wires, toxic vapors, fire, blood, or body fluids. As rescuers, injured crew members unable to help anyone else will complicate an already difficult scene.

Initial patient assessment

Stop and assess the overall condition of the victim. Determine whether or not assisting the patient with the resources at hand is possible or if it requires further help. When more definitive care is required for more serious injury cases, seek assistance immediately. Call for help and activate the EMS system. The following information is important to notice during an initial assessment:

- Number of patients
- General condition of patient(s)
- Mechanism [type] of injury
- Patient(s) level of consciousness
- Monitoring for causes or symptoms of shock.
- Mechanisms consistent with a serious injury such as a gun shot wound, fall from a great height, major burn, crushing accident, etc.
- If the patient's state-of-health has been compromised, for example, prolonged exposure to the elements, dehydration, malnourishment, etc.

In this section, serious injury cases are considered those that need attention from a higher medical professional.

Protective devices

Human blood may contain blood borne pathogens such as Hepatitis B virus and HIV which causes Hepatitis B and AIDS (respectively). Crew members should take all reasonable precautions to prevent direct contact with human blood. They should do this by wearing personal protective equipment (PPE) such as clean disposable gloves or more complete equipment depending on the degree of contamination before making contact with the patient. Human blood can contain infectious agents that may cause a serious or fatal disease. If available, wear masks and eye protection in any instance of known or suspected respiratory infection (i.e., TB). Dispose of blood-soaked gloves and other material with great care.

Unprotected crew members, who come in direct contact with human blood, should immediately report each incident to their supervisor.

Handling and Transporting of Injured

General

Transporting injured persons aboard boats to medical treatment facilities may be encountered by boat crew members. In many situations, it is difficult, if not impossible, for medical help to reach victims. Therefore, the boat crew must possess a basic knowledge of how to transport injured persons safely and quickly to a location where appropriate medical treatment is available.

Boat Operator duty

The sooner a victim arrives at a place where higher medical attention is available, the better. It is the responsibility of the Boat Operator and crew to safely transport the victim as rapidly as possible while preventing further injury, shock, or unnecessary pain.

Moving a patient

Moving a patient is precise work and any carelessness is unacceptable. It requires close teamwork and great care. Even procedures that may seem simple and obvious, such as placing a patient on a stretcher, demand training, coordination, and skill.

The following are important rules to remember when transporting an injured person:

- Make notifications so appropriate medical resources can be activated.
- If possible, avoid moving the patient until that person is examined and all injuries are protected by properly applied splints, dressing, etc.
- If head or neck injury is suspected, immobilize prior to movement.
- Seek assistance before moving a patient.
- For conscious patients, always explain the move procedure in advance.
- Patient movements should be careful, deliberate, and the minimum required.
- Almost all patients are transported lying down.
- The patient must be continuously monitored.

Chapter 6: Water Survival

Overview

The danger of falling overboard, capsizing, or sinking is always present. Few people can stay alive for long in the water without some type of survival equipment. Fear, fatigue, and exposure are the enemies of water survival. The desire to live, think clearly, and proficiently use available equipment make the difference between life and death. The Boat Operator has overall responsibility for the safety of the boat and crew.

The Boat Operator must ensure that all required safety equipment is on board, readily accessible, in working condition, and its use and operation understood by all. However, each boat crew member has the personal responsibility to stay alert and knowledgeable in these matters. This section addresses the characteristics and use of survival gear and signaling devices, including pyrotechnics.

Personal Flotation Device

Introduction

The term "**personal flotation device" (PFD)** is a general name for the various types of devices designed to wear afloat in water. PFDs include life preservers, vests, cushions, rings, and other throwable items. They are available in five different types: Type I, II, III, IV and V. Each type of PFD provides a certain amount of flotation.

Regardless of the type, all PFDs must be Coast Guard approved, meaning they comply with Coast Guard specifications and regulations relating to performance, construction, and materials. A usable PFD is labeled Coast Guard approved, in good serviceable condition, and of appropriate size for the intended user.

- All LAPD Boat Operators and crew members **shall** wear a PFD in accordance with their Units policy.

Type I PFD

General

The **Type I PFD**, or "off-shore life jacket," is a one-piece, reversible PFD intended primarily for use by survivors, passengers on towed vessels, or prisoners aboard vessels. A Type I PFD provides an unconscious person the greatest chance of survival in the water. The Type I PFD is the only wearable device required to be reversible. It comes in two sizes, an adult size (90 pounds and over) which provides at least 20 pounds of buoyancy and a child size (less than 90 pounds) which provides at least 11 pounds of buoyancy, and must be international orange in color.

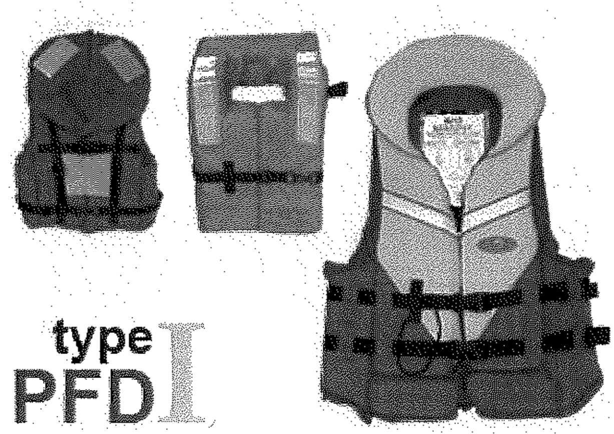
Advantages

Type 1 PFD is effective for all waters, especially open, rough, or remote waters where rescue may be delayed. It is designed to turn most unconscious wearers in the water from a face-down position to a vertical or slightly backward position, allowing the wearer to maintain that position and providing **at least 20 pounds** of buoyancy. This buoyancy will allow you to relax and save energy while in the water, thus extending your survival time.

Disadvantages

There are three major disadvantages to this type of PFD:

- Bulky and it restricts movement.
- Its buoyancy restricts the underwater swimming ability you may need to escape from a capsized boat or to avoid burning oil or other hazards on the surface of the water.
- Minimal protection against hypothermia.



Type II PFD

General

The **Type II PFD**, also known as a "near-shore buoyant vest," is a wearable device that will turn some unconscious wearers to a face-up position in the water. It comes in different colors and in three categories:

- Adult (more than 90 pounds) which provides at least 15.5 pounds of buoyancy;
- Child, medium (50 to 90 pounds) which provides at least 11 pounds of buoyancy ; and
- Infant (available in two sizes, less than 50 pounds and less than 30 pounds) that provides at least 7 pounds of buoyancy.

Advantages

This type is usually more comfortable to wear than the Type I. It is usually the preferred PFD if there is a chance of a quick rescue, such as when other boats or people are nearby.

Disadvantages

The turning characteristic of the Type II is not as strong as with a Type I because of a lesser amount of flotation material, and therefore, under similar conditions, will not be as effective in turning a person to a face-up position.

Type III PFD

General

The Type III PFD, also known as a "floatation aid'" is routinely worn aboard boats when freedom of movement is required, the risk of falling over the side is minimal, and the water temperature is greater than 60 degrees Fahrenheit. It is not designed to turn an unconscious wearer to a face-up position. The design is such that a conscious wearer can place themselves in a vertical or slightly backward position. Most "float coats" are Type III PFDs.

Advantages

Type III PFD offers boat crew members greater comfort and freedom of movement. It is designed so **wearers can place themselves** in a face-up position in the water. The Type III PFD allows greater wearing comfort and is particularly useful when water skiing, sailing, hunting from a boat, or other water activities.

Disadvantages

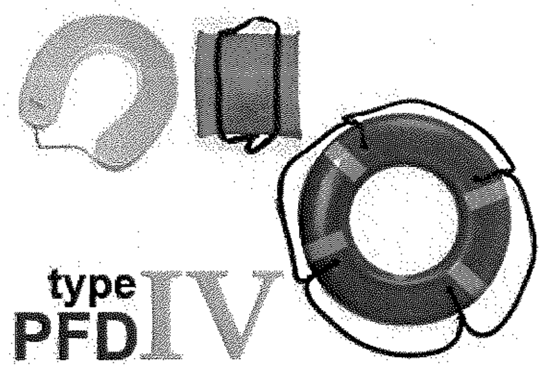
There are some disadvantages in the Type III PFD:

- Flotation characteristics are marginal and not suitable for wear in heavy seas.
- Tendency to ride-up on the wearer in the water.
- Wearer may have to tilt head back to avoid a face-down position in the water.
- While the Type III has the same amount of buoyancy material as the Type II PFD, the distribution of the flotation material in a Type III reduces or eliminates the turning ability.

Type IV PFD

General

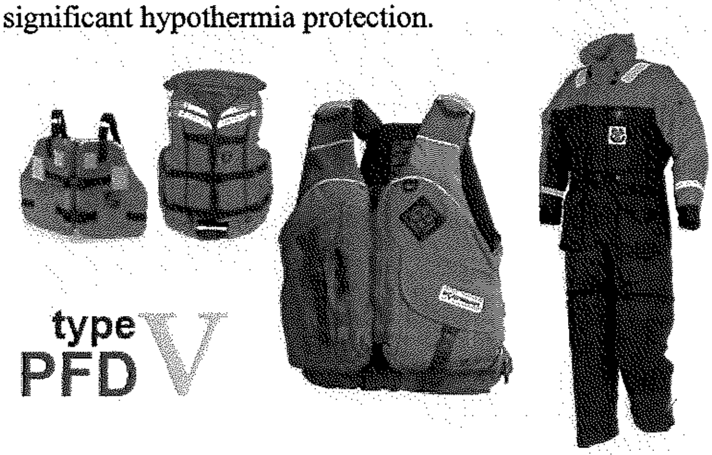
The Type IV PFD is a Coast Guard approved device that is thrown to a person in the water and is grasped by the user until rescued. The most common Type IV devices are buoyant cushions and ring buoys. Buoyant cushions come in many different colors. Ring buoys must be white or orange in color. One of the disadvantages of the Type IV PFD is that it is not worn, although some can be secured to the body once reached in the water.



Type V PFD

General

Type V PFDs are also known as "Special Use Devices." They are intended for specific activities and may be carried instead of another PFD **only if used according to the approval condition on the label**. For example, a Type V PFD designed for use during commercial white-water rafting will only be acceptable during commercial rafting. A Type V is not acceptable for other activities unless specified on the label. Examples of Type V PFDs are: the Coast Guard work vest, sailboard PFDs, "thermal protective" PFDs (deck suits/exposure suits), and hybrid inflatable PFDs. Some Type V devices provide significant hypothermia protection.



Inflatable PFD

General

Inflatable PFDs rely on inflatable chambers that provide buoyancy when inflated. The specific type of PFD is determined by it characteristics.

Inflatable PFDs have the following features:

- They use a CO2-filled cylinder to inflate the device that is triggered manually or automatically.

  Automatic mechanisms use a water-soluble capsule or water-pressure sensor attached to the inflation unit. The mechanism pierces the CO2 cylinder and releases the gas when it is submerged. These PFDs have a back-up manual ripcord.

  Manual mechanisms release the CO2 gas from the cylinder as a result of pulling the ripcord.

- They contain a back-up oral-inflation tube that also deflates the PFD, this oral-inflation tube is also used to maintain buoyancy if pressure is lost.
- Inflatable PFDs are less bulky than inherently buoyant PFDs.
- These PFDs are highly visible when inflated.
- Typical 35lb - 40lb buoyancy when inflated.

Inflatable PFD

HIGHER BUOYANCY MEANS HIGHER LIFT

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

PFD Storage and Care

Storage

Despite the mildew inhibitor treatment required for PFDs, stowing them in moist, damp lockers will increase deterioration of the fabric because of mildew. Remember, heat, moisture, and sunlight will increase the deterioration of the parts of PFDs. Therefore, store PFDs in a cool, dry place out of direct sunlight. A "dry" area is considered any suitable area where water will not condense on a PFD.

All PFDs should be kept away from oil, paint, and greasy substances. Remember, more important than their storage condition is that they are readily accessible. The Coast Guard does not consider any PFD "readily accessible" if it is kept in its original wrapper. Persons under stress may be unable to get them out promptly. Also, the wrapper can trap moisture leading to mildew and rot.

Care

If a PFD requires cleaning, wash it in fresh, warm water with a mild detergent. Then rinse the PFD in clean, fresh water.

Hypothermia Protective Clothing Overview

Introduction

Accidentally falling into cold water has two potentially lethal consequences: drowning or hypothermia. Previously, we discussed the protection provided by PFDs against drowning.

Hypothermia protective clothing is designed to permit you to function in cold weather and water conditions. There are three primary types used:

- Dry Suit
- Wet Suit
- Survival (Exposure) Suit

General

Boat Operators shall require boat crew members to don proper hypothermia protective clothing and a P.F.D. during heavy weather or hazardous operations.

Timely rescue is a high priority when victims are in the water.

Proper clothing

The best way to avoid cold related injuries is to wear proper clothing. When choosing clothing combinations, the best advice is to layer clothing. As the work effort changes or when an article of clothing becomes damp, the number of layers can be adjusted for comfort.

More layers of clothing reduce maneuverability, which can be dangerous for boat crewmembers.

Maintaining body heat

Wet clothing robs the body of heat by breaking down the thermal protection of insulated clothing. It is extremely important to replace wet clothing as soon as possible to prevent cold related injuries, particularly if the person is idle after a period of heavy perspiring. Many cold weather medical problems involve wet hands and feet. These areas should receive special care.

Boat Crew Survival Kit

General

Every boat shall carry a survival kit to help the crew survive in hazardous situations, such as when a boat capsizes or sinks, or someone is lost overboard.

The Survival kit should include a Boat Crew Signal Kit and Survival Knife:

Boat Crew Signal Kit, which provides crewmembers a means to signal their position on the surface of the water, day or night. The Boat Crew Signal Kit should be carried in the pockets and tethered to the PFD, mesh survival vest, or hypothermia protective device. The kit does not interfere with wearing a PFD or hypothermia protective.

The **Survival Knife** is the basic tool used to free yourself from entangling lines. It is also used to cut material blocking a path in escaping a capsized or sinking boat. The selection of a knife is critical; your life may depend upon it. Folding knives are convenient to carry, but may be impossible to open with gloves or with loss of fingers use due to a cold environment. Folding knives may also lack the blade strength required in an emergency. A knife designed for water use such as a diver's knife is the best choice for a survival knife. It should be double edged, corrosion resistant, and checked periodically for sharpness.

Boat Crew Signal Kits contain the following:

- **Signal Mirror**
- **Signal Whistle**
- **Distress Signal Light (Strobe)**
- **Aerial Signal Flare**

Signal Mirror

The **emergency signaling mirror** is a pocket-sized mirror with a sighting hole in the center and a lanyard attached (see Figure 6-1). However, any common mirror is useful as an emergency signaling device.

Emergency Signal Mirror and Whistle
Figure 6-1

Use The mirror is used to attract the attention of passing aircraft, boats, or ground rescue teams by reflecting light at them.

Light reflected in this manner can be seen at a great distance from the point of origin. Practice is the key to effective use of a signal mirror.

Instructions for using the mirror are printed on its back. The steps below describe how to properly use this accessory.

Step	Procedures
1	Face a point about halfway between the sun and an object you wish to signal.
2	Reflect sunlight from the mirror onto a nearby surface such as the raft, your hand, etc.
3	Slowly bring the mirror up to eye-level and look through the sighting hole. You will see a bright light spot, this is the aim indicator.
4	Hold the mirror near your eye and slowly turn and manipulate it so the bright light spot is on target.

Signal Whistle

The sound produced by a whistle will attract the attention of rescuers and guide them to your location (see Figure 6-1). During periods of restricted visibility, fog, and darkness, rescuers may hear the sound it produces before they sight your distress signal light.

Depending on weather conditions, a whistle's audible sound may be heard up to 1,000 meters/1,100 yards. Any wind has the effect of carrying the sound downwind.

Distress Signal Light (Strobe)

The **Distress Signal Light** is a lightweight, compact, battery-operated strobe light that emits a high intensity visual distress signal. The light is intended to omit approximately 50 to 70 flashes per minute (see Figure 6-2).

This light is used to attract the attention of aircraft, ships, or ground parties. Crewmembers should carry the distress signal light in a pocket, or attach it to a line or belt. Keep it tethered to a garment that you are wearing.

Distress Signal Light (Strobe)
Figure 6-2

Aerial Signal Flare

Personal Aerial signal Flares are used to attract vessels, aircraft, and ground rescue teams (see Figure 6-3).

These signals generally produce a red star display at an altitude of 250-450 feet for a minimum time of 6.9 seconds. Their luminous intensity is about 16,000-candle power.

Instructions for use are printed on each flare and vary with each type or manufacture. Crewmembers should be familiar on there use before the need arises.

Aerial Signal Flare
Figure 6-3

Emergency Procedures in the Event of Capsizing

General

Capsizing is the most demanding situation the boat crew could experience. In the event of a capsized vessel, hold on to a reference point and wait for the boat to stop rolling. Interior lights may still operate. Exit the boat and meet crewmates at the boat's upturned hull. Stay together and stay with the boat for as long as possible. Avoid all moving machinery (Propellers, etc.).

Re-entering the capsized boat is not recommended.

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Chapter 7: Marlinspike Seamanship

Overview

Marlinspike Seamanship is the art of handling and working with all kinds of line or rope. It includes knotting, splicing, and fancy decorative work. **There is no better measure of a sailor's worth than skill in marlinspike seamanship**. Much practice is required to become proficient in this skill. Knowledge of line handling terminology, phrases and standard communication among the crew is necessary. To be less than proficient may be costly when the safety of LIFE and PROPERTY depends on the crew's knowledge of marlinspike seamanship.

This section contains information about the types, characteristics, use, and care of line. All crew members should be familiar with definitions, safety practices, line handling commands, and directions for tying knots and making splices commonly used on Sheriff Patrol boats. Included are instructions about basic boat line handling.

Line Characteristics

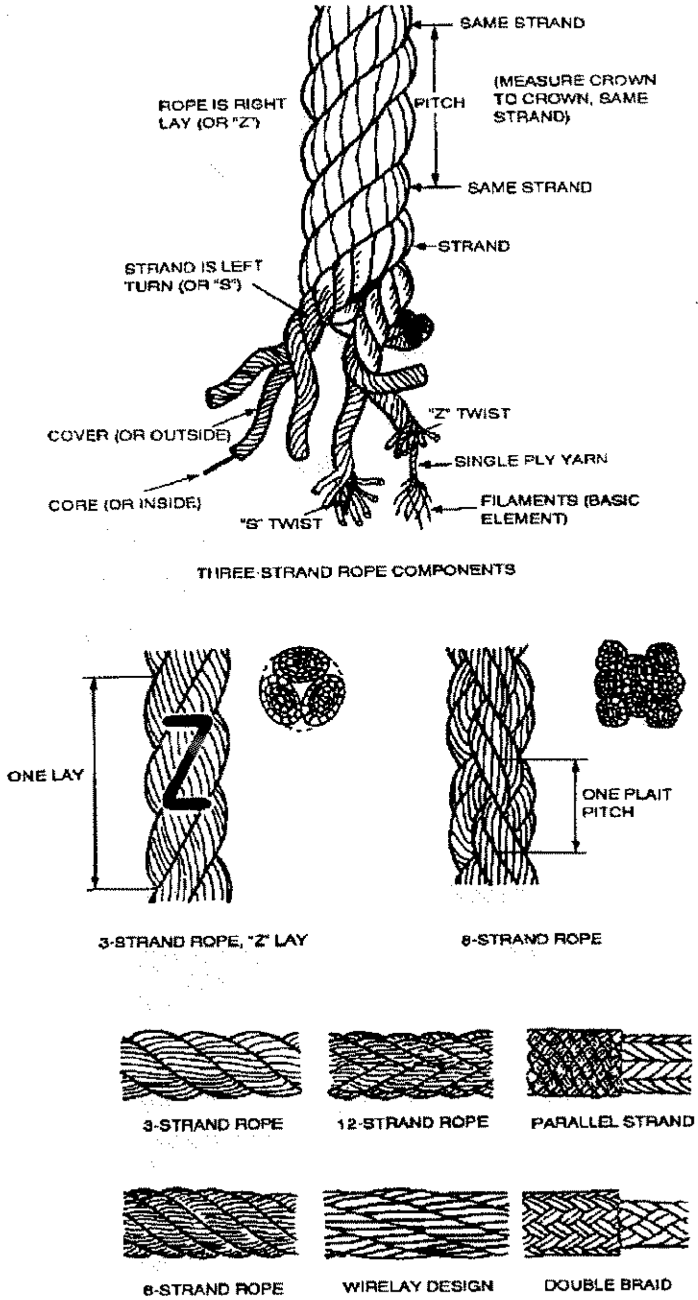
General line construction

Lines are made of natural or synthetic fibers twisted into yarns. The yarns are grouped together in such a way to form strands. Finally, the strands are twisted, plaited, or braided, in various patterns, to form line.

Construction

Strands are twisted to either the right or the left. This twisting is the "lay" of the line. Line may have either a left lay or a right lay depending upon how the strands are twisted together. Line is usually constructed as plain laid, plaited, and double braided lines. Figure 7-1 illustrates fiber rope components and construction. The type of construction will depend upon the intended use of the line.

Type	Characteristics
Plain laid	Made of three strands, right or left-laid. Most common is right-hand laid.
Cable laid	Made of three, right-hand, plain-laid lines laid together to the left to make a larger cable.
Plaited line	Made of eight strands, four right-twisted and four left-twisted. Strands are paired and worked like a four strand braid.
Braided line	Usually made from three strands (sometimes four) braided together. The more common braided lines are hollow-braided, stuffer-braided, solid-braided, and double braided.
Double braided line	Two hollow-braided ropes, one inside the other. The core is made of large single yarns in a slack braid. The cover is also made of large single yarns but in a tight braid that compresses and holds the core. This line is manufactured only from synthetics, and about 50% of the strength is in the core.



Fiber Rope Components and Construction
Figure 7-1

Synthetic Line

Composition

Synthetic line is made of inorganic (man-made) materials. The characteristics of synthetic line are considerably different from natural fiber line. The differences will vary depending on the type of material from which the line is made. The table below identifies the various types of synthetic fiber line used.

Type	Description
Nylon	A synthetic fiber of great strength, elasticity, and resistance to weather. It comes in twisted, braided, and plaited construction, and can be used for almost any purpose where its slippery surface and elasticity is not a disadvantage.
Dacron	A synthetic fiber of about 80% if the strength of nylon but will only stretch 10% of its original length.
Polyethylene and Polypropylene	A synthetic fiber of about half the strength of nylon, 25% lighter than nylon making it easier to handle, and floats in water.

Commonly used types

The most common types of synthetic line used on LAPD boats are nylon and polypropylene. Because of its superior strength and elasticity, nylon is used where the line must bear a load.

Limitations

The main disadvantage is lack of strength compared to nylon line of equal size. Its loose course weave makes it easy to splice but susceptible to chafing. Aggravating this is polypropylene's characteristic of deteriorating rapidly when exposed to continuous sunlight. It can in fact, lose up to 40% of its strength over three months of exposure. For this reason the line is best kept covered when not in use. It should be inspected and replaced on a regular basis.

Slippage

Synthetic line slips much easier than natural line. Because of this, it will slip through deck fittings and not hold knots as well. Be careful when bending synthetic line to an object or to another line to ensure the knot will not slip out. One way to help prevent this is to leave a longer tail on the running or bitter end than you would with natural fiber line.

Considerations

When using synthetic lines consider the following:

- Synthetic line will slip more easily than natural fiber line. You must use caution when paying it or surging it from deck fittings.
- Beware of slippage when bending synthetic line together or securing it.
- Never stand in any position exposing yourself to the dangers of snap back if the line parts.
- Do not double up the line during a towing operation.
- Keep working surfaces of bitts free of paint and rust.
- Do not stand in the bight of a line or directly in line with its direction of pull.

To minimize the hazard of being pulled into a deck fitting when a line suddenly surges ensure all crew members stand as far as possible from the equipment. Work the lines with your hands a safe distance from the fittings. This is particularly important during towing operations.

Inspection

General

A periodic inspection of all lines used should be made, paying special attention to the following items:

- Aging
- Chafing
- Kinks
- Cockles
- Cutting
- Overloading or shockloading
- Rust
- Eye splices

Aging

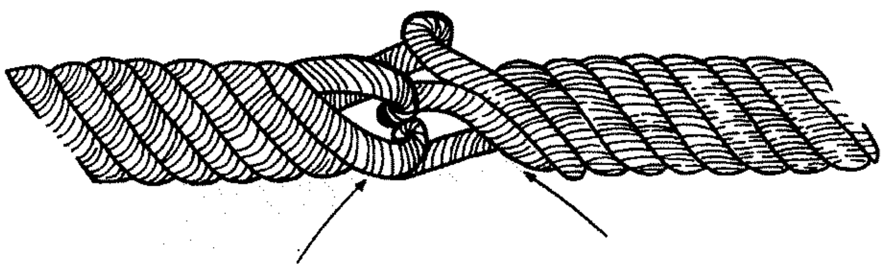
Aging affects natural fibers more severely than synthetic. Cellulose, the main component in natural fibers will deteriorate with age, getting more brittle and turning yellow or brownish. When bent over bitts or cleats, the fibers easily rupture and break. During bending, line strength may decrease up to five times. To check for aging, open the lay of the line and note the color of the interior fibers. In an old line they will be gray or dark brown. Aging is not a significant problem for nylon line, although it will change its color with age. Polypropylene line deteriorates rapidly when exposed to sunlight.

Chafing

Chafing is wear affecting the outer surface of a line, caused by the friction of the line rubbing against a rough surface. To check for chafing, visually inspect the outer surface of the line for frayed threads and broken or flattened strands. With synthetic line, chafing can also cause hardening and fusing of the outer layer.

Kinks

A kink (Figure 7-2) is a twist or curl caused when the line doubles back on itself. Never place a line with a kink in it under strain. The tension will put a permanent distortion in the line. Remove all kinks before using a line.



Line with a Kink
Figure 7-2

Cockles

A cockle (or hockle) is actually a kink in an inner yarn that forces the yarns to the surface. Cockles can be corrected by stretching the line and twisting the free end to restore the original lay. A cockle can reduce line strength by as much as a third.

Braided lines will not kink or hockle.

Cutting

A line damaged by cutting will usually show brooming and yarn end protrusion. This can weaken the line and probably cause line failure under strain.

Overloading or shock-loading

Signs that a line was overloaded are stretch out and hardness. Line stretched to the point where it will not come back has a decreased diameter. To determine this, place the line under slight tension and measure the circumference of a reduced area and of a normal area. If the circumference is reduced by five percent or more, replace the line.
Another indication of synthetic line overloading, is hardness to the touch. You will notice this hardness if you gently squeeze the line. Don't use overloaded line.

A line under strain is dangerous. If a line parts, it will do so with a lot of force, depending on the size and type of line, and how much strain it is under when it parts. As a general rule, when a line is under stress, always keep an eye on it. If you stand in line with the strain you might be seriously injured if the line parts and snaps back at you.

Rust

Rust stains, extending into the cross section of natural fiber and nylon fiber yarns can lower line strength as much as 40%.

Eye splices (double braided nylon line)

Prior to each use, inspect all eye splices in your towline and side lines (mooring lines). Pay particular attention to the female section ensuring there are not "flat spots" where the crossover is buried at the base of the eye. Also inspect the entire eye for chafing and cuts.

Estimating the Length of a Line

Procedure

Estimating a length of a line can be a useful skill. One method of doing so is as follows:

Step	Procedure
1	Hold the end of a length of line in one hand.
2	Reach across with your other hand and pull the line through the first hand, fully extending both arms from the shoulder.
3	The length of line from one hand to the other, across your chest, will be roughly six feet (one fathom). Actually, this distance will be closer to your height, but this measure is close enough for a rough and quick estimate of line needed.

If more line is needed, repeat the process keeping the first hand in place on the line as a marker until you have measured off the length of line required. For example, if you need 36' of line, you would repeat the procedure six times.

Breaking Strength

Knots and splices

Knots are used for pulling, holding, lifting, and lowering. When using line for these purposes it is often necessary to join two or more lines together. Knots and bends are used for temporary joining, and splices provide a permanent joining. In either case, the Breaking Strength (BS) of the joined line is normally less than the BS of the separated lines.

The weakest point in a line is the knot or splice. They can reduce the BS of a line as much as 50 to 60 percent. A splice, however, is stronger than a knot. Figure 7-3 lists each of the commonly used knots and splices. It provides their percent of line BS lost and percent of line BS remaining.

Knots or Splice Remaining	Percent of Line Breaking Strength Lost	Percent of Line Breaking Strength Remaining
Square	46	54
Bowline	37	63
Two Bowlines (Eye in Eye)	43	57
Becket Bend	41	59
Double Becket Bend	41	59
Round Turn	30-35	65-70
Timber Hitch	30-35	65-70
Clove Hitch	40	60
Eye Splice	5-10	90-95
Short Splice	15	85

Percent of Line Breaking Strength Loss
Figure 7-3

Basic Knots

General

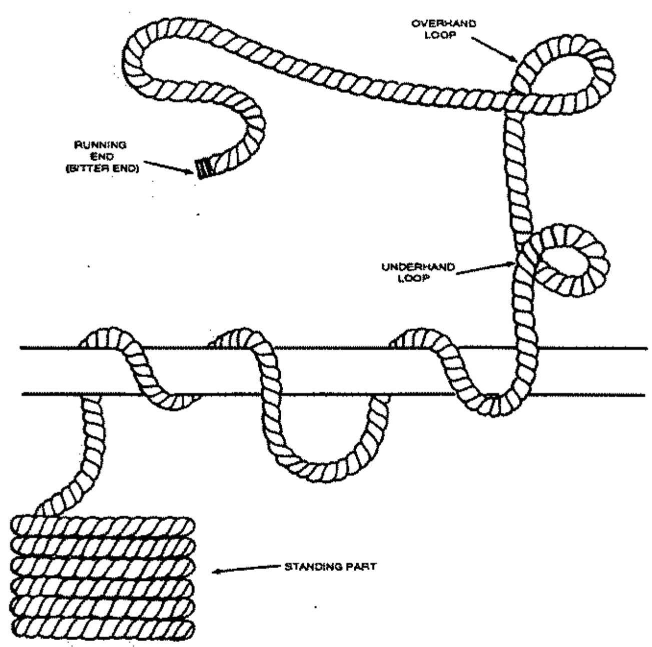
Knots are the intertwining of the parts of one or more lines to secure the lines to themselves, each other (bends), or other objects (hitches). Because knots decrease the strength of the line, they should always be treated as temporary. If you need something permanent, use a splice or seizing.

Definitions

In making knots and splices you must know the names for the parts of a line and the basic turns employed. Refer to figures 7-4 and 7-5 for an example of the following knots.

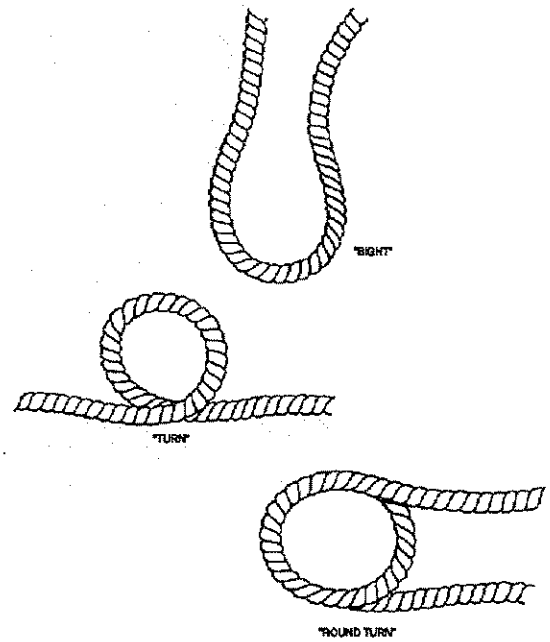
Basic Knots

Knot	Description
Bitter End	The running end or the free end of a line. It is the end of the line that is worked with.
Standing Part	The long unused or belayed end. The remaining part of the line including the end that is not worked.
Overhand Loop	A loop made in a line by crossing the bitter end over the standing part.
Underhand Loop	A loop made in the line by crossing the bitter end under the standing part.



Basic Parts and Loops
Figure 7-4

Knot Name	Description
Bight	A half loop formed by turning the line back on itself.
Turn	A single wind or bight of a rope, laid around a belaying-pin, post, bollard, or the like.
Round Turn	A complete turn or encircling of a line about an object, as opposed to a single turn.



Bight and Turns
Figure 7-5

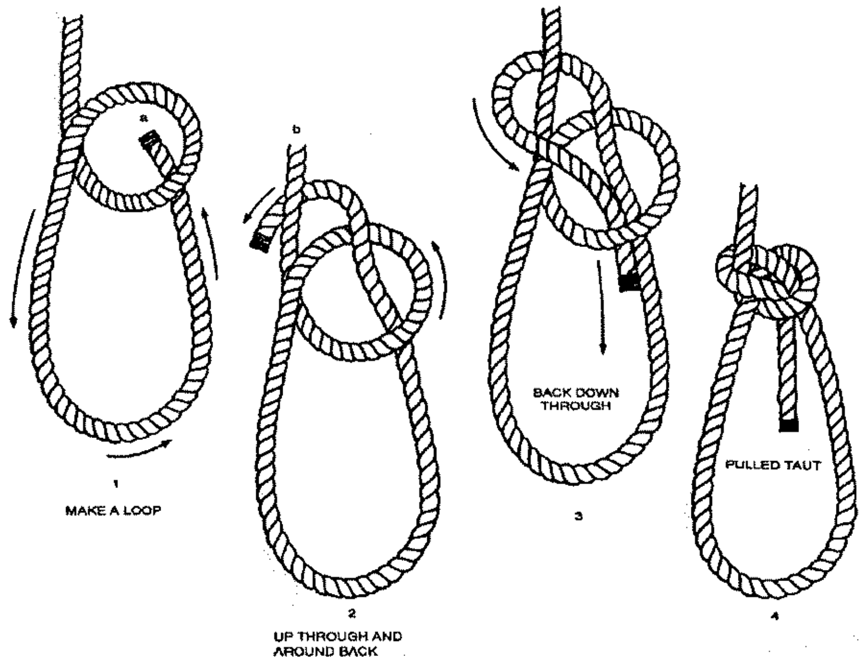
Anatomy of a knot

Good knots are easy to tie, easy to untie, and hold well. A good knot should not untie itself. A knot used to secure lines together is a bend. A knot used to secure a line to an object, such as a ring or eye, is a hitch. The knots listed below are those most commonly used in boat operations. Learn to tie them well, for the time may come when the skill to do so could decide the outcome of a mission.

Bowline

The bowline is a versatile knot. Use it anytime you need a temporary eye in the end of a line. It also works for tying two lines securely together, though there are better knots for this. An advantage of bowlines is that they do not slip or jam easily. Refer to figure 7-6 as you follow these steps below.

Step	Procedure
1	Make an overhand loop in the line the size of the eye desired.
2	Pass the bitter end up through the eye.
3	Bring the bitter end around the standing part and back down through the eye.
4	Pull the knot tight by holding the bitter end and the loop with one hand and pulling on the standing part with the other.

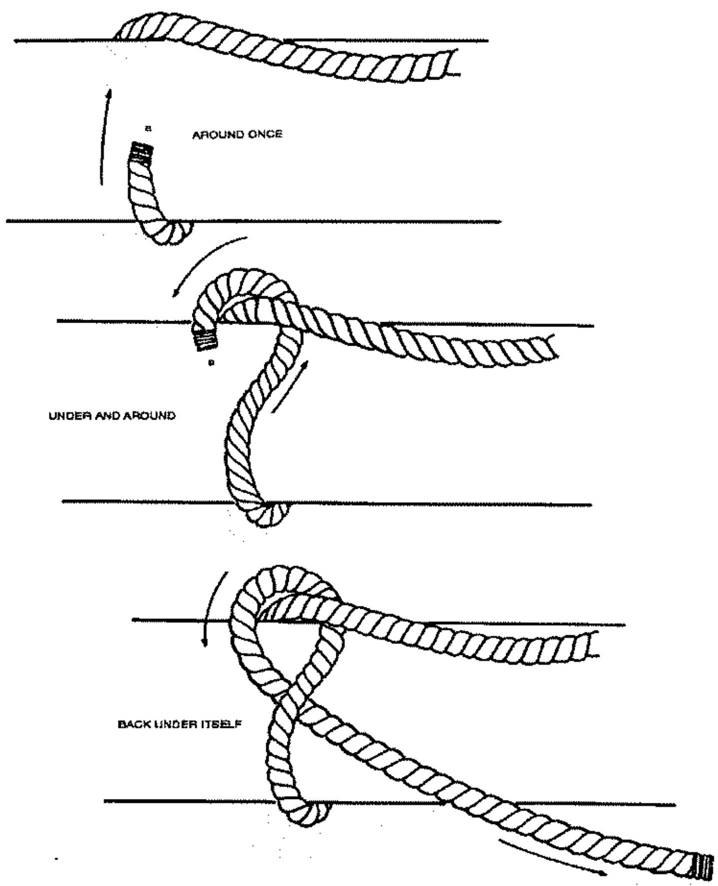


Bowline
Figure 7-6

Half hitches

Hitches are used for temporarily securing a line to objects such as a ring or eye. One of their advantages is their ease in untying. The half hitch is the smallest and simplest hitch. Since a single half hitch may slip easily, use care in cases where it will encounter extreme stress. (Figure 7-7)

Step	Procedure
1	Pass the line around the object.
2	Bring the working end "a" around the standing part and back under itself.

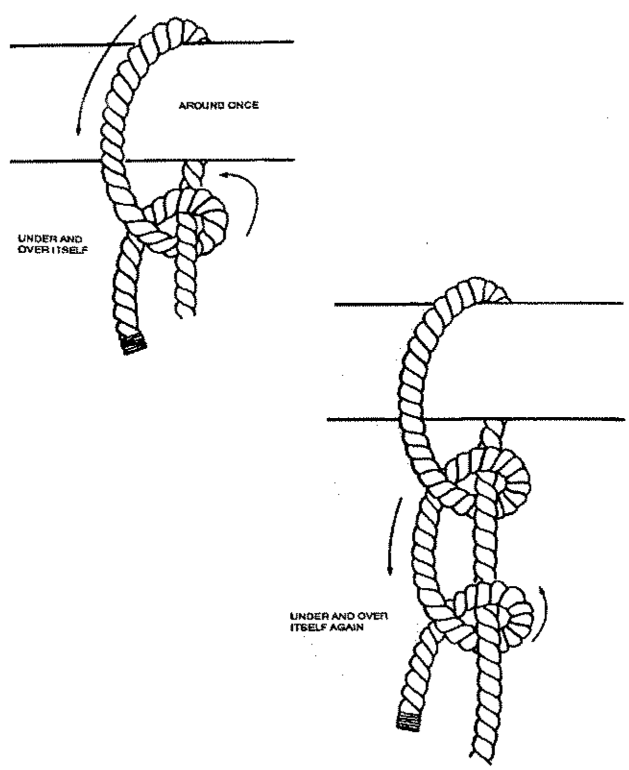


Half Hitch
Figure 7-7

Two half hitches

To reinforce or strengthen a single half hitch, tie more. Two half hitches make a more reliable knot than a single half hitch. Use them to make the ends of a line fast around its own standing part. A round turn or two, secured with a couple of half hitches, is a quick way to secure a line to a pole or spar. Two half hitches are needed to secure a line at an angle where it might slide vertically or horizontally. Refer to the figure as you follow the steps below. (Figure 7-8)

Step	Procedure
1	Take a turn around the object.
2	Bring the bitter end (running end) under and over the standing part and back under itself.
3	Continue by passing bitter end under and over the standing part and back under itself.

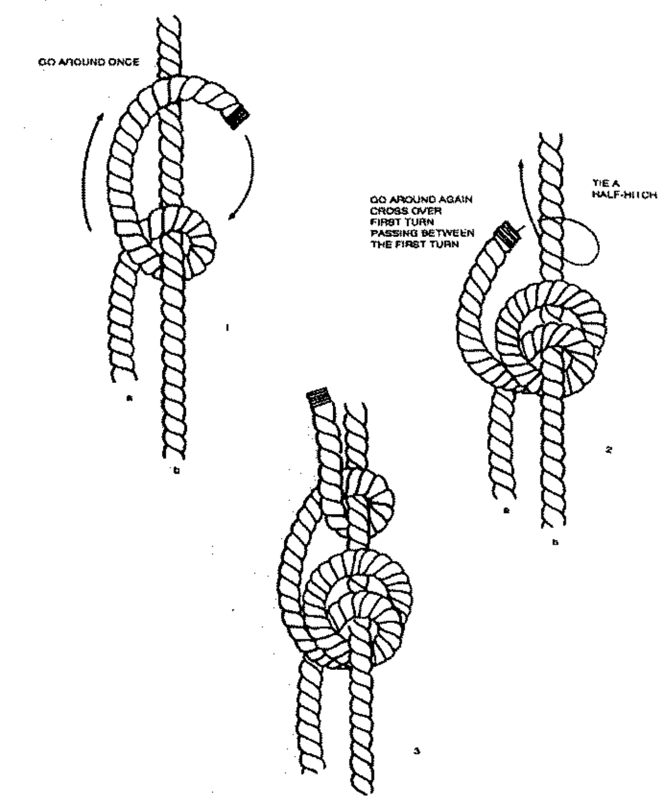


Two Half Hitches
Figure 7-8

Rolling hitch (Stopper)

A rolling hitch is used to attach one line to another, where the second line is under a strain and cannot be bent. (Figure 7-9)

Step	Procedure
1	With the bitter end ("a") make a turn over and under the second line ("b") and pass the link over itself.
2	Pass "a" over and under "b" again bringing "a" through the space between the two lines on the first turn.
3	Pull taut and make another turn with the bitter end ("a") taking it over, then under, then back over itself.
4	Pull taut and tie a half hitch.

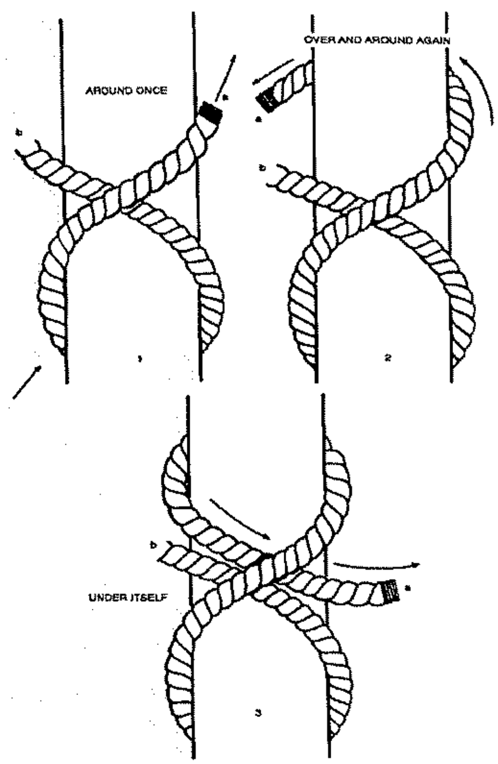


Rolling Hitch
Figure 7-9

Clove hitch

A clove hitch is preferred for securing a heaving line to a towline. It is the best all-around knot for securing a line to a ring or spar. Correctly tied, a clove hitch will not jam or loosen. However, if it is not tied tight enough it may work itself out. Reinforce it with a half hitch. (Figure 7-10)

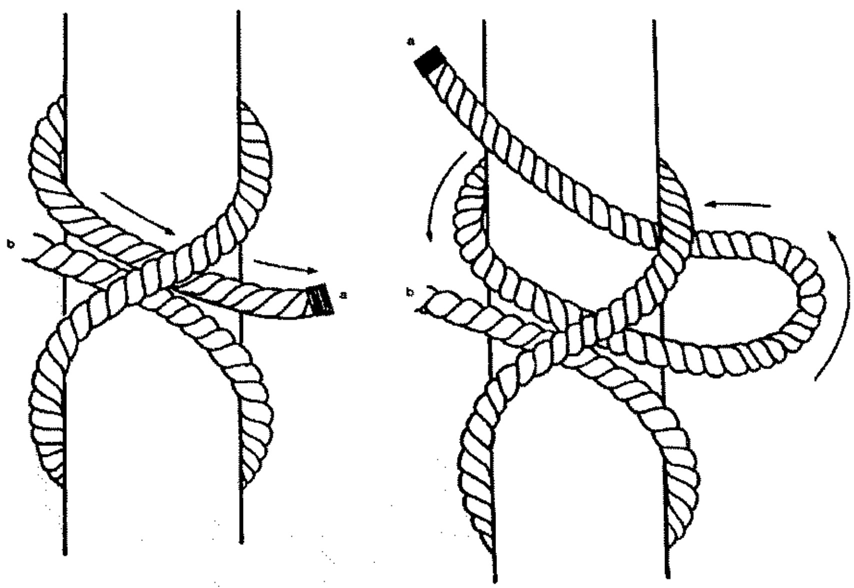
Step	Procedure
1	Pass the bitter end ("a") around the object so the first turn crosses the standing part.
2	Bring the bitter end ("a") around again and pass it through itself.
3	Pull taut.
4	Reinforce by tying a half hitch.



Clove Hitch
Figure 7-10

Slip clove hitch

Use a slip clove hitch in lieu of a clove. Tie it in the same manner as the clove hitch but finish it with a bight to allow for quick release. It is sometimes used for stowing lines and fenders and should not be used when working with the line. (Figure 7-11)

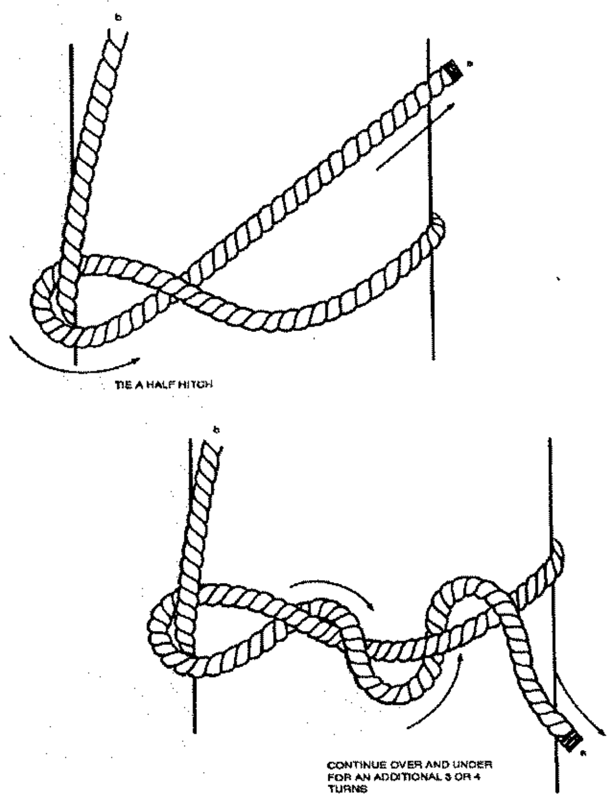


Slip Clove Hitch
Figure 7-11

Timber hitch

Timber hitches are used to secure a line to logs, spars, planks or other rough surfaced object. Do not use it on pipes or other metal objects. (Figure 7-12)

Step	Procedure
1	Tie a half hitch.
2	Continue taking the bitter end ("a") over and under the standing part.
3	Pull the standing part taut.
4	You may add two half hitches for extra holding. Unless you can slip the half hitch over the end of the object, tie it before making the timber hitch.

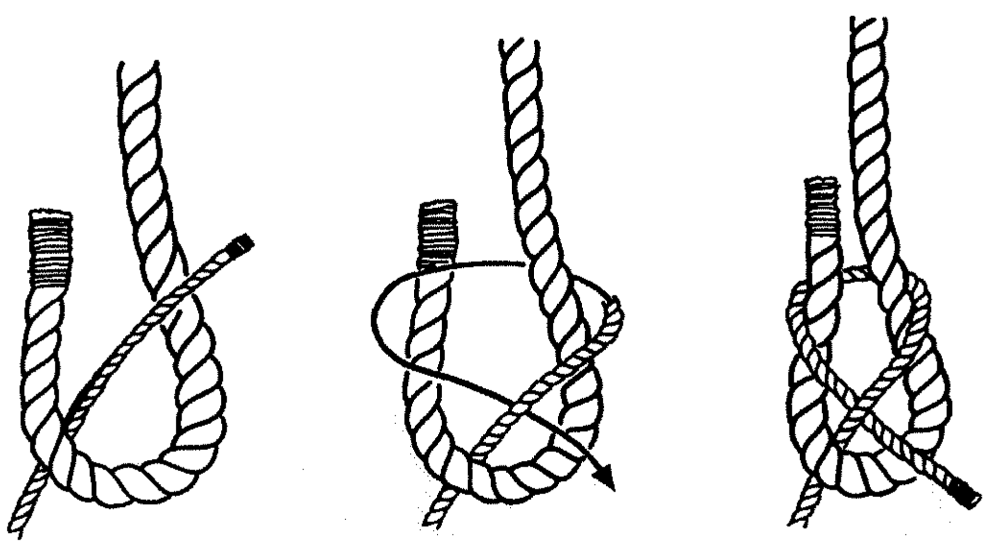


Timber Hitch
Figure 7-12

Single becket bend (sheet bend)

Lines can be lengthened by bending one to another using a becket bend. It is the best knot for connecting a line to an eye splice in another line. It can be readily taken apart even after being under a load. Single becket bends are used to join line of the same size or nearly the same size. It is intended to be temporary. Most commonly used to attach a heaving line to a heavy towline to pass between vessels. The larger of stiffer of the two making the bend. (Figure 7-13)

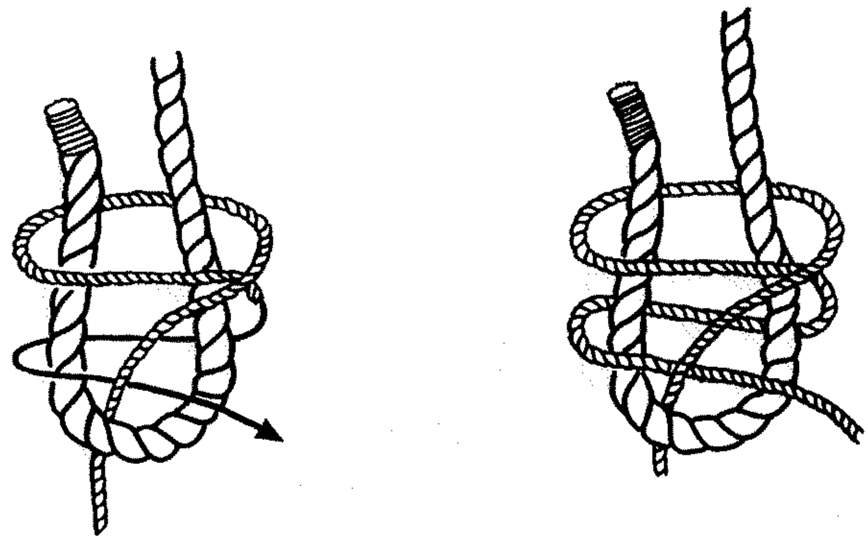
Step	Procedure
1	Form a bight in one of the lines to be joined together, line "a".
2	Pass the bitter end of the second line "b" up through the bight formed by the first line "a."
3	Wrap the end of line "b" around the bight in "a".
4	Pass the end of "b" under its own standing part.
5	Pull taut.



Single Becket/Sheet Bend
Figure 7-13

Double becket bend (double sheet bend)

The double becket bend works for joining lines of unequal size. The larger of stiffer of the two used as the bend. It is tied in the same manner as the single becket bend except for the following variation in step 4 above: Pass line "b" around and under its standing part twice. Use the double becket when used to join two tow lines to lengthen the tow line. (Figure 7-14)

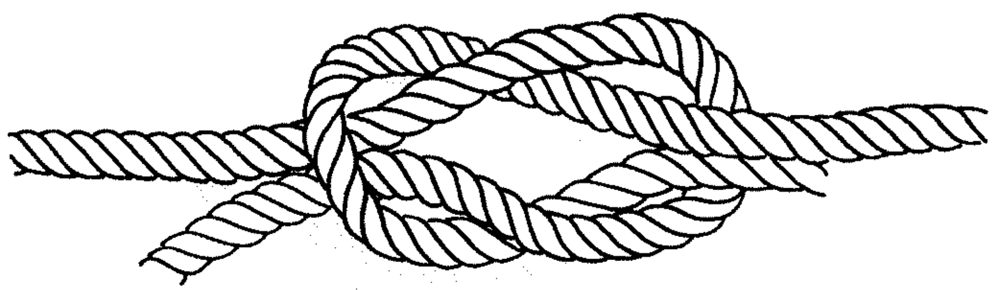


Double Becket/Sheet Bend
Figure 7-14

Reef knot (square knot)

Called a square knot by Boy Scouts, the reef knot is one of the most commonly used knots in marlinspike seamanship. Reef knots are rarely used on small boats because they jam badly under strain. Also, reef knots do not effectively hold lines of different sizes or materials. Reef knots are best used to finish securing laces (canvas cover, awning, sail to a gaff, etc.), temporary whippings, and other small stuff. Avoid the knot and use the becket bend in its place. (Figure 7-15)

Step	Procedure
1	Tie a single overhand knot.
2	Tie a second overhand knot on top so it mirrors (right and left reversed) the first one. The ends should come out together.
3	Draw tight.

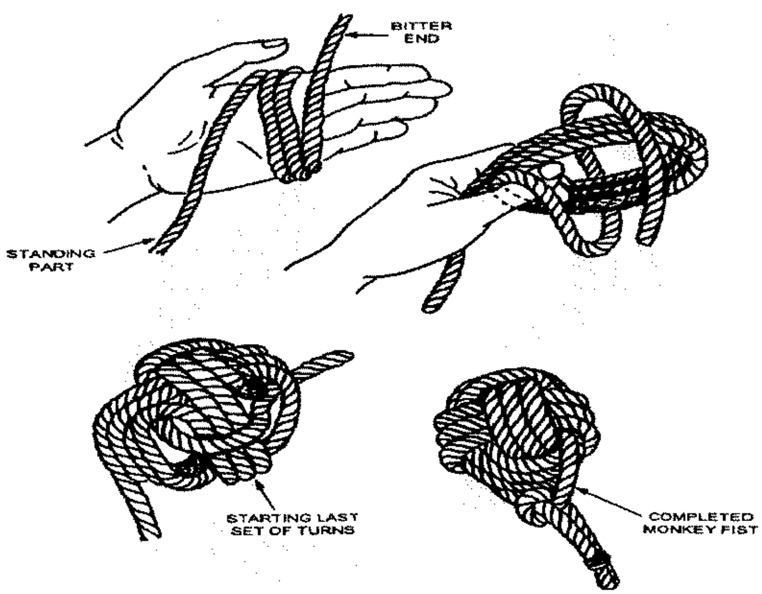


Reef Knot (Square Knot)
Figure 7-15

The monkey's fist

Because some lines, such as towlines, are too heavy and awkward to throw any distance, a heaving line, with a "Monkey's fist" tied on one end, is often used. (Figure 7-16)

Step	Procedure
1	Lay a bight of the line across the fingers of the left hand, about three and one-half feet from the end, holding the standing part with the left thumb.
2	With your fingers separated, take three turns around them.
3	Next take three turns around the first three and at right angles to them.
4	Take the knot off your fingers and take an additional three turns around the second three and inside the first three.
5	Take additional care at this step. Place the core weight into the knot and tighten it down carefully.
6	After tightening, there should be about 18 inches of line left on the bitter end. This can be brought up and seized alongside to the standing part.



Monkey's Fist
Figure 7-16

Figure eight (stopper)

A figure eight knot is an overhand knot with an extra twist. It will prevent the end of a line from feeding through a block or fairlead when heavy loads are involved. It is also easier to untie and does not jam as hard as the over hand knot. (Figure 7-17)

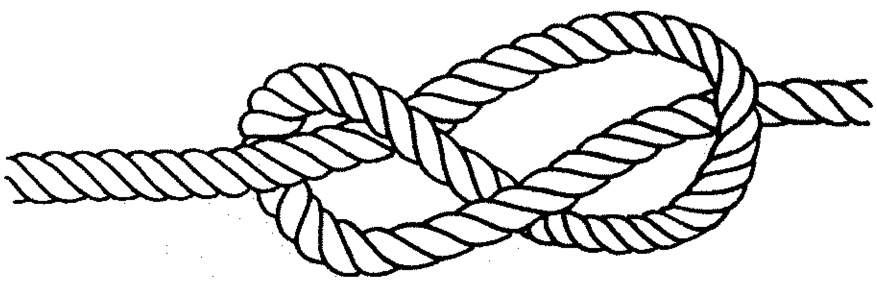
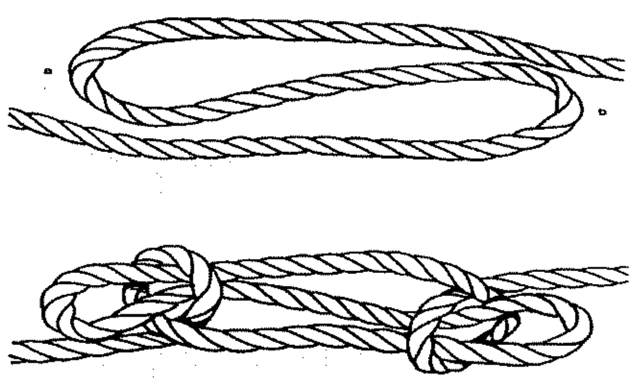


Figure Eight knot
Figure 7-17

Sheepshank

This hitch is used for temporarily shortening a piece of line. It consists of two bights of line, side-by-side, with a half hitch at either end. (Figure 7-18)

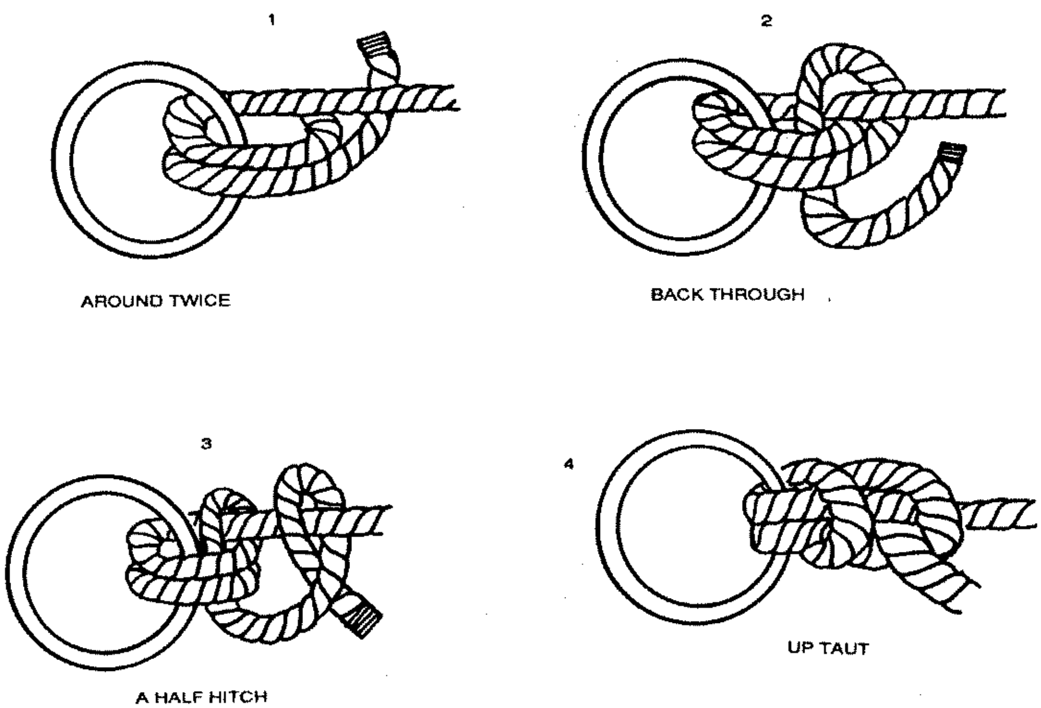


Sheepshank
Figure 7-18

Fisherman's or anchor bend

This bend is used to secure a line to a ring in an anchor or mooring buoy and can also be tied around a spar. (Figure 7-19)

Step	Procedure
1	Pass the bitter end through the ring and around twice creating two loops spiraling downward
2	Wrap the bitter end up around the standing end and pass back through the loops at the top.
3	Tie a half hitch.
4	Pull taut.

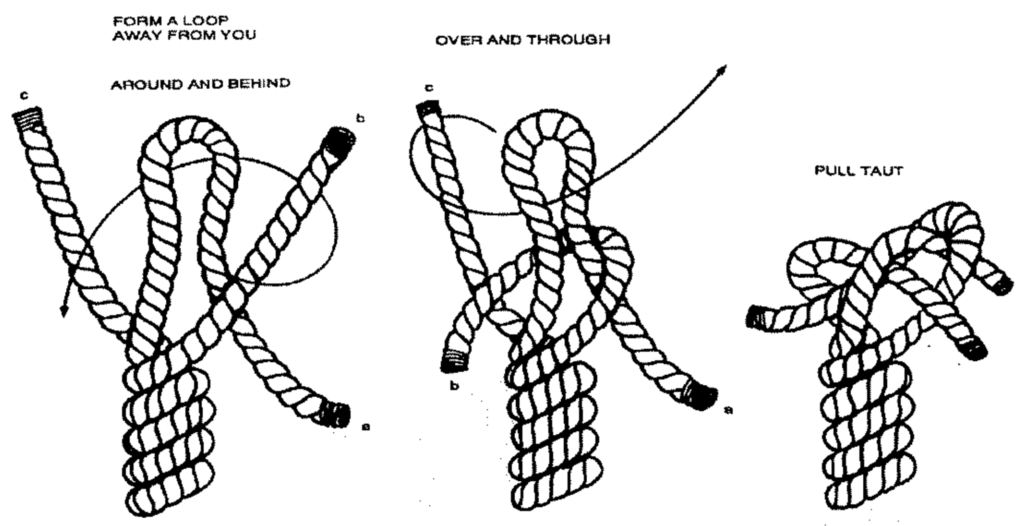


Fisherman's or Anchor Bend
Figure 7-19

Crown knot

A crown knot may be used to prevent an unwhipped line from unlaying. (Figure 7-20)

Step	Procedure
1	Unlay the strands of the line about 12".
2	Separate the strands and hold them up with the middle strand facing you.
3	Bend the middle strand "a" away from you and form a loop.
4	Bring the right strand "b" around behind the loop, placing it between strand "c".
5	Bring strand "c" over strand "b" and through the loop formed by strand "a".
6	Pull taut by heaving on each of the three strands.
7	Lay the back splice by tucking each strand back up the line. The splicing is done as if making an eye splice.

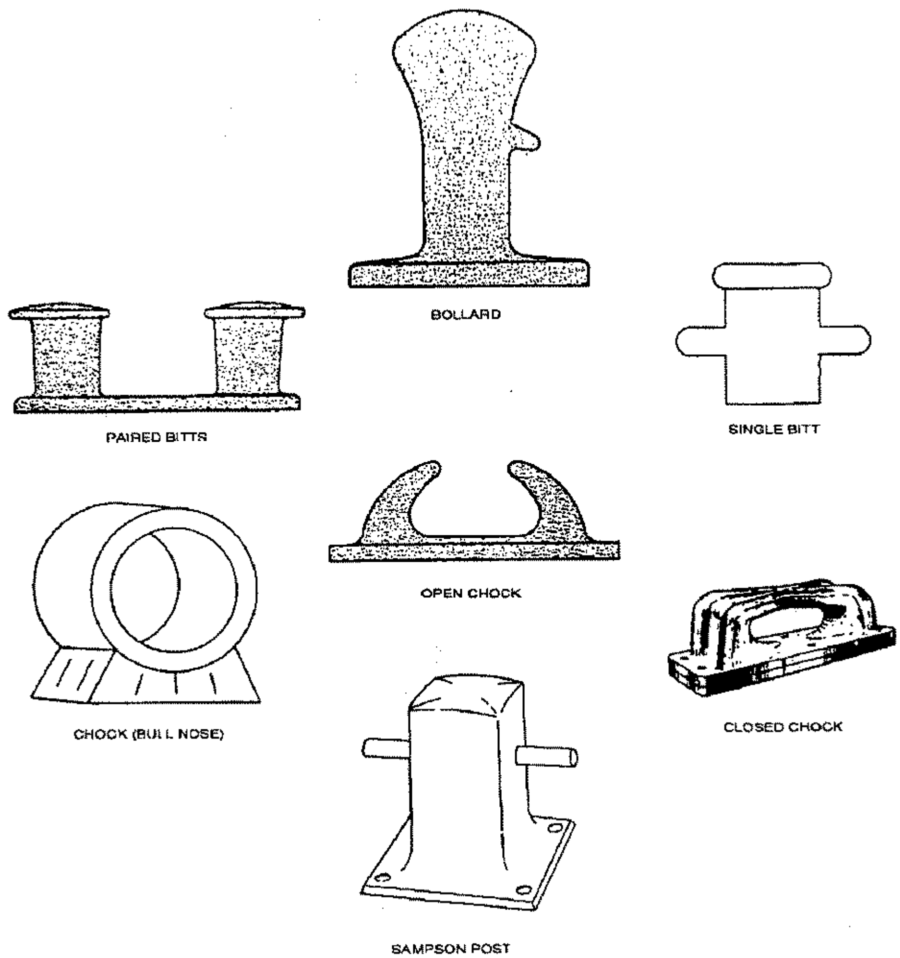


Crown Knot
Figure 7-20

Deck Fittings

General Deck fittings are attachments or securing points for lines. They permit easy handling and reduce wear and friction on lines.

Types of fittings There are three basic types of deck fittings: Bitts, cleats, and chocks. Several types of deck fittings are shown. (Figure 7-21)



Types of Deck Fittings
Figure 7-21

Line Handling

General

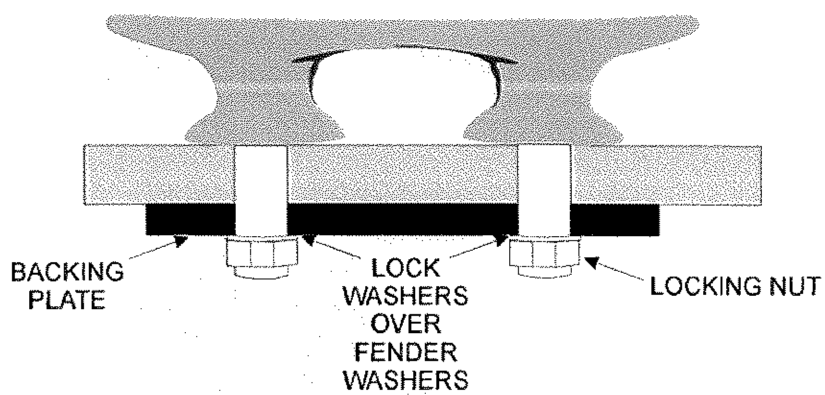
Most Patrol boats have a towing bitt and a bow bitt. You find cleats on the decks next to the gunwales on each side of a boat used with bitts and cleats to help prevent chafing of the line. The chock provides a smooth surface for the line to run over or through. Because of the difference in the structural design of nonstandard boats, the strength of their deck fittings will vary widely.

Using proper sized line

The size of the deck hardware depends on the size of line to be used for mooring docking and towing. Cleats are sized by length, and the rule of thumb is the line should be 1/16" in diameter for each inch of cleat ($^3/_8$" line = 6" cleat, 1/2"line = 8" cleat.

Back up plates

All deck hardware that is used for towing should have back up plates to distribute the load over a wide area. The back up plate can be made of pressure treated hardwood or exterior grade plywood, at least twice as thick as the largest bolt diameter. Use bolts, not screws. A flat washer and a lock washer must be used with the bolt. The flat washer is three times the bolt diameter. If metal is used, the thickness should be at least the same as the bold diameter. The use of soft aluminum is not recommended. Bedding compound should be used in all installations. (Figure 7-22)



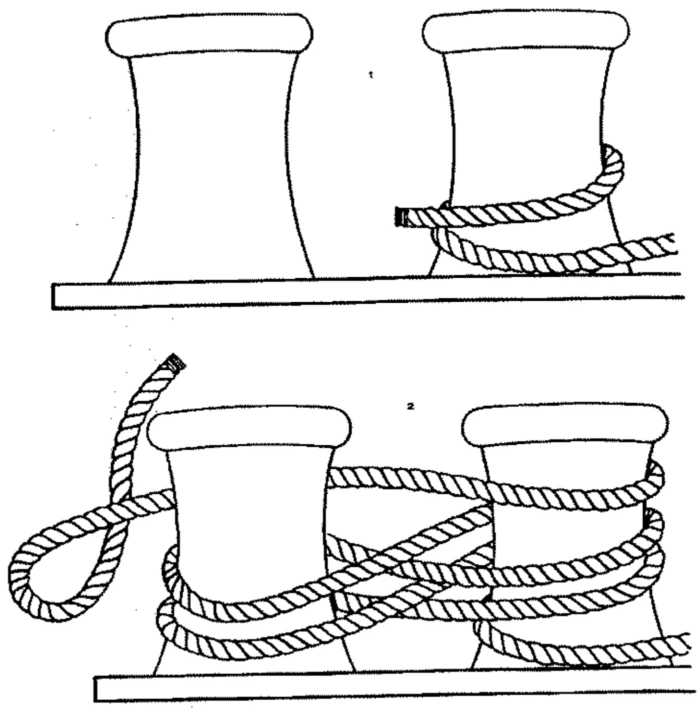
Back Up Plate
Figure 7-22

Securing a line to a bitt

The procedure below describes how to secure a line to a bitt. (Figure 7-23)

Step	Procedure
1	Make a complete turn around the near horn
2	Make several figure eights around both horns. (Size of line and cleats may restrict the number of turns. Minimum of 3 turns is the standard).
3	Finish off with a round turn.

Avoid the use of half-hitches, weather hitches, and lock hitches on standard boats

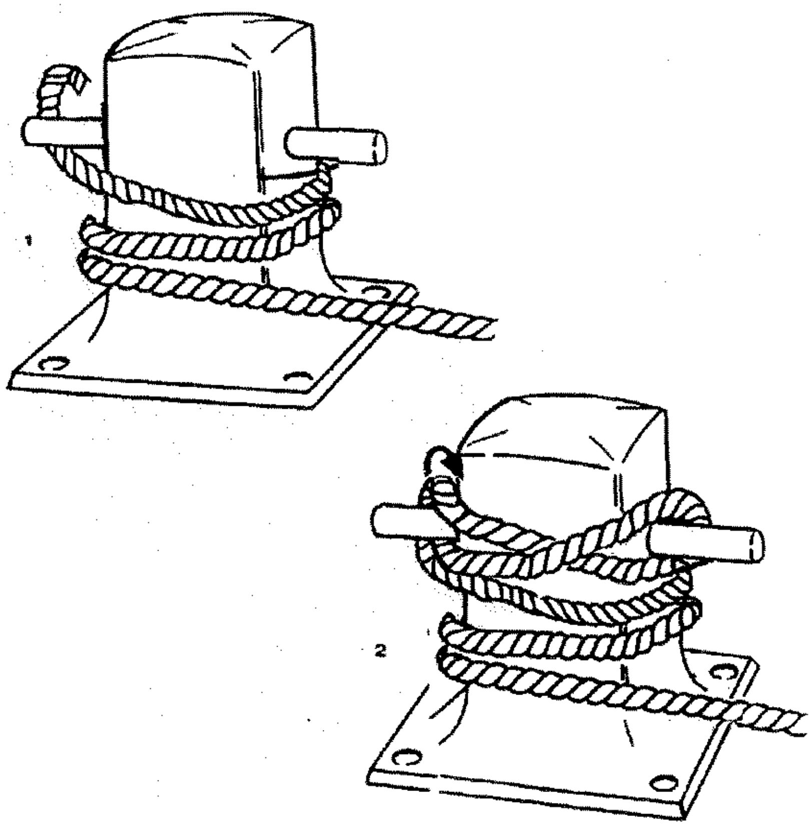


Securing a Line to a Bitt
Figure 7-23

Securing a line to a Sampson Post

A Sampson Post is a vertical timber or king post on the forward deck of a boat. They are used as a bow cleat or bitt. (Figure 7-24)

Step	Procedure
1	Make a complete turn around the base of the Sampson Post.
2	Form several figure eights around the horns of the Sampson Post. (Standard is 3 turns.) A half hitch is not needed to secure the line when 3 or more turns are on. You <u>will</u> need a half hitch to secure the line when 3 turns are not possible due to a short line.

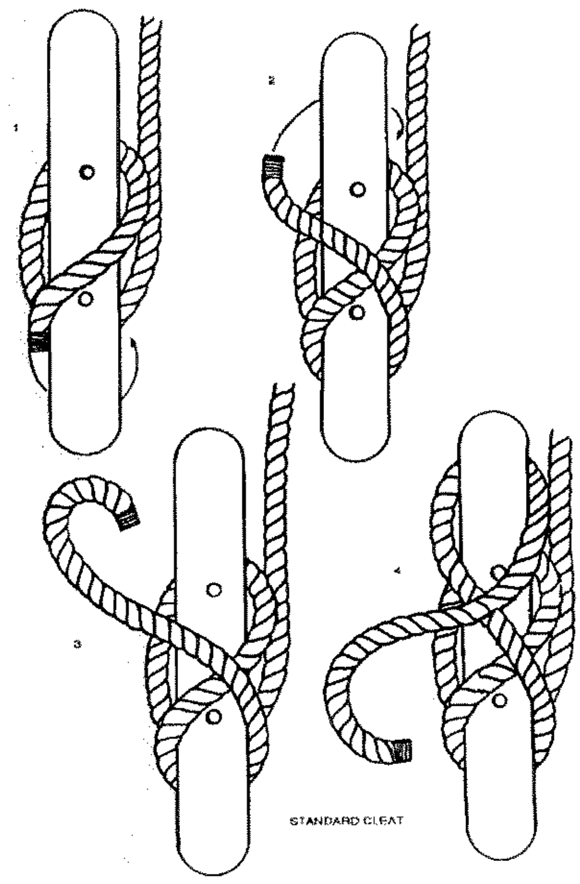


Securing a Line to a Sampson Post
Figure 7-24

Securing a line to a standard cleat

The procedure below describes how to secure a line to a standard cleat. (Figure 7-25)

Step	Procedure
1	Make a complete turn around the cleat. This turn should start from the farthest horn of the cleat on the same side that the boat is on.
2	Lead the line over the top of the cleat and around the horn to form a figure eight.
3	If possible, make two more figure eights and secure with a half hitch.

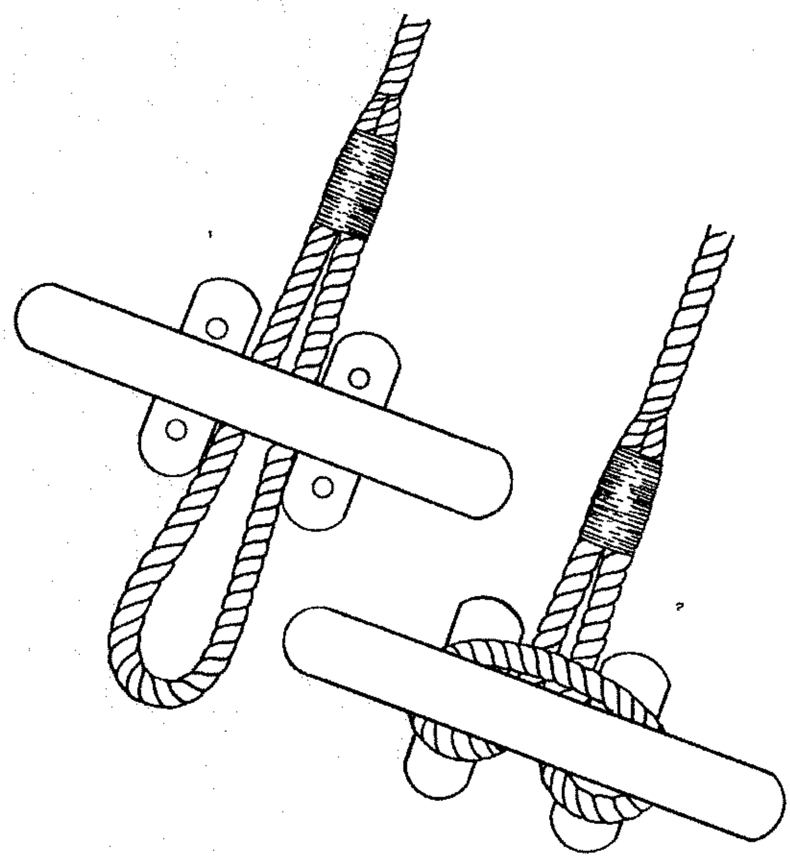


Securing a Line to a Standard Cleat
(Figure does not show extra figure eights)
Figure 7-25

Securing a line to a mooring cleat

The procedure below describes how to secure an eye of a line to a mooring cleat. The method is discouraged since it may be difficult to remove under strain. Generally, for our purposes, simply place the eye of the line over the cleat. This method works great when the cleat has a broken horn. (Figure 7-26)

Step	Procedure
1	Feed the eye of the line through the opening.
2	Loop the line back over both horns and pull the line taut.

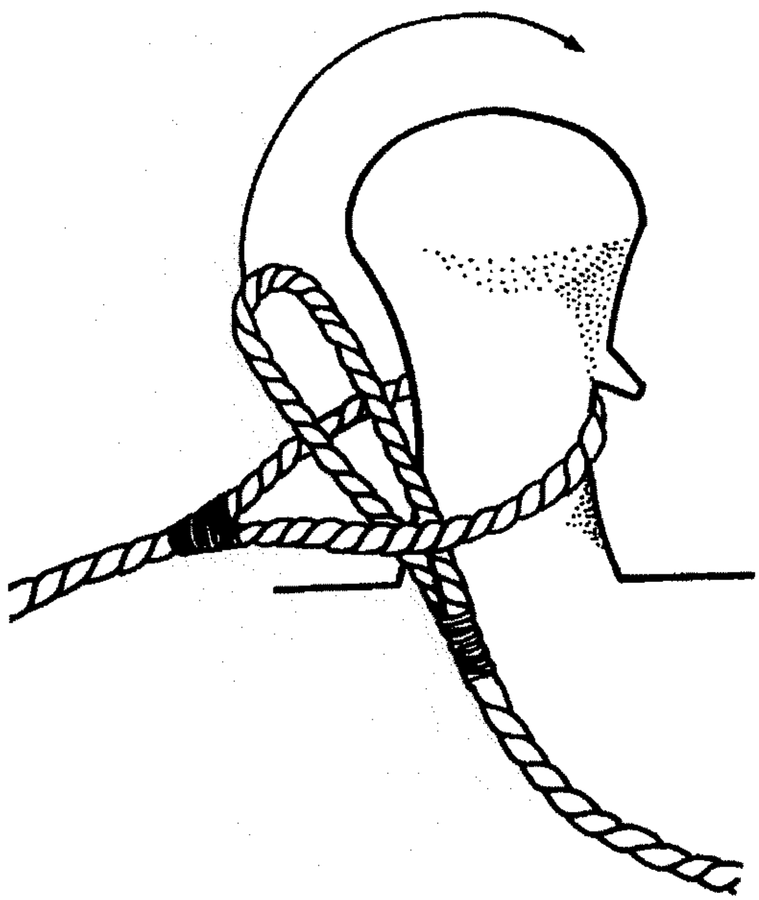


Securing a Line to a Mooring Cleat
Figure 7-26

Dipping the eye

When two lines with eye splices are placed on a bollard, it may not be possible to remove the bottom line until the top line is removed. By dipping the eye, both lines can be placed for easy removal (Figure 7-27).

Step	Procedure
1	Place the eye of one mooring line over the bollard.
2	Take the eye of the second line up through the eye of the first line.
3	Place the eye of the second line over the bollard.



Dipping the Eye
Figure 7-27

Securing a towline

The towline is a potential danger to anyone near it. Towlines should be made up so slack can be paid out at any time or so the line can be slipped (cast off) in an emergency. Any adjustment of the towline on the tow bitt should be done with no significant strain on the line. Additional information on the use of towlines is found in Chapter 17.

Step	Procedure
1	Place a working turn on the bit by placing the towline over one of the horns and cross over to the other horn. It is from this position the tow line is lengthened or shortened.
2	When the proper amount of line is out, at the direction of the Boat Operator, secure the line using figure eights. A minimum of three turns is needed to secure the line
3	Complete with one round turn on the bitt. No half-hitch is needed with at least three turns on the bitt to add in rapid removal if needed.

Avoid the use of half-hitches, weather hitches, and lock hitches on standard boats.

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Chapter 8: Terminology

Overview

Knowledge of your boat's characteristics is crucial in performing safe boat operations. All crew members must be able to recognize and correctly apply boat related terminology. They must also be able to locate any piece of gear quickly and operate all equipment efficiently, even in the dark. To accomplish these tasks, crew members must be familiar with the boat's layout. Each boat has specific operational characteristics and limitations. These are outlined in the boat's manuals. Some types of characteristics the boat crew should be familiar with include:

- Maximum speed
- Economical cruising speed
- Maximum range at various speeds
- Maximum endurance of boat at cruising speed
- Minimum required crew size
- Maximum number of people that can be safely carried
- Maximum load capacity

This section covers the basic knowledge needed to know your boat. For additional definitions, see the Glossary.

Boat Nomenclature and Terminology

As with any profession or skill, there are special terms mariners use. Many of these terms have a fascinating history. Fellow mariners will expect that you are familiar with these terms and use them in your routine conversation. Many of these words will be discussed within this section.

Definitions The following are common terms used for location, position and direction aboard a boat. Figure 8-1 provides a diagram of a boat with the more common terms noted.

Bow The front end of a boat is the bow. When you move toward the bow, you are going **forward;** when the boat moves forward, it is going **ahead.** When facing the bow, the front right side is the **starboard bow**, and the front left side is the **port bow**.

Amidships The central or middle area of a boat is amidships. The right center side is the **starboard beam,** and the left center side is the **port beam.**

Stern The rear of a boat is the stern. When you move toward the stern, you are going **aft**. When the boat moves backwards, it is going **astern.** If you are standing at the stern looking forward, you call the right rear section the **starboard quarter** and the left rear section the **port quarter.**

Starboard The entire right side of a boat, from bow to stern.

Port The entire left side of a boat, from bow to stern.

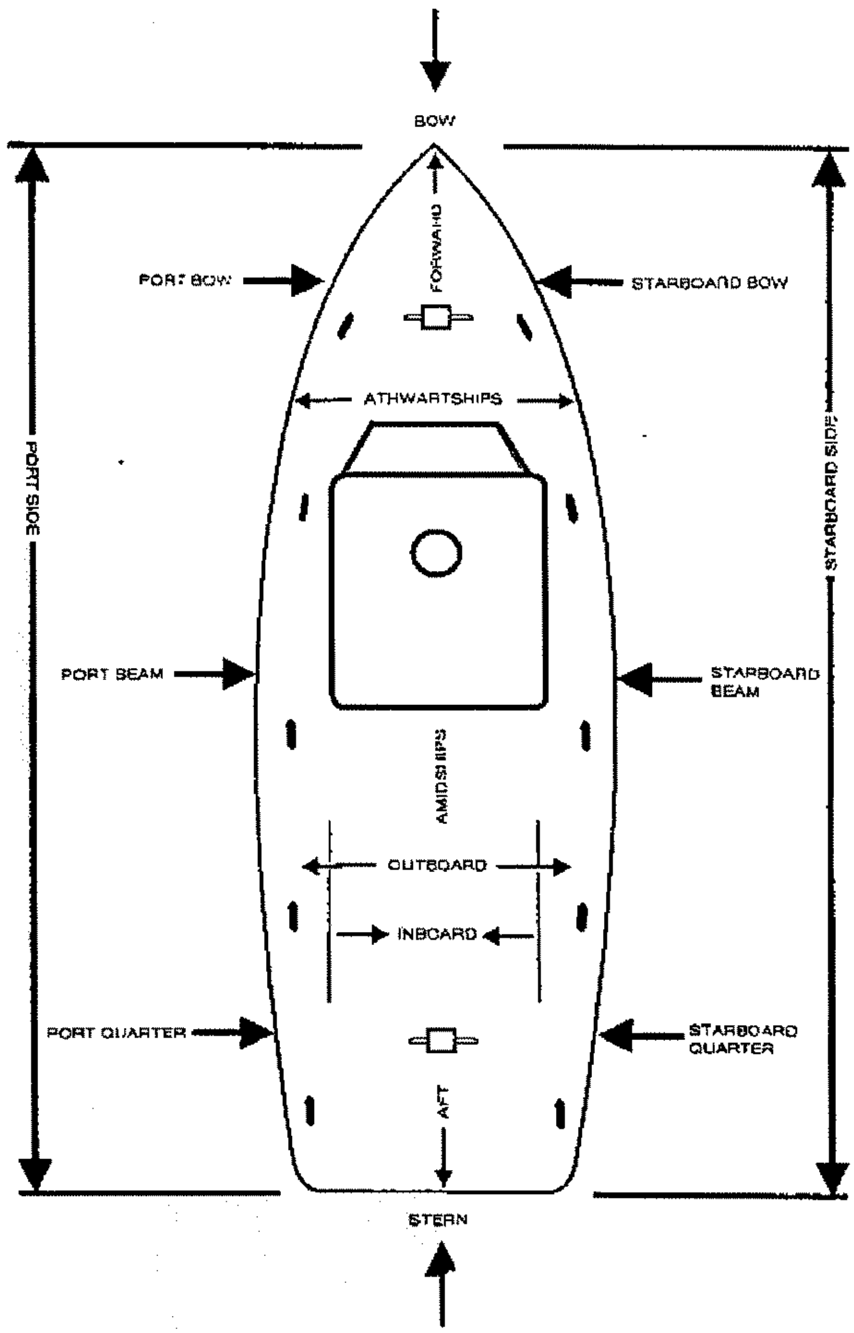
Fore and aft A line, or anything else, running parallel to the centerline of a boat.

Athwartships A line or anything else running from side to side.

Outboard From the centerline of the boat toward either port or starboard side.

Inboard From either side toward the centerline. However, there is a variation in the use of outboard and inboard when a boat is tied up alongside something. The side tied up is inboard; the side away is outboard.

Going topside	Moving from a lower deck to a weather deck or upper deck.
Going below	Moving from an upper deck to a lower deck.
Going aloft	Going up into the boat's rigging.
Weather deck	Deck exposed to the elements (weather).
Lifelines	Lifelines or railings, erected around the edge of weather decks, are all technically called lifelines although they may have different proper names.
Windward	In the direction from which the wind is blowing; toward the wind.
Leeward	Opposite point from which the wind is blowing; away from the wind. Pronounced "loo-urd".



Position and Direction Aboard Boats
Figure 8-1

Boat Construction

General

The hull is the main body of a boat. It consists of a structural framework and a skin or shell plating. The hull may be constructed of many different materials, the most common being metal or fiberglass. A metal skin is usually welded to the structural framework, although riveting is sometimes used. A vessel could be monohull or multi-hull, such as catamarans and trimarans. The three basic types of hull forms based on vessel speed are:

- Displacement hull
- Planing hull
- Semi-displacement hull

Factors influencing hull shapes

Many factors influence hull shapes and affect the boat's **buoyancy** (its ability to float) and **stability** (its ability to remain upright). Factors that influence hull shapes are discussed as follows:

Factor	Description
Flare	Flare is the outward turn of the hull as the sides of the hull come up from the water line. As the boat is launched into the water, the flare increases the boat's displacement and creates a positive buoyant force to float the boat.
Tumble home	Tumble home is the reverse of flare and is the shape of the hull as it moves out going from the gunwale to the water line. This feature is most noticeable when viewing the transom of an older classic cruiser.
Camber	A deck usually curves athwartships, making it higher at the centerline than at the gunwales so the water flows off the deck. This curvature is called camber.
Sheer	Sheer is the curvature of the main deck from the stem to the stern. When the sheer is pronounced and the bow of the boat is higher than the main deck at amidship, additional buoyancy is provided in the bow. Reserve buoyancy is the additional flotation provided by flare and sheer.
Chine	The turn of the boat's hull below the water line is called the **chine**. It is "soft" if it is rounded and "hard" if it is squared off. Chine affects the boat's speed on turning characteristics.
Transom	The **transom** at the stern of the boat is either wide, flat, or curved. The shape of the stern affects the speed, hull resistance, and performance of the boat.

Length on Water Line Length The boat's **length on water line** (LWL) is the distance from the bow to the stern, measured at the water line when the boat is stationary. Note that this length changes as the boat rides high or low in the water. Another way of measuring the length of the boat is the length of the craft from its stem to its stern in a straight line. This is termed **length over all** (LOA) and does not change according to the way the boat sits in the water.

Beam and Breadth **Beam** and **breadth** are measures of a boat's width. Beam is the measurement of the widest part of the hull. Breadth is the measurement of a frame from its port inside edge to its starboard inside edge.

Molded beam is the distance between outside surfaces of the shell plating of the hull at its widest point.

Extreme breadth is the distance between outside edges of the frames at the widest point of the hull.

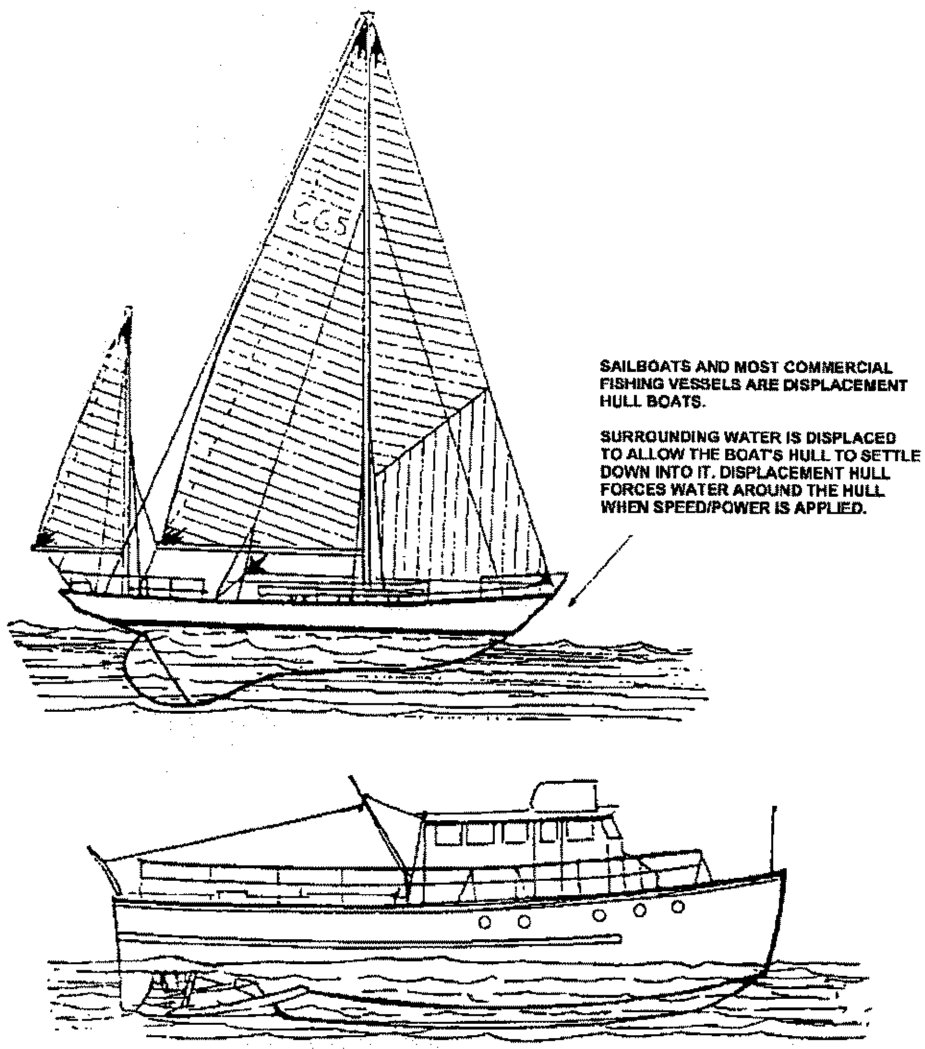
Draft **Draft** is the depth of the boat from the actual waterline to the bottom of its keel.

Draft, Appendage **Draft appendage** is the depth of the boat from the actual water line to the bottom of its keel or other permanent projection (e.g., propeller, rudder, skeg, etc.), if such a projection is deeper than the keel. The draft is also the depth of water necessary to float the boat. The draft varies according to how the boat lies in the water.

Trim **Trim** is a relative term that refers to the way the boat sets in the water and describes generally its stability and buoyancy. A **change in trim** may be defined as the change in the difference between drafts forward and aft. A boat is **trimmed** by the bow when the draft forward increases and the draft is greater than the stern draft. A boat is trimmed by the stern if it is down by the stern.

Displacement hull A **displacement hull** boat pushes away (displaces) water allowing the hull to settle down into the water. Underway, the hull pushes out this water, creating waves. (**See Figure 8-2**) The water separates at the bow and closes at the stern. Tremendous forces work against a displacement hull as the power pushing it and the boat's speed both increase. At maximum displacement speed, there is a distinct **bow** and **stern** wave. The length of these waves depends upon the boat's length and speed. (The longer the boat the longer the wave length.) The bow and the stern ride lower in the water as you increase speed and the water level alongside, amidships becomes lower than that of the surrounding water.

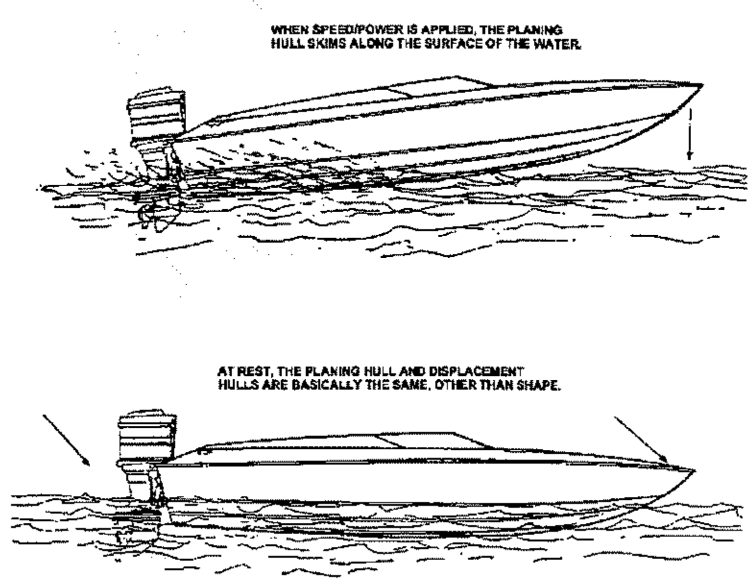
This is caused by the increase in the velocity of the water flowing under the boat and its interaction with the bow and stern wave. As the boat travels along, it rides in a depression created by its own passage. The displacement hull vessel's maximum speed is determined by the vessel's waterline length. **Heavy displacement hulls cannot exceed a speed of 1.34 times the square root of their waterline length** without requiring excessive power. This speed is known as **critical** speed. When towing a vessel, you must be careful not to tow beyond that vessel's critical speed. For details on towing displacement hulls, see *Section 17, Towing*.



Displacement Hulls
Figure 8-2

Planing hull

At rest the planing hull and the displacement hull both displace the water around them. The planing hull reacts nearly the same as a displacement hull when it initially gets underway - it takes considerable power to produce a small increase in speed. But at a certain point, external forces acting on the shape cause an interesting effect - the hull is lifted up onto the surface of the water. (See Figure 8-3) The planing hull skims along the surface of the water whereas the displacement hull always forces water around it. This is called planing. Once "on top" of the water, the power/speed ratio is considerably altered. Very little power increase results in a large increase in speed. You must apply power gradually when going from the displacement mode to the planing mode or from the planing mode to the displacement mode. When you decrease the power gradually, the hull makes an even, steady transition, like slowly moving your hand from above the water's surface, through it, and into the liquid below. However, if power is rapidly decreased the transition will be a rough one, for the hull will slap the surface of the water like the slap resulting by hitting a liquid surface with your hand.



Planing Hulls
Figure 8-3

Additionally, the rapid "re-entry" into the displacement mode from above the surface, through the surface, and back into the water causes rapid deceleration as the forces in the water exert pressure against the hull. The effect is like rapidly braking an automobile.

Semi-displacement hull The semi-displacement hull is a combination of characteristics of the displacement hull and the planning hull. This means that up to a certain power level and speed (power/speed ratio), the hull remains in the displacement mode. Beyond this point, the hull is raised to a partial plane. Essentially, the semi-displacement hull, like the displacement hull, always remains in the water. It never gets "on top" of the water. When in the displacement mode, the power/speed ratio is similar to the power/speed ratio described above for the displacement hull. When in the semi-planning mode, it is affected by a combination of forces for the displacement mode and some for the planning mode. Thus, while a small power increase will increase speed, the amount of resulting speed will not be as great as the same power increase would produce for a planning hull.

Keel

General The keel is literally the backbone of the boat. It runs fore and aft along the center bottom of the boat.

Keel parts **The following are all integral parts of the keel.**

Frames **Frames** are attached to the keel which extend **athwartships** (from side to side). The skin of the boat is attached to the frames. The keel and the frames strengthen the hull to resist external forces and distribute the boat's weight.

Stem The **stem** is an extension of the forward end of the keel. Although there are a number of common stem shapes, all are normally slanted forward (raked) at an upward angle to reduce water friction.

Sternpost The **sternpost** is a vertical extension of the aft end of the keel.

Keel types There are many types of keels. However, in metal boats, there are two types of particular interest: the bar keel and the flat plate keel.

Bar keel The bar keel is popular because its **stiffeners** (vertical or upright members which increases strength) protects the boat's hull plating if the boat grounds on a hard bottom. It also reduces rolling in much the same way as the more modern bilge keel does. The bilge keel is a fin or stabilizer fastened horizontally to the turn of the bilge. A disadvantage of the bar keel is that, because it extends below the bottom of the boat, it increases the boat's draft.

Flat or flat plate keel It consists of an "I" beam fastened to the flat plate or it may be built-up from a "rider plate" - a metal plate reinforcing the upper or inner surface of the keel, a vertical keel, and a flat keel. The flat keel, with its vertical keel and rider plate, is built within the boat's hull.

Principle Boat Parts

Bow The shape of a boat's bow, its profile, form, and construction determine hull resistance as the boat advances through the water. Hull resistance develops from friction and from the wave the hull makes as it moves in the water. Wave making resistance depends on the boat's speed.

The bow of a boat must be designed with enough buoyancy so it lifts with the waves and does not cut through them. The bow flare provides this buoyancy.

Boats intended for operation in rough seas and heavy weather have "full" bows. The bow increases the buoyancy of the forward part of a boat and deflects water and spray. When a boat is heading into a wave, the bow will initially start to cut into the wave. It may be immersed momentarily if the seas are rough. As the bow flare cuts into the wave it causes the water to fall away from a boat's stern, shifting the center of buoyancy to move forward from the center of gravity. The bow lifts with the wave and the wave passes under the boat, shifting the center of buoyancy aft. This action causes the bow to drop back down and the vessel achieves a level attitude.

Stern The shape of the stern affects the speed, resistance, and performance of the boat. It also affects the way water is forced to the propellers.

The design of the stern is critical in following seas where the stern is the first part of a boat to meet the waves. If the following waves lift the stern too high, the bow may be buried in the sea. The force of the wave will push the stern causing it to pivot around toward the bow. If this is not controlled, the result can be that a boat pitch poles or broaches.

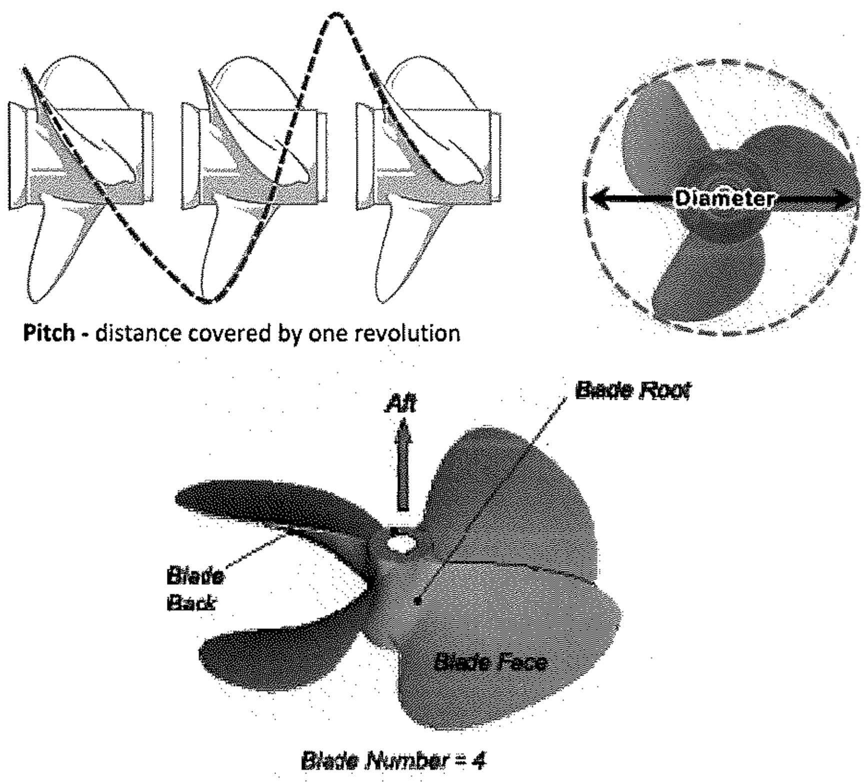
Rudder The rudder controls the direction of the boat and may vary widely in size, design, and method of construction. The shape of the stern, the number of propellers, and the characteristics of the boat determine the type of rudder a boat has.

Propeller Most boats are driven by one or more screw propellers which move in spirals somewhat like the threads on a screw. That is why the propeller is commonly referred to as a screw. The most common propellers are built with three and four blades. The propeller on a single-screw boat typically turns in a clockwise direction (looking from aft forward) as the boat moves forward. Such screws are referred to as "right-handed." On twin screw boats, the screws turn in opposite directions, rotating outward from the centerline of the boat. The port screw is "left-handed" and turns counter-clockwise. The starboard screw is "right-handed" and turns clockwise.

Propeller parts A propeller consists of blades and a hub. The area of the blade down at the hub is called the **root** and its outer edge is called the **tip** (see Figure 8-4).

Propeller edge The edge of the blade that strikes the water first is the **leading edge**; the opposite is the **following edge.** The diameter of the screw, the circle made by its tips and its circumference, is called the **tip circle.** Each blade has a degree of twist from root to tip called **pitch** (see Figure 8-4).

Pitch Pitch is the distance a propeller advances in one revolution with no slip (see Figure 8-4). Generally, less pitch in the same diameter propeller makes it easier for the engine to reach its preferred maximum RPM; thus, like putting a car in first gear, more power (and sometimes more speed) is available. Similarly, (like third gear in a car) more pitch may give more speed, but lower RPMs gives less power. Optimum performance is obtained when pitch is matched to the optimum design speed (RPM) of the engine.

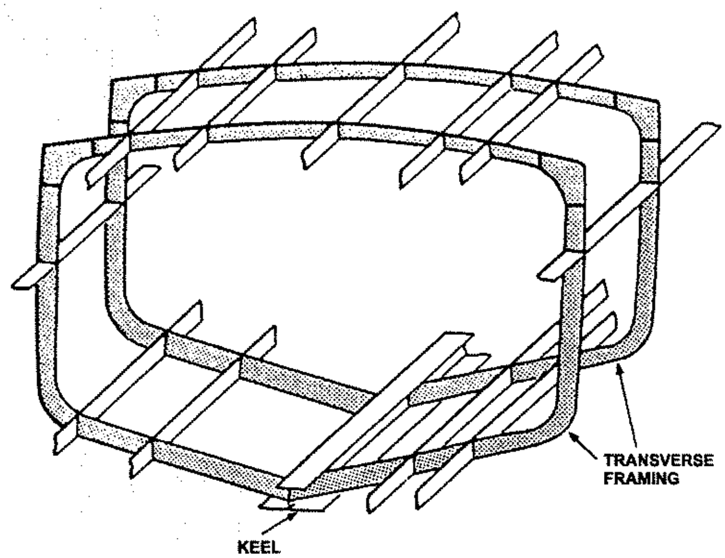


Parts of a Propeller
Figure 8-4

Decks A deck is a seagoing floor and provides strength to the hull by reinforcing the transverse frames and deck beams. The top deck of a boat is called the weather deck because it is exposed to the elements and is watertight. In general, decks have a slight downward slope from the bow. The slope makes any water taken aboard run aft. A deck also has a rounded, athwartship curve called **camber.** The two low points of this curve are on the port and starboard sides of the boat where the weather deck meets the hull. Water that runs aft down the sheer line is forced to the port or starboard side of the boat by the camber. When the water reaches one of the sides, it flows overboard through holes, or **scuppers**, in the side railings.

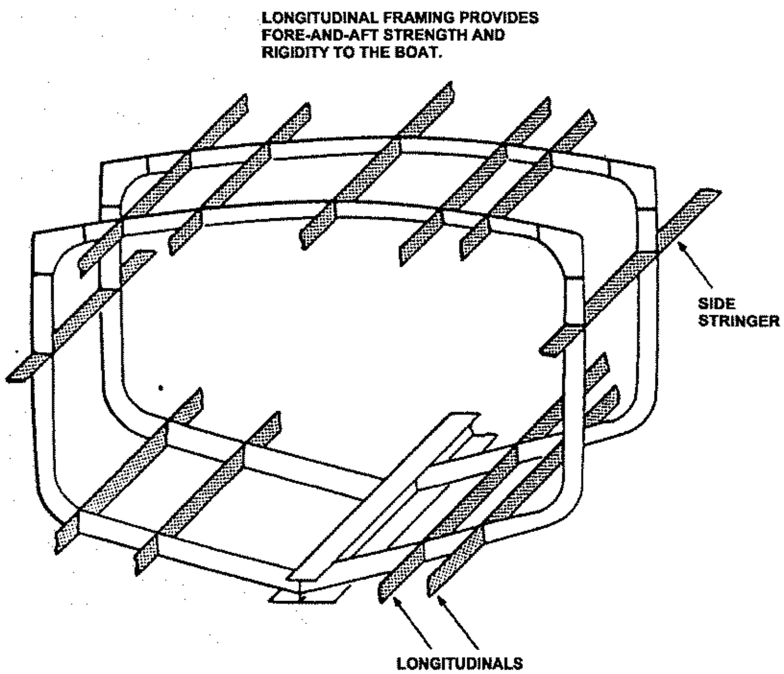
Frames As previously stated, it is the framing that gives the hull its strength. Frames are of two types:

Transverse Frames Watertight bulkheads or web frames are located at certain points in the hull to further increase the strength of the hull. Just as the keel is the backbone of the hull, transverse frames and are often referred to as ribs. Transverse frames extend athwartships and are perpendicular (vertical or upright) to the keel and are spaced at specified distances. (See Figure 8-8). They vary in size from the bow to the stern giving the boat hull its distinct shape when the skin is attached. They are numbered from the bow to the stern to help you quickly identify a particular location in the interior and, in the event of damage to the hull, to isolate the area of damage.



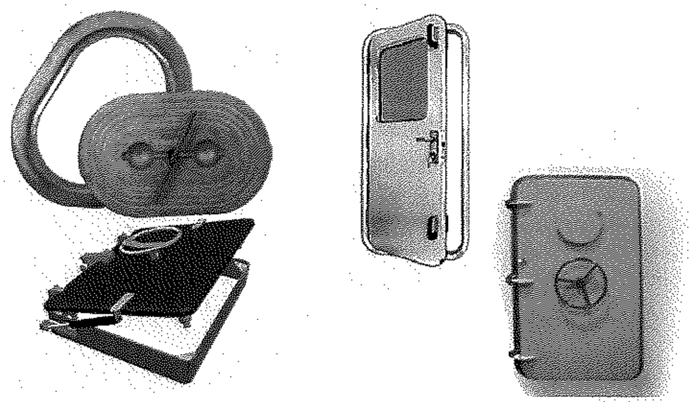
Transverse Framing System
Figure 8-5

Longitudinal frames Longitudinal frames provide hull strength along the length of the hull (fore and aft). (See Figure 8-6). As you will note, they run parallel to the keel and at right angles to the transverse frames. In addition to strengthening the hull, the top longitudinal frames provide a skeletal structure over which deck plating is laid.



Longitudinal Framing System
Figure 8-5

Hatches and Doors If decks are seagoing floors, then hatches are seagoing doors. In order for a **bulkhead** (a seagoing wall) with a hatch in it to be watertight, the hatch must be watertight. A weather deck hatch is made watertight by sealing it into a raised framework called a **coaming.** Watertight doors are designed to resist as much pressure as the bulkheads through which they provide access. Hatches and Doors operate with quick-acting devices such as wheels or handles or they may be secured with individual dogs (see Figure 8-6).



Water Tight Hatches and doors
Figure 8-6

Gaskets Rubber gaskets form tight seals on most watertight closure devices. These gaskets, mounted on the covering surface of the closure device (e.g., door, hatch, scuttle cover), are pressed into a groove around the covering. The gaskets are sealed tight by pressing against a fixed position "knife edge."

Knife Edges Watertight closures must have clean, bright, unpainted, smooth knife edges for the gaskets to press against. A well-fitted watertight closure device with new gaskets will still leak if knife-edges are not properly maintained.

Interior The interior of a boat is compartmentalized into bulkheads, decks, and hatches. The hatches are actually "doors" through the bulkheads. With the hatches closed, the space between them becomes watertight and is called a **watertight compartment**. These watertight compartments are extremely important. Without them the boat has no **watertight integrity** and a hole anywhere in the hull will cause it to sink. By dividing the hull into several watertight compartments, the watertight integrity of the boat is significantly increased. One or more of these compartments may flood without causing the boat to sink. A boat could be made unsinkable if its hull could be divided into enough watertight compartments. Unfortunately, excessive compartmentation would interfere with the engineering spaces and restrict your movement in the interior spaces

Boat Measurements

General	There are specific terms for the length and width of a boat and also specific methods for determining these measurements. The more common boat measurements are discussed below.
Overall length	The overall length of a boat is technically called the length overall (LOA) and is the distance from the foremost to the aftermost points on the boat's hull.
Waterline length	The waterline length of a boat is technically called the length on water line (LWL). It is the distance between fore and aft where the surface of the water touches the hull when a boat is normally loaded.
Beam and breadth	Beam and breadth are measures of a boat's width. **Beam** refers to the distance from the outside hull plating on one side of the boat to the outside hull plating on the other side. **Breadth** refers to the distance between the outside edge of a frame on one side of the boat to the outside edge of the same numbered frame on the opposite side.

Displacement

General	Displacement is the weight of a boat and is measured in long tons (2,240 lbs) or pounds.
Gross tons	The entire cubic capacity of a boat express in tons of 100 cubic feet.
Net tons	The carrying capacity of a boat expressed in tons of 100 cubic feet. It is calculated by measuring the cubic content of the cargo and passenger spaces.
Deadweight tons	Deadweight is the difference between the **light displacement** and the **maximum loaded displacement** of a boat and is expressed in long tons or pounds.

Light displacement Light displacement is the weight of the boat excluding fuel, water, outfit, cargo, crew, and passengers.

Loaded displacement Loaded displacement is the weight of the boat including fuel, water, outfit, cargo, crew, and passengers.

General Boat Equipment

All boats should carry basic equipment for the routine procedures, such as tying up, or anchoring. There is also equipment that is needed to conduct specific operations, such as search and rescue, towing, or pollution response. Crew members must be familiar with the use of the equipment carried on board and where it is located.

General boat equipment list The general equipment found on LAPD boats and a brief statement of the purpose of each item is provided below.

Item	Purpose
Anchors	For anchoring in calm, moderate, and heavy weather.
Anchor Lines	Provides scope to prevent the anchor from dragging. Enables retrieval of the anchor. Serves as an additional towline if necessary.
Screw Pin Shackle	Attaches chafing chain to shank of anchor.
Swivel	Allows anchor line to spin freely.
Thimble	Prevents chafing of anchor line at connection point with associated hardware
Towline	Used for towing astern
Alongside Lines	Used for alongside towing.

Heaving Line (75' to 100') Used for passing a towline when a close approach is not possible

Boat Hook For reaching dockside lines, fending boat from boat, and recovering objects from water.

Shackles For weighing a disabled boat's anchor, attaching towing bridles to towlines, attaching towlines to trailer eyebolt, etc.

First Aid Kit For emergency treatment of injuries suffered by crew members or survivors.

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Chapter 9: Stability

Overview

This section briefly discusses stability. This is the ability of a vessel to return to an upright position after being heeled over. Many forces influence the stability of a vessel in the water and each type of vessel reacts differently. Boat Operators must be aware of how internal forces (those caused by the boat's design and loading) and external forces (those caused by nature) affect the boat. With practice and experience, Boat Operators learn to anticipate how a vessel being piloted and a vessel being assisted will react to various internal and external forces. Recognizing unstable vessel conditions will lead to safe operations for both the boat crew and persons on a craft in distress.

Safety assessment and management guidelines

Emergency situations can cause people to panic or act before thinking despite the best of training and preparation. Therefore, boat crews must work together as a team to minimize any potential or immediate jeopardy for both civilian casualties and themselves. Never enter an emergency situation without first assessing the risk involved for the boat crew members and civilian victims (Risk Assessment). Always be aware of the dynamics of the emergency situation (Situational Awareness), and implement a control plan that fits each unique emergency (Stability Risk Management Plan).

Risk assessment and management

Risk assessment starts with understanding why mishaps occur. Responsibility for identifying and managing risk lies with every member of the boat crew. Realistic training based on standard techniques, critical analysis, and debriefing missions will help every person in a boat crew to contribute to developing and implementing a Risk Management Plan. A Risk Management Plan identifies and controls risk according to a set of preconceived parameters.

- Make the best attempt to account for all persons.
- Attempt to have all lines, rigging, etc. removed from the water around the vessel to avoid fouling the screws.
- Have all required equipment ready and test run pumps.

Situational awareness

Situational Awareness is the accurate perception of the factors and conditions affecting the boat crew at a given time during any evolution. More simply stated, situational awareness is knowing what is going on around you at all times while continuing to perform the task assigned to you.

Any time you identify an indication that situational awareness is about to be lost, you must make a decision whether or not to continue with the rescue attempt.

Everyone in the crew owns some responsibility for making these important decisions. The decision takes the form of action/reaction and communication. The person in charge of the boat makes the final decision but the boat crew has the responsibility to recognize dangerous situations and bring them to the attention of the Boat Operator.

Stability risk management plan

The entire crew must constantly watch for any loss of stability in their own vessel and that of the distressed craft. Do not assume that the Boat Operator has been able to observe all of the warning signs. Advise the Boat Operator of stability concerns that may have been overlooked and any warning signs. Use these warning signs as a guideline for a Stability Risk Management Plan.

- Observe the roll of your own boat and, for a distressed vessel, observe its roll upon approaching and when under tow.
- Be aware of external forces - wind, waves and water depth.
- Be aware of control loading, amount of weight and placement, on own and the distressed craft.
- If necessary, attempt to keep your equipment aboard your vessel when dewatering the vessel.
- Attempt to tow the vessel only after any loss of stability has been corrected.
- Adjust course, speed, or both as necessary to decrease rolling or listing.
- Avoid sharp turns or turns at high speed when loss of stability is possible.
- Maintain communication between the Boat Operator and crew.

When a vessel is visibly unstable (i.e., listing, trimmed to the bow/ stern or when down flooding occurs) never make your vessel fast to or tow the distressed vessel. A flooded vessel may appear stable when it in fact is not. Compare the boats reaction to water conditions with your own boat's movements.

Understanding Stability

Introduction

When a vessel is heeled over in reaction to some external influence, other than damage to the vessel, it tends to either return to an upright position or to continue to heel over and capsize. The tendency of a vessel to remain upright is its **stability**. The greater the tendency to remain upright, and the stronger the force required to heel the vessel over in any direction, the more stability the vessel achieves. The stability of a vessel in the water is very important to all members of a boat crew. Being able to anticipate how your vessel and the vessel you are assisting will react in any given set of circumstances is dependent on your knowledge of stability. Weight and buoyancy are the two primary forces acting upon a floating vessel that affect stability. The weight pushes the vessel down into the water. Buoyancy is the force that is pushing up from the water to keep the vessel afloat. The interaction of these two forces determines the vessel's stability.

Center of Gravity

Center of gravity

The center of gravity is the point at which the weight of the boat acts vertically downwards. Thus, the boat acts as though all of its weight were concentrated at the center of gravity. Generally, the lower the center of gravity, the more stable the vessel.

Changes in the center of gravity

The center of gravity of a boat is fixed for stability and does not shift unless weight is added, subtracted, or shifted. When weight is added, for example when a vessel takes on water, the center of gravity moves toward the added weight. When the weight is removed, the center of gravity moves in the opposite direction.

If a vessel has been damaged so that water is flowing in and out of a hole below the waterline, known as free communication with the sea, the result is a loss of buoyancy which generally means a significant reduction in stability.

Buoyancy

Buoyancy

The buoyancy is the upward force of water displaced by the hull. The force of buoyancy keeps the boat afloat; however, it may be overcome and the boat will sink if too much weight is added.

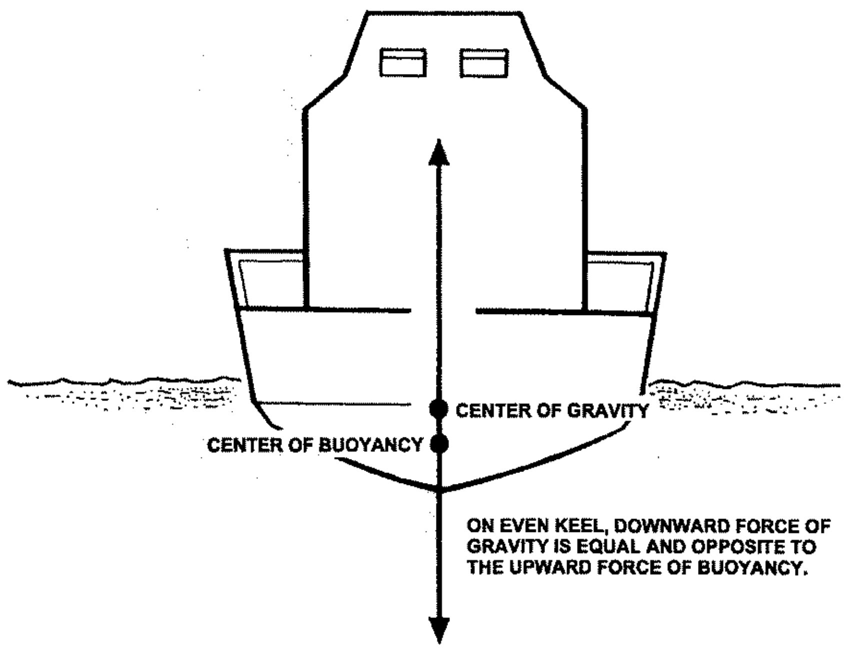
Center of buoyancy

The center of buoyancy is the center of gravity of displaced water. Similar to the center of gravity, this is the point on which all upward/vertical force is considered to act. It lies in the center of the underwater form of the hull.

Equilibrium

Equilibrium

When a boat is at rest, the center of buoyancy acting upwards/vertically is below the center of gravity acting downwards; it is considered to be in equilibrium. Equilibrium is affected by movement of the center of gravity or center of buoyancy or by some outside forces, such as wind and waves (See Figure 9-1).



Stability In Equilibrium
Figure 9-1

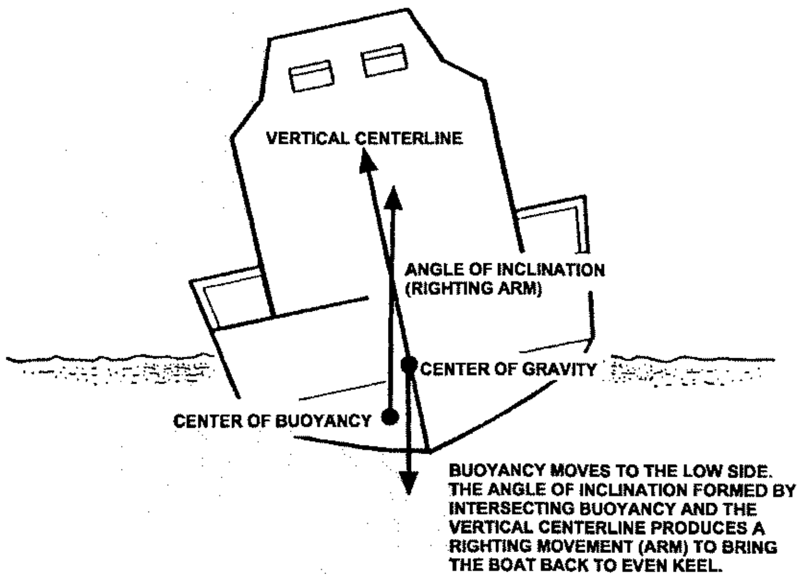
Rolling

When a boat rolls, the force of the center of gravity will move in the same direction as the roll. The downward force of gravity is offset by the upward force of buoyancy and causes the boat to heel.

Heeling

In heeling, the underwater volume of the boat changes shape causing the center of buoyancy to move.

The center of buoyancy will move towards the part of the hull that is more deeply immersed. When this happens the center of buoyancy will no longer be aligned vertically with the center of gravity. The intersection of the vertical line thru the center of bouyancy and the vertical centerline is called the metacenter. When the metacentric height (the distance between center of gravity and metacenter) is positive, that is the metacenter is above center and gravity, the center of buoyancy shifts so that it is outboard of the center of gravity the boat is considered to be stable, and the forces of buoyancy and gravity will act to bring the boat back to an upright position. If the center of buoyancy is inboard of the center of gravity, that is the metacentric height is negative, the forces of buoyancy and gravity will tend to roll the boat further towards capsize (See Figure 9-2).



Heeling
Figure 9-2

Listing

If the center of gravity is not on the centerline of the boat, the boat will heel until equilibrium is reached with the center of buoyancy and center of gravity in alignment. This condition is referred to as **list**.

Heeling is a temporary leaning, listing is a permanent leaning, and both are different from rolling which is a side-to-side motion.

Types of Stability

Types of stability

A boat has two principle types of stability:

- Longitudinal
- Transverse

A boat is usually much longer than it is wide. Therefore, the longitudinal plane (fore and aft) is more stable than its transverse plane (beam).

Longitudinal (fore and aft) stability

Longitudinal (fore and aft) stability tends to balance the boat, preventing it from pitching end-over-end (pitch poling). Vessels are designed with enough longitudinal stability to avoid damage under normal circumstances. However, differences in vessel design varies the longitudinal stability characteristics of different vessels depending on the purpose for which a vessel is designed. Some vessels can suffer excessive pitching and offer a very wet and uncomfortable ride during rough sea and weather conditions. Such an uncomfortable ride often affects the endurance and capability of people on vessels you are assisting.

Transverse (athwartships) stability

Transverse (athwartships) stability tends to keep the boat from rolling over (capsizing). Additional weight above the center of gravity increases the distance from the center of gravity up to the center of buoyancy. As a result, stability is also decreased. Removal of weight from below the center of gravity also decreases stability. If the center of gravity is raised enough the boat will become unstable.

Moment and Forces

Moment and forces

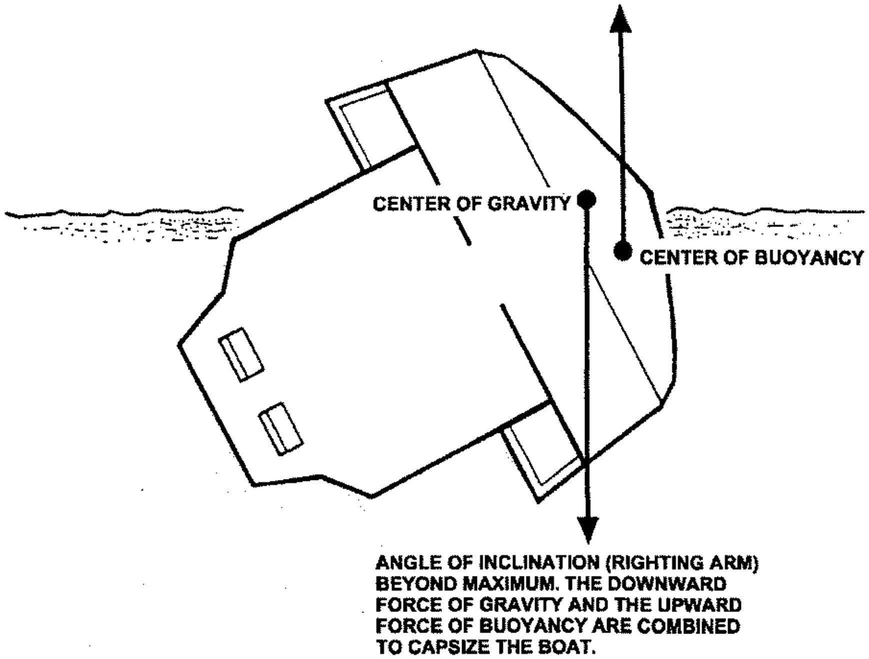
The force that causes a vessel to return to an even keel, or upright position is called the vessel's **moment**. Both static and dynamic forces can reduce stability and moment. Moments, and the internal and external forces that act to increase or decrease the righting moment, are important factors in determining the stability of a vessel at any given point in time.

Righting moment and capsizing

A **righting moment** is the force causing a vessel to react against a roll and return to an even keel. Generally, the broader a boat's beam, the more stable that boat will be and the less likely it is to capsize. For any given condition of loading, the center of gravity is at a fixed position. As a boat heels, the center of buoyancy moves to the lower side of the boat forming an angle of inclination. Larger changes in the movement of the center of buoyancy will result with any given angle of heel. This change provides greater righting movement, up to a maximum angle of inclination.

Too much weight added to the side of the vessel that is heeled over can overcome the forces supporting stability and cause the vessel to capsize. (See Figure 9-3.)

A boat may also capsize when aground as the volume of water beneath the vessel decreases and the vessel loses balance. As the amount of water supporting the vessel is reduced, there is a loss of buoyancy force being provided by that water. In addition, the upward force acting at the point of grounding will increase and cause the unsupported hull to fall to one side.



Righting Moment and Capsizing
Figure 9-3

Static and dynamic forces

Unless acted upon by some external force, a boat that is properly designed and loaded remains on an even keel. The two principle forces that affect stability are **static** and **dynamic** forces.

1. Static forces are caused by placement of weight within the hull. Adding weight on one side of a boat's centerline or above its center of gravity usually reduces stability. Flooding or grounding a boat makes it susceptible to static forces which may adversely affect stability.

2. Dynamic forces are caused by actions outside the hull such as wind and waves. Strong gusts of wind or heavy seas, especially in shallow water, may build up a dangerous sea tending to capsize a boat.

For a boat crew member this understanding is useful when approaching a vessel to provide assistance. Observing the vessel's roll can provide some initial indications about the stability of the vessel.

- Watch the time required for a complete roll from side to side. The time should remain about the same regardless of the severity of the angle or roll.

- If the time increases significantly or the boat hesitates at the end of the roll, the boat is approaching or past the position of maximum righting effect. Take immediate steps to decrease the roll by changing course or speed or both.

Vessel design

General vessel design features that influence stability include:

- Size and shape of the hull
- Draft of the boat (the distance from the surface of the water to the keel)
- Trim (the angle from horizontal at which a vessel rides)
- Displacement
- Freeboard
- Superstructure size, shape, and weight
- Non-watertight openings

Many of these features are discussed in Section 8, *Terminology*.

Losing Stability

Introduction

A vessel may be inclined away from its upright position by certain internal and external influences such as:

- Waves
- Wind
- Turning forces when the rudder is put over
- Shifting of weights on board
- Addition or removal of weights
- Loss of buoyancy (damage)

These influences exert heeling moments on a vessel causing it to list (permanent) or heel (temporary). A stable boat does not capsize when subjected to normal heeling moments due to the boat's tendency to right itself (righting moment).

Stability After Damage

General

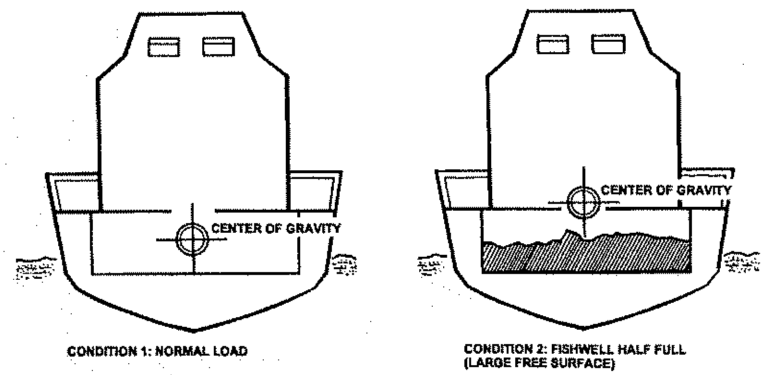
When assisting a damaged vessel consider that any change in stability may result in the loss of the vessel. The added weight of assisting personnel or equipment may cause the vessel to lose its righting moment, lose stability, and capsize. This consequence, and the danger involved, must be considered when determining risk to avoid harm to the crew and further damage or loss of a vessel.

Free Surface Effect

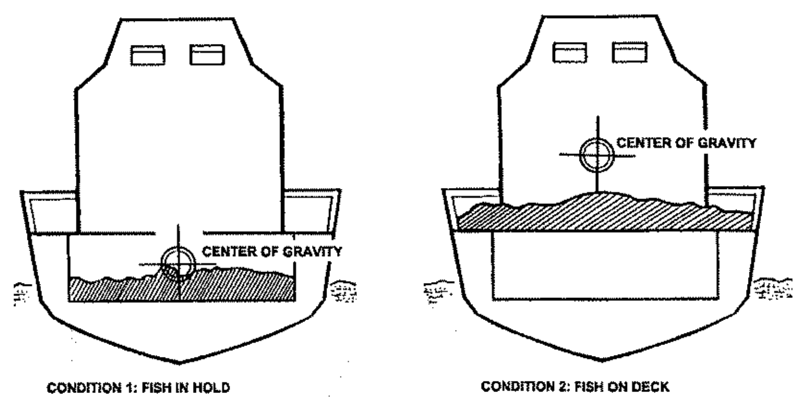
General

Compartments in a vessel may contain liquids as a matter of design or as a result of damage. If a compartment is only partly filled, the liquid can flow from side to side as the vessel rolls or pitches. The surface of the liquid tends to remain parallel to the waterline. Liquid that only partly fills a compartment is said to have **free surface** and water in such a compartment is called **loose water**. When loose water shifts from side to side or forward and aft due to turning, speed changes, or wave action, the vessel does not want to right itself. This causes a loss of stability. This can cause the vessel to capsize or sink. A cargo of fish free to move about inside a compartment will have the same effect, a condition commonly found on fishing vessels (See Figures 9-4 and 9-5).

Note that the area of free surface is very important, and in particular its width. If the free surface area doubles in width, its adverse effect on stability will change by a factor of four.



Effects of Free Surface
Figure 9-4



Effects of Load Weight
Figure 9-5

Corrective actions

Corrective actions include

- Minimize the number of partially filled tanks (fuel, water, or cargo); ballast with sea water as necessary.
- Maintain fish wells completely empty or filled at all times.
- Prevent cargo such as fish from rolling back and forth on the deck.

Free Communication with the Sea

General

Damage to the hull of a vessel can create free communication with the sea, the movement of sea water into and out of the vessel.

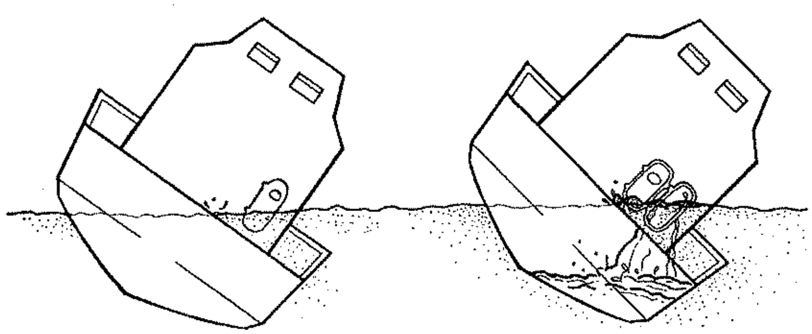
Corrective actions

Corrective actions include:

- Patch the hull opening.
- Place weight on the high side to decrease the list toward the damaged side.
- Remove weight above the center of gravity on the damaged side.

Effects of Down flooding

Down flooding is the entry of water into the hull resulting in progressive flooding and loss of stability. Vessels are designed with sufficient stability and proper righting moments as long as they are not overloaded. These design features cannot compensate for the carelessness of a boat crew who fails to maintain the watertight integrity of a vessel and allow it to needlessly take on water. (See Figure 9-7.)



Effects of Down flooding
Figure 9-7

Corrective actions Corrective actions include:

- Keep all watertight fittings and openings secured when a vessel is underway.
- Pump out the water.

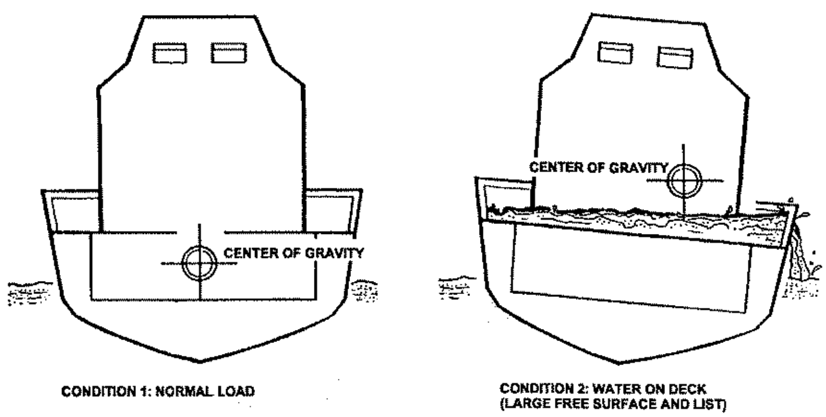
Effects of Water on Deck

General Water on deck can cause stability problems by:

- Increasing displacement (increasing draft and decreasing stability and trim).
- Contributing to free surface effect.
- Amplifying the rolling motion of the vessel which may result in capsizing.

Corrective actions Corrective actions include:

- Decrease trim, increase freeboard.
- Change course, speed or both.
- Ensure drain openings are unobstructed (See Figure 9-8).



Effects of Water on Deck
Figure 9-8

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Chapter 10: Boat Handling

Overview

This chapter covers handling vessels under power. Topics include:

- Forces that move or control a vessel
- Basic maneuvering and boat operating
- Maneuvering techniques for general categories of vessels
- Purpose-based boat handling evolutions and procedures

Vessels under sail are addressed in regards to nomenclature only.

Boat handling requires an understanding of many variables and complex problems. Though you can only develop boat handling skills through hands-on experience, the information in this chapter provides a basic description of principles and practices.

The LAPD boat crew utilizes a variety of vessels. These include twin screw boats, Outboards, inboard/outboards and jet drive propulsion. Though "good" Boat Operators are familiar with the characteristics of their boat and how it operates, the "best" Boat Operators are knowledgeable in the operation of all these types of vessels, including sailboats. They know how varying weather and sea conditions affect the operation of not just their vessel, but are also keenly aware of the limitations the weather and sea impose on other vessels. They have a thorough knowledge of navigation, piloting and characteristics of their operating area. Above all, the best Boat Operators understand how to mesh the capabilities of their vessel to weather and sea conditions to conduct the safest possible boat operations.

Environmental Forces

General

Environmental forces that affect the horizontal motion of a vessel are wind, seas and current. Remember the Boat Operator has no control over them. Take the time to observe how the wind, seas and current alone and together affect your vessel. Determine how these forces cause your vessel to drift and at what speed and angle. Boat Operators must use environmental forces to their advantage and use propulsion and steering to overcome the environmental forces. Usually, a good mix of using and overcoming environmental forces results in smooth, safe boat handling.

Winds

The wind acts on the hull topsides, superstructure, and the crew onboard smaller boats. The amount of surface upon which the wind acts is called sail area. The vessel will make "leeway" (drift downwind) at a speed proportional to the wind velocity and the amount of sail area. The "aspect" or angle the vessel takes due to the wind will depend on where the sail area is centered compared to the underwater hull's center of lateral resistance. A vessel with a high cabin near the bow and low freeboard aft would tend to ride stern to the wind. If a vessel's draft is shallower forward than aft, the wind would affect the bow more than the stern. A sudden gust of wind from abeam when mooring a vessel like this might quickly set the bow down on a pier.

Close quarters situations

Knowledge of how the wind affects a vessel is very important in all close quarters situations, such as docking, recovery of an object in the water, or maneuvering close aboard another vessel. If maneuvering from a downwind or leeward side of a vessel or pier, look for any wind shadow the vessel or pier makes by blocking the wind. Account for the change in wind by planning maneuvers with this wind shadow in mind.

Seas

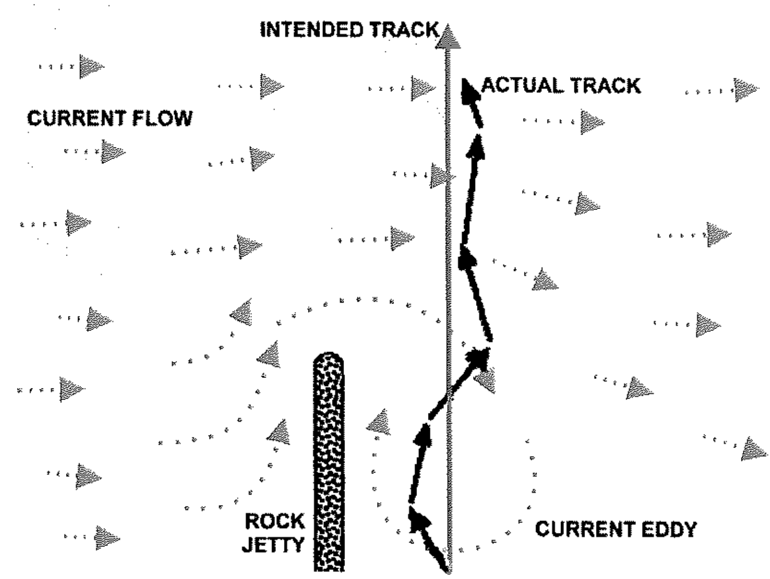
Seas are a product of the wind acting on the surface of the water. Seas affect boat handling in various ways, depending on their height and direction and the particular vessel's characteristics. Vessels that readily react to wave motion, particularly pitching, will often expose part of the underwater hull to the wind. In situations such as this, the bow or stern may tend to "fall off" the wind when cresting a wave, as less underwater hull is available to prevent this downwind movement.

Relatively large seas have the effect of making a temporary wind shadow for smaller vessels. In the trough between two crests, the wind may be substantially less than the wind at the wave crest. Very small vessels may need to make corrective maneuvers in the trough before approaching the next crest.

Current

Current will act on a vessel's underwater hull. Wind will cause a vessel to make leeway through the water current and cause drift over the ground. **A one-knot current may affect a vessel to the same degree as 30 knots of wind.** Strong current will easily move a vessel upwind.

Learn to look for the signs of current flow so that you are prepared when current affects the vessel. Be particularly aware of instances where current shear is present. As with wind, a large, stationary object like a breakwater or jetty will cause major changes in the amount and direction of current (Figure 10-1). Note the amount of current around floating piers or those with open pile supports. Use caution when maneuvering in close quarters to buoys and anchored vessels. Observe the effect of current by looking for current wake or flow patterns around buoys or piers. Watch how currents affect other vessels.



Effects of Current
Figure 10-1

Combined environmental forces

Environmental conditions can range from perfectly calm and absolutely no current to a howling gale at spring tides. Chances are that even if you don't operate at either extreme, some degree of environmental forces will be in action.

Know your vessel's response

Know how your vessel responds to combinations of wind and current and determine which one has the greatest effect on your vessel. It may be that up to a certain wind speed, current has more control over a given vessel, but above that certain wind speed, the boat sails like a kite. Know what will happen if you encounter a sudden gust of wind; will your boat immediately veer, or will it take a sustained wind to start it turning?

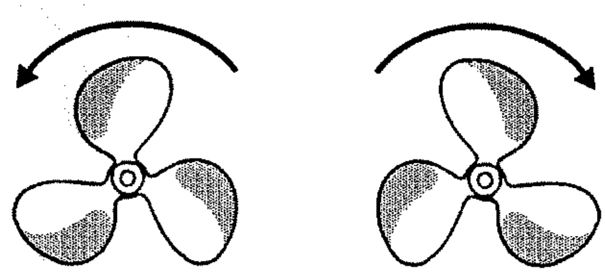
When current goes against the wind, the wave patterns will be steeper and closer together. Be particularly cautious where current or wind is funneled against the other. Tide rips, breaking bars, or gorge conditions frequently occur in these types of areas and may present a challenge to even the most proficient Boat Operator.

Before learning how to overcome these forces, you must learn how they act on a vessel.

Assumptions

For this discussion of propulsion, we make the following assumptions:

- If a vessel has a single-shaft motor or drive unit, it is mounted on the vessel's centerline.
- When applying thrust to go forward, the propeller turns clockwise (the top to the right or a "right-handed" propeller), viewed from astern, and turns counterclockwise viewed from astern when making thrust to go astern.
- If twin propulsion is used, the propeller to starboard operates as above (right-hand turning), while the port unit turns counterclockwise when making thrust to go forward when viewed from astern (left-hand turning). The screws are arranged so that the top of each blade turns outboard while turning for propulsion. See Figure 10-2.

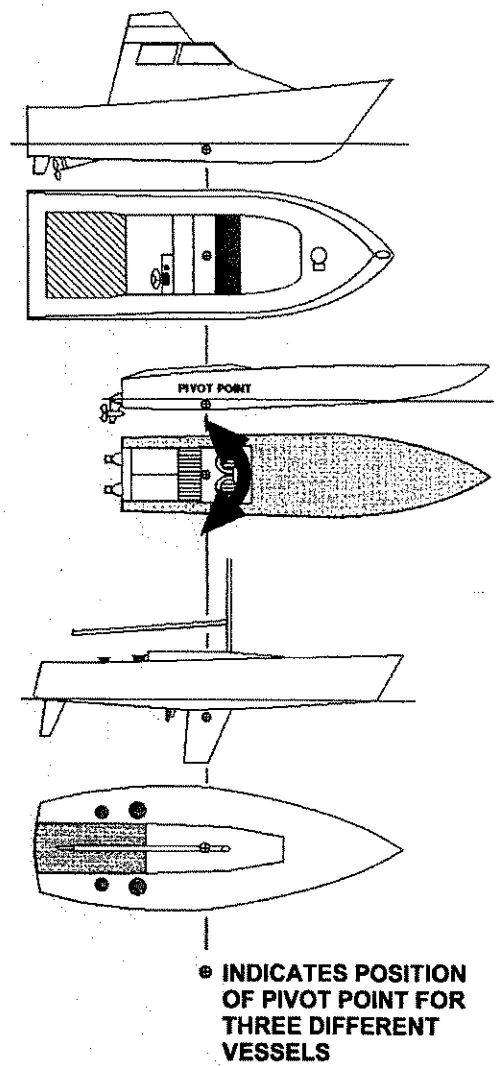


Viewed from astern, turning for propulsion to go ahead. Propeller on right (starboard shaft) turns clockwise and is called a right-handed propeller. When backing, rotation is opposite.

Propellers
Figure 10-2

Propulsion and steering

The key to powered vessel movement is the effective transfer of energy from the source of the power (an internal combustion engine) to the water through a mechanism that turns the engine's power into thrust. This thrust moves the boat. There must also be an element of directional control, both fore and aft, and from side to side.



Pivot Point
Figure 10-3

Propulsion and steering are considered together here for two reasons. Applying thrust has no use if you can't control the vessel's direction, and often the device providing the propulsion also provides the steering.
There are three common methods to transfer power and provide directional control:

- Rotating shaft and propeller with separate rudder
- A movable (steerable) combination as an outboard motor or stern drive
- By an engine-driven pump mechanism with directional control, called a water jet. This includes **P**ersonal **W**ater **C**raft.

All three arrangements have their advantages and disadvantages from the standpoint of mechanical efficiency, ease of maintenance, and vessel control. Using one type of propulsion instead of another is often a matter of vessel design and use parameters, operating area limitations, life cycle cost and frequently, personal preference. There is no single "best choice" for all applications. Regardless of which type you use, become familiar with how each operates and how the differences in operation affect vessel movement.

On almost every boat, propulsion and steering arrangement is designed to operate more efficiently and effectively when going ahead than when going astern. Also, every vessel rotates in a transverse direction about a vertical axis on its pivot point (Figure 10-3). The fore and aft location of the pivot point varies from boat to boat, but is generally just forward of amidships when the boat is at rest. As a hull moves either ahead or astern, the effective position of the pivot point moves either forward or aft, respectively.

Shaft, Propeller, and Rudder

Shaft

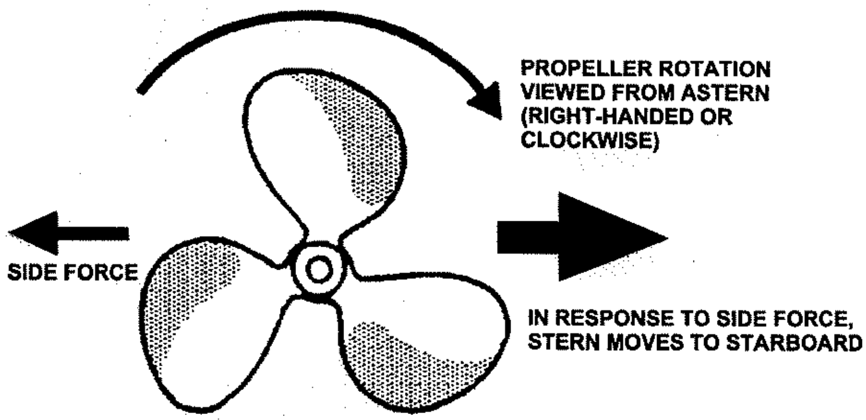
In small craft installations, the propeller shaft usually penetrates the bottom of the hull at an angle to the vessel's designed waterline and true horizontal. The practical reason for this is because the engine or marine gear must be inside the hull while the diameter of the propeller must be outside and beneath the hull. Additionally, there must be a space between the propeller blade arc of rotation and the bottom of the hull. For single-screw vessels, the shaft is generally aligned to the centerline of the vessel. However, in some installations, a slight offset (approximately one degree) is used to compensate for shaft torque. To finish the installation, the rudder is usually mounted directly astern of the propeller.

Shaft (continued)

For twin-screw vessels, we will only consider the case where both shafts are parallel to the vessel's centerline (or nearly so), rudders are mounted astern of the propellers, and the rudders turn on vertical rudder posts.

Propeller action

When rotating to move in a forward direction, a propeller draws its supply of water from every direction forward of and around the blades. Each blade's shape and pitch develop a low pressure area on the forward face of the blade and a high pressure area on the after face of the blades, forcing it in a stream toward the stern. This thrust, or dynamic pressure, along the propeller's rotation axis is transmitted through the shaft, moving the boat ahead as the propeller tries to move into the area of lower pressure.



Side Force
Figure 10-4

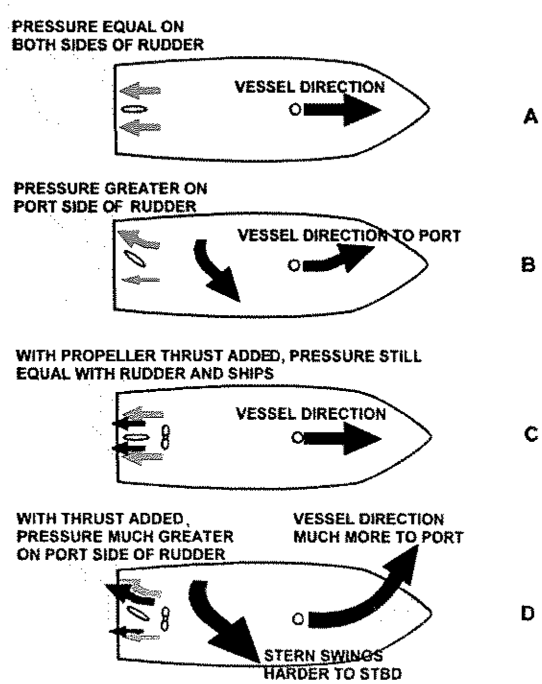
The important facts to know: for a right-handed screw turning ahead, the stern will tend to move to starboard (Figure 10-4), and for a right-handed screw when backing, the stern will tend to move to port. For a left-handed screw (normally the port shaft on a twin-screw boat), the action is the opposite.

An easy way to remember how side force will push the stern is to think of the propeller as a wheel on the ground. As the wheel rolls clockwise, it moves to the right. As a propeller turns clockwise when viewed from astern, the stern moves to starboard.

Rudder action

If a vessel is moving through the water (even without propulsion), you normally use the rudder to change the vessel's heading. As a hull moves forward and the rudder is held steady (amidships) pressure on either side of the rudder is relatively equal and the vessel will usually keep a straight track. When you turn the rudder to port or starboard, pressure decreases on one side of the rudder and increases on the other. This force causes the vessel's stern to move to one side or the other. As noted above, because a vessel rotates about its pivot point, as the stern moves in one direction, the bow moves in the other (Figures 10-5 (a) and (b)).

The speed of the water flowing past the rudder greatly enhances the rudder's force. The thrust or screw discharge current from a propeller while operating ahead increases the water flow speed past the rudder. Also, if you turn the rudder to a side, it directs about one-half of the propeller thrust to that side, adding a major component of force to move the stern (Figures 10-5 (c) and (d)). When operating astern, the rudder is in the screw suction current. The rudder cannot direct any propeller thrust, and since the screw suction current is neither as strong nor as concentrated as the screw discharge current, water flow past the rudder does not increase as much. The combined effects of screw current and rudder force when operating astern are not nearly as effective as when operating ahead. As rudder force is determined by water flow along it, a rudder loses some of its effectiveness if the propeller cavitates and aerated water flows along the rudder.



Effect of Rudder Action
Figure 10-5

Outboard Motors and Stern Drives

General

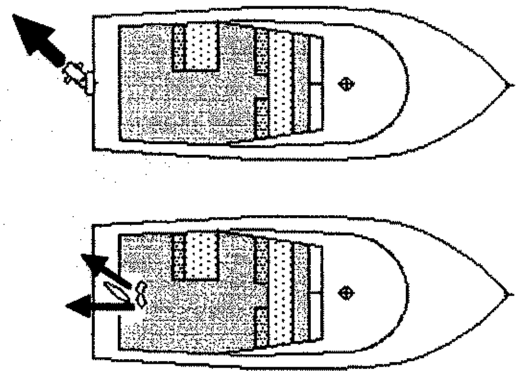
Outboard motors and stern drives will be considered together as both include a pivoting gear case and propeller drive unit (called a lower unit on an outboard). The differences between these drive arrangements and the shaft/propeller/rudder arrangement is the screw currents and thrust from an outboard or stern drive can be developed at an angle to the vessel centerline (directed thrust). Also, the point where thrust and steering are developed is usually aft of the vessel hull.

The lower unit contains drive gears, a spline connection, and on many set-ups, through-the-propeller hub exhaust. Many lower unit gear housings are over six inches in diameter. Where the stern drive is powered by an inboard engine attached through the transom to the drive unit (the outdrive) and is commonly referred to as an inboard/outdrive or I/O. The outboard "powerhead" (engine) is mounted directly above the lower unit. Both outboards and stern drives can usually direct thrust at up to 35 to 40 degrees off the vessel centerline. Also, both types generally allow the Boat Operator some amount of trim control. Trim control adjusts the propeller axis angle with the horizontal or surface of the water.

The major difference in operation between the I/O and outboard is the outboard motor, operating with a vertical crankshaft and driveshaft, develops a certain degree of rotational torque that could cause some degree of "pull" in the steering. This usually occurs when accelerating or in a sharp turn to starboard. If caught unaware, the Boat Operator could have difficulty stopping the turning action. The easiest way to overcome this torque-lock is to immediately reduce Revolution Per Minute (RPM) before trying to counter-steer.

Thrust and directional control

Outboards and stern drives have a small steering vane or skeg below the propeller. The housing above the gear case (below the waterline) is generally foil shaped. Though these features help directional control, particularly at speed, the larger amount of steering force from an outboard or stern drive is based upon the ability to direct the screw discharge current thrust at an angle to the vessel's centerline (Figure 10-6). This directed thrust provides extremely effective directional control when powering ahead. When making way with no propeller RPMs, the lower unit and skeg are not as effective as a rudder in providing directional control.



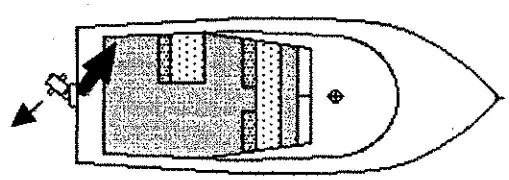
The outboard or outdrive (top) directs all the thrust in the direction the helm is turned where the inboard with separate propeller and rudder (bottom) directs only 60-70% of the thrust to the side.

Lower Unit/Outdrive Directed Thrust
Figure 10-6

The propeller forces discussed above also apply to the propellers on outboards or outdrive. However, because you can direct these drives, you can counter side force. The steering vane/skeg angle is usually adjustable, also assisting in countering side.

Propeller side force

When backing, you can direct outboard/outdrive thrust to move the stern to port or starboard. When backing with the unit hard over to port, propeller side force introduces an element of forward motion (Figure 10-7), but can be countered through less helm. When backing to starboard, the side force tends to cause an element of astern motion and also tries to offset the initial starboard movement. Many lower units are fitted with a small vertical vane, slightly offset from centerline, directly above and astern of the propeller. This vane also acts to counter side force, particularly at higher speeds.

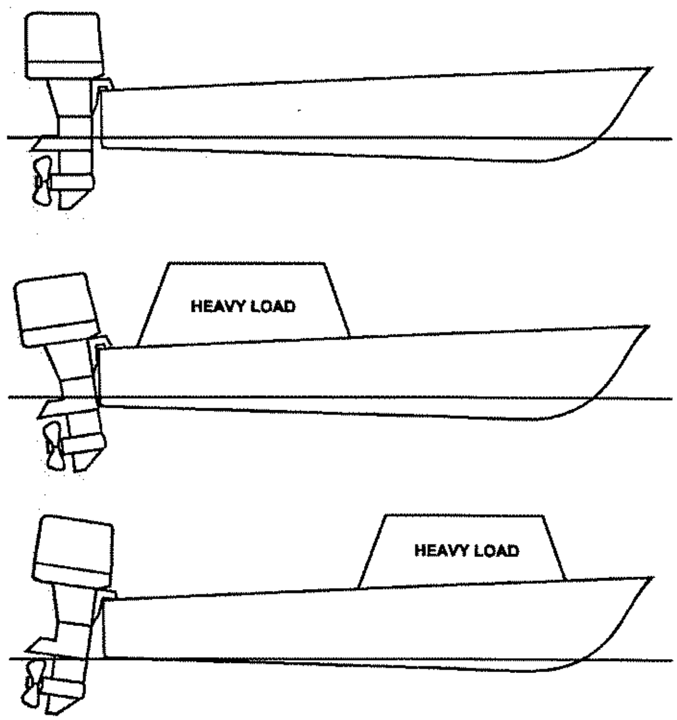


With helm over, the propeller side force (small arrow) has a fore and aft component.
This example shows the effect of side force when backing with an outdrive.
With helm to port, the boat's transom will move both to port and forward (large arrow)

Lower Unit/Outdrive Side Force
Figure 10-7

Vertical thrust

Outboards and stern drive usually allow a level of vertical thrust control. Trim controls the angle of attack between the propeller's axis of rotation and both the vessel waterline and the surface of the water. Vertical thrust control, especially applied aft of the transom, changes the attitude the vessel hull will take to the water (Figure 10-8). Use small amounts of trim to offset for extreme loading conditions or to adjust how the vessel goes through chop.



Trim to Offset Loading Condition
Figure 10-8

In addition to trim, a vertical component of thrust develops in another situation. Depending on the type of hull, if a vessel is forced into an extremely tight turn with power applied, thrust is directed sideways while the vessel heels, actually trying to force the transom up out of the water, causing a turn to tighten even more.

In lightweight or highly buoyant outboard powered boats, use of full power in tight turns can cause loss of control or ejection of crew or Boat Operator. If installed, the helmsman should always attach engine kill switch lanyard to themselves.

Cavitation

As noted earlier, cavitation frequently occurs when backing with outboard motors. As through-hub exhaust gas bubbles are drawn forward into the propeller blade arc, the aerated water increases the possibility of cavitation. Though outboards and stern-drives are fitted with an anti-cavitation plate above the propeller, always take care to limit cavitation, particularly when backing or maneuvering using large amounts of throttle.

Waterjets

General

A water jet is an engine-driven impeller mounted in a housing. The impeller draws water in and forces it out through a nozzle. The suction (inlet) side of the water jet is forward of the nozzle, usually mounted at the deepest draft near the aft sections of the hull. The discharge nozzle is mounted low in the hull, exiting through the transom. The cross-sectional area of the inlet is much larger than that of the nozzle. The volume of water entering the inlet is the same as being discharged through the nozzle, so the water flow is much stronger at the nozzle than at the intake. This pump-drive system is strictly a directed-thrust drive arrangement. A water jet normally has no appendages, nor does it extend below the bottom of the vessel hull, allowing for operation in very shallow water.

Thrust and directional control

Vessel control is through the nozzle-directed thrust. To attain forward motion, the thrust exits directly astern. For turning, the nozzle pivots (as a stern drive) to provide a transverse thrust component that moves the stern. For astern motion, a bucket-like deflector drops down behind the nozzle and directs the thrust forward. Some water jet applications include trim control as with a stern drive or outboard. With this, thrust can be directed slightly upward or downward to offset vessel loading or improve ride.

From time to time, you might see a water jet with a small steering vane, but in most cases the only vessel control is by the nozzle-directed thrust. If a water jet craft is proceeding at high speed, power brought down quickly to neutral, and the helm put over, no turning action will occur. Of the three drive arrangements discussed, the water jet alone has no directional control when there is no power.

No side force

Since the water jet impeller is fully enclosed in the pump-drive housing, no propeller side force is generated. The only way to move the stern to port or starboard is by using the directed thrust.

Cavitation

Water jet impeller blades revolve at an extremely high speed. A much higher degree of cavitation normally occurs than associated with external propellers without a loss of effective thrust. In fact, a telltale indicator of water jet propulsion is a pronounced aerated-water discharge frequently seen as a rooster tail astern of such craft.

As the impeller rotation does not change with thrust direction, frequent shifting from ahead to astern motion does not induce cavitation. However, as the thrust to make astern motion reaches the water jet inlet, the aerated water is drawn into the jet, causing some reduction of effective thrust. As with all types of propulsion, slowing the impeller until clear of the aerated water reduces cavitation effects.

Basic Maneuvering

To learn basic handling and maneuvering characteristics of a vessel, a trainee must first observe a skilled Boat Operator. Also, one must first learn to operate the vessel in relatively open water, away from fixed piers and moored vessels or the critical gaze of onlookers.

Learning Controls

General

When you step up to the controls of any vessel for the first time, immediately become familiar with any physical constraints or limitations of the helm and engine controls. Ideally, controls should be designed and mounted to allow a wide range of operators of different arm length and hand size, though this is not always so.

Obstructions/ hazards

Determine if anything obstructs hand or arm movement for helm and throttle control. Check for a firm grasp of the wheel through 360 degrees, anything that prevents use of the spokes, awkward position of throttle/gear selector, layout that prevents use of heavy gloves, inaccessible engine shut-down handles, an easily fouled outboard kill-switch lanyard or other common-sense items. Learn what they are before you snag a sleeve while maneuvering in close quarters or bang a knee or elbow in choppy seas.

Determine the helm limits

The following are some guidelines for determining the helm limits.

Step	Procedure
1	Determine the amount of helm from full right rudder to full left rudder.
2	Check for any binding, play, or slop in the helm and rudder control and at what angle it occurs.
3	Ensure that the helm indicates rudder amidships.
4	Ensure that a rudder angle indicator accurately matches rudder position and matches a centered helm.

Check engine control action

The following are some items to check when checking engine control action.

Step	Procedure
1	Is throttle separate from shifting/direction mechanism?
2	Any detent, notch or stops that separate neutral, ahead and astern.
3	Force required to shift from neutral to ahead or astern.
4	Binding or excessive looseness at any stage of the throttle control.
5	Is "neutral" easily found without looking at the control handle?
6	Do the controls stay put or do they tend to slide back?
7	Is idle speed adjusted properly?

Smooth, positive operation of helm and engine controls is absolutely necessary for safe boat operation. Poor control operation causes unsafe boat operations.

Rechecking controls

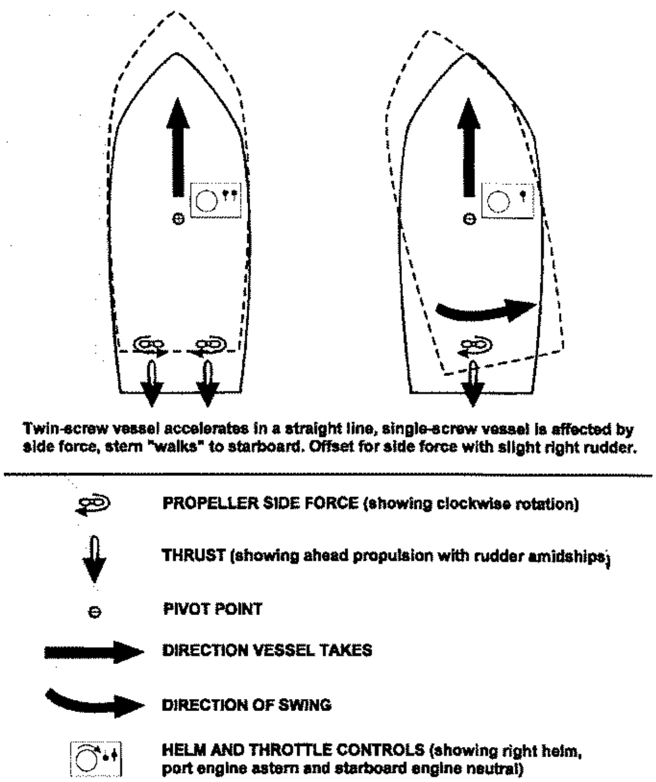
After checking all controls while moored with engines secured, recheck their operation with engines running while securely moored. It may not be safe to apply full ahead to astern throttle, but note any time lag between throttle shift and propulsion, from neutral to ahead, neutral to astern, ahead to astern, and astern to ahead.

When going from an ahead position to an astern position, and when going from astern position to ahead position, pause briefly at the neutral position.

Moving Forward in a Straight Line

General

When moving forward in a straight line, advance throttle gradually and firmly. If the vessel is single-screw, outboard, or outdrive, propeller side force will tend to move the stern slightly to starboard (Figure 10-9). Offset the side force with slight starboard helm. If twin-engine, advance throttles together. The vessel should not yaw in either direction if power is applied evenly. Check engine RPMs so both engines turn at the same speed. Compare tachometer readings.



Accelerated Ahead
Figure 10-9

Use helm to control direction

Use small amounts of helm to offset any propeller side force or the effects of winds and seas. Always note compass course and correct frequently to stay on course. Develop a practiced eye and steer on a geographic point or range. Try to steer for a point between buoys. Apply small, early helm corrections to stay on course, rather than large corrections after becoming well off course. Avoid over steer, leaving a snake-like path. At low speeds, helm correction will be more frequent than at higher speeds.

Get on plane

For planning or semi-displacement hulls, the boat will gradually gain speed until planning. If fitted with trim control (including trim tabs on inboard boats), slight, bow-down trim may lessen the amount of time needed to get on plane or "on step."

Determine appropriate speed

Don't ram the throttle to the top and leave it there.

Leave a margin of power

Always leave a margin of power available for emergencies. Determine the best speed for your vessel. Many vessels will not exceed or will only marginally exceed a given speed, regardless of the power applied. At some point, the only effect of applying additional throttle is increased fuel consumption with no speed increase. A good normal operating limit for semi-displacement vessels is usually 90 percent maximum power, allowing the remaining 10 percent for emergency use or to get out of a tight spot.

Maintain safe speed for ability or conditions

A boat at high speed has a large amount of force. With an untrained operator, this force can be dangerous. Consider different factors to determine safe speed.

- *High seas.* **Slow down as winds and seas increase**; the boat will handle more easily. Pounding or becoming airborne fatigues the hull and could injure the crew or cause them chronic skeletal problems. If it takes tremendous effort just to hang on, the crew will be spent and not able to perform their jobs. Minimize taking spray and water on deck.
- *Traffic density.* **Don't use high speed in high traffic density areas**. A safe speed allows you to respond to developing situations and minimize risk of collision, not only with the nearest approaching vessel, but with others around it.
- *Visibility.* **If you can't see where you're going, slow down**. Fog and rain are obvious limits to visibility, but there are others. Geographic features and obstructions, along with heavy vessel traffic, can limit the view of "the big picture." Darkness or steering directly into the sun lessens ability to see objects or judge distances. Prevent spray on the windscreen as much as possible and clean it regularly. Spray build-upon the windscreen is particularly hazardous in darkness or in glare.
- *Shoal waters.* In extremely shallow water, the bottom has an effect on the movement of the vessel. **Slow down in shallow waters**. In extremely shallow water, the vessel's stern tends to "squat" and actually moves closer to the bottom.

Watch your wake

As a vessel proceeds, a combination of bow and stern waves move outward at an angle to the vessel track. The wake height and speed depend on vessel speed and hull type. Some of the largest wakes are caused by relatively large, semi-displacement hulls, proceeding at cruising speed. Some lighter craft actually make less wake at top speed in the planning mode rather than at a slower speed. Displacement craft make the largest wake at hull speed. Determine how to make your vessel leave the least wake; it might require slowing appreciably.

Whenever you maneuver, keep your crew member informed, especially if rapidly accelerating, turning or slowing. A quick warning shout could prevent injury.

All vessels are responsible for their wake and any injury or damage it might cause. Only an unaware Boat Operator trails a large wake through a mooring area or shallows, tossing vessels and straining moorings. "Get-home " and a false sense of urgency are two reasons Boat Operators forget to watch their wake. **A large, unnecessary wake, particularly in enclosed waters or near other, smaller vessels, ruins the credibility of a professional image.**

Turning the Boat with the Helm

General

To move in a straight line, small, frequent, momentary helm inputs adjust the position of the stern and bow to head in the desired direction. To intentionally change the vessel heading, use larger, more sustained helm movement.

Aware of the pivot point

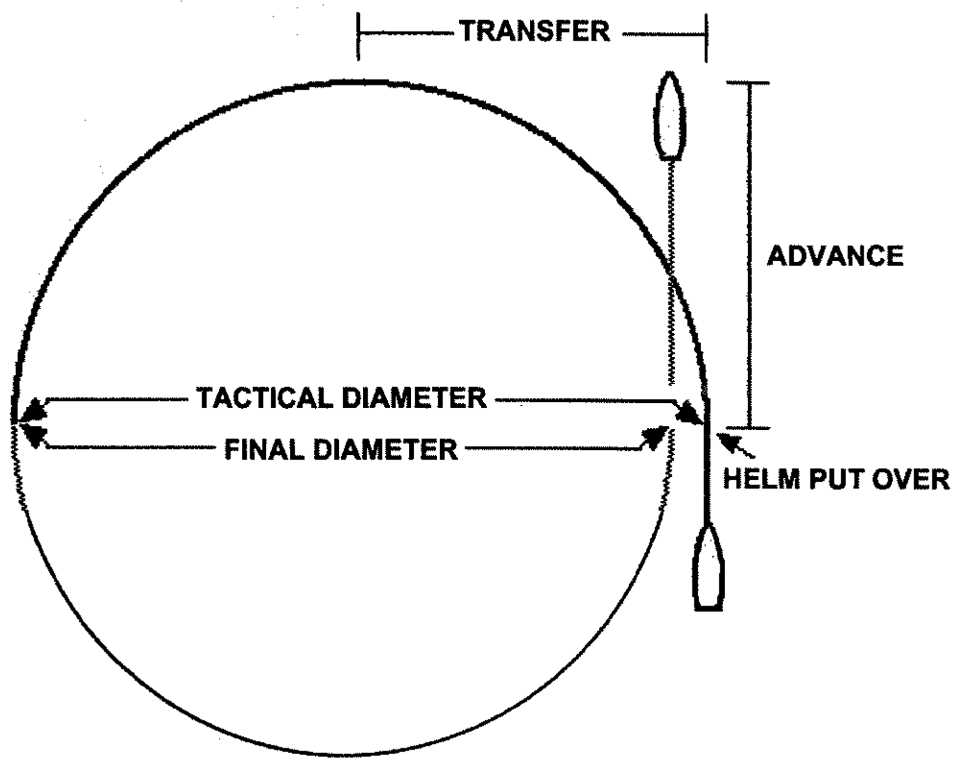
As noted earlier, you change the direction of the bow by moving the stern in the opposite direction. As the stern swings a certain angle, the bow swings the same angle. Depending on the fore and aft position of the pivot point, the stern could swing through a larger distance than the bow, at the same angle. When a hull moves forward through the water, the effective pivot point moves forward. The higher the forward speed, the farther the pivot point moves forward.

Note how propulsion type affects turning

Because outboards, stern drives and water jets use propulsion thrust for directional control, they can make a much tighter turn (using helm alone) with a given hull shape than if the same hull had shaft, propeller and rudder. With extended outboard mounting brackets, the directed, lower-unit thrust is farthest aft of the pivot point compared to the other configurations. Some brackets move the thrust three to four feet aft of the hull. The location aft of pivot point, along with the amount of directed thrust determines how much the stern will kick away from the direction of the turn. With directed thrust, the stern will usually skid outward more than with shaft, propeller and rudder, making the bow describe a very tight arc.

Learn the vessel's turning characteristics

If you proceed on a steady heading and then put the helm over to one side or the other, the boat begins to turn. Up to the time the boat turns through 90 degrees, the boat has continued to advance in the original direction. By the time the boat has turned through 90 degrees, it is well off to the side of the original track. This distance is transfer. As the boat continues through 180 degrees, its path has defined its tactical diameter. For a particular vessel, these values vary for speed and rudder angle (Figure 10-10).



Turning Characteristics
Figure 10-10

Develop a working knowledge of your vessel's turning characteristics. This will allow you to decide whether to make particular maneuver in a certain space solely with the helm or whether other maneuvering is needed. Learn when to ease the helm so as not to over steer a course change.

Note loss of speed through the water

Some planning hulls and most semi-displacement craft will slow appreciably when turning at high speeds. As the boat heels into a turn, the hull provides less buoyancy to keep the vessel on plane at a given speed. Also, as the aft part of the hull skids across the water while in a heel, it presents a flat shape in the original direction of movement and pushes water outward. The bottom becomes a braking surface. For light-displacement vessels, a full helm at high speed maneuver minimizes advance.

With light-displacement, high-powered craft, maximum helm at high speed will quickly stop a boat's progress in the original direction of movement. Though such a turning action is effective to avoid contact with an immediate hazard, the violent motion could eject an unsuspecting crewmember. Don't use this technique except as an emergency maneuver and especially don't use this maneuver to demonstrate the boat's capability to non-crew.

Stopping the Boat

If you pull back the throttle to neutral, the vessel will begin to lose forward motion. For a heavy-displacement vessel, once propulsion is stopped, the vessel will continue to move forward for some distance. The vessel carries its momentum without propulsion. For a semi-displacement hull or planning hull, as you retard throttle and reduce power, the boat quickly comes off plane. As the vessel reverts to displacement mode, the resistance of the hull going through the water instead of on top the water slows the boat. The vessel still carries some way, but at only a fraction of the original speed. Experiment with your vessel and see how rapidly the boat slows after going from cruising speed to neutral throttle. Know the amount of head reach your vessel carries from different speeds. It is very important when maneuvering.

Use astern propulsion to stop the vessel

Slowing the vessel's forward movement won't always do. A complete and quick stop to dead in the water may be required. Do this by applying astern propulsion while still making forward way. First, slow the vessel as best possible by retarding throttle. After the vessel begins to lose way, apply astern propulsion firmly and forcefully. Power must be higher than that available at idle speed to prevent engine stall. On a single-screw vessel, the stern will want to swing to port. After all way is off, throttle to neutral.

At low forward speeds, astern propulsion is frequently used to maneuver, both to check forward way and to gain sternway.

With a water jet, reverse thrust is immediate. No marine gear or drive unit changes shaft and propeller rotation. The deflector or bucket plate drops down and redirects thrust forward. As with other drives, use enough astern engine power to overcome potential engine stall.

Though many vessels are tested and capable of immediately going from full speed ahead to full reverse throttle, this crash stop technique is extremely harsh on the drive train and may cause engine stall. Though much of the power goes to propeller cavitation, this technique can be effective in an emergency.

The crash stop is an *emergency* maneuver. It may damage the drive train and stall the engine(s). In most cases, with high levels of crew professionalism, skill and situational awareness, it is not necessary.

Backing the Vessel

General

Control while making sternway is essential. Because vessels are designed to go forward, many vessels don't easily back in a straight line. Due to higher freeboard and superstructure forward (increased sail area), many vessels back into the wind. Knowledge of how environmental forces affect your boat is critical when backing.

Besides watching where the stern goes, keep track of the bow. The stern will move one direction and the bow the other around the pivot point. As a vessel develops sternway, the apparent pivot point moves aft and the bow may swing through a greater distance. Keep firm control of the helm to prevent the rudder or drive from swinging to a hard-over angle.

Don't back in a way that allows water to ship over the transom. Be careful with boats of very low freeboard aft. Outboard powered vessels, with low cut-out for motor mounting and a large portion of weight aft are susceptible to shipping water while backing, particularly in a chop. If shipped water does not immediately drain, it jeopardizes stability.

Most inboard engines exhaust through the transom. Outboard motors exhaust astern. Backing could subject the crew and cabin spaces to a large amount of exhaust fumes. Limit exposure to exhaust fumes as best possible. If training, frequently change vessel aspect to the wind to clear fumes. After backing, ventilate interior spaces.

Screw and rudder While backing, the rudders are in the weaker, less concentrated screw suction current, and most steering control comes from flow across the rudder due to sternway.

Single-engine vessels Propeller side force presents a major obstacle to backing in the direction you want. The rudder does not have much effect until sternway occurs, and even then, many boats will back into the wind despite your best effort. If backing to the wind, know at what wind speed the boat will back into the wind without backing to port.

- Before starting to back, apply right full rudder to get any advantage available.
- A quick burst of power astern will cause the stern to swing to port, but use it to get the boat moving.
- Once moving, reduce power somewhat to reduce propeller side force and steer with the rudder. As sternway increases, less rudder will be needed to maintain a straight track astern.
- If more sternway is needed to improve steerage, increase power gradually; a strong burst astern will quickly swing the stern to port.
- If stern swing to port cannot be controlled by the rudder alone, use a burst of power ahead for propeller side force to swing the stern to starboard. Don't apply so much power as to stop sternway or to set up a screw discharge current that would cause the stern to swing farther to port. As the vessel backs, it uses sternway water flow across the rudder to steer.
- If this fails, use a larger burst of power ahead, with helm to port. Sternway will probably stop, but propeller side force and discharge current across the shifted rudder will move the stern to starboard. Now try backing, again.

Twin-engine vessels Back both engines evenly to offset propeller side force. Use asymmetric power (one engine at higher RPM than the other) to help steer the stern. Asymmetric power will also give unequal propeller side force that will help steer.

- Apply astern power evenly, keeping rudders amidships.
- If the stern tends to one side, first try to control direction with slight helm adjustment. If not effective, either increase backing power on the side toward the direction of veer or decrease power on the opposite side.

Stern drives and outboards

Use the directed thrust to pull the stern to one side or the other. As the power is applied aft of the transom, use care to keep the bow from falling off course due to winds. Avoid cavitation that can easily occur when backing with a lower unit. Propeller side force is present, but is offset through helm. A lower unit that is not providing thrust is not efficient when trying to steer while backing. It is better to keep steady, slow RPMs than to vary between high power and neutral.

Single-outboard/ outdrive

- Offset propeller side force with right rudder.
- Apply astern power gradually, but be careful not to cause propeller cavitation.

Twin-outboard/ outdrive

If astern power is matched, propeller side forces will cancel. As with twin inboards, first try to offset any stern swing with helm before using asymmetric power. If less thrust than that provided by both drives at clutch speed is needed, use one motor or engine. This will keep speed low but will keep thrust available for steering, rather than shifting one or both engines from reverse to neutral. If using one unit, compensate with helm for propeller side force and the increased, off-centered drag caused by the other lower unit.

Waterjets

There is no propeller side force and thrust is directed. Going from forward to reverse thrust has no marine gear or drive train to slow things. Thrust is simply redirected with the "bucket." Unless thrust is applied and being directed, there is no directional control at all.

Avoid bursts of power astern when backing. Bursts of power when making astern thrust will excessively aerate the water jet intake flow ahead of the transom.

Using Asymmetric or Opposed Propulsion (Twin Screw Theory)

General

Asymmetric propulsion while backing was covered above. The techniques presented here are additional methods of maneuvering that capitalize on twin-engine vessel capability to differ the amount or direction of thrust produced by the two engines. Any difference in thrust affects the boat's heading. The amount of this difference can vary from that needed to hold a course at cruising speed to turning a boat 360 degrees in its own length by opposing propulsion (splitting throttles). Liken the concept of asymmetric or opposed propulsion to "twisting" the boat, but the forces and fundamentals discussed earlier still apply and affect vessel response. Pivot point, propeller side force and turning characteristics remain important. Because the drives are offset from vessel centerline on a twin-engine vessel, they apply a turning moment to the hull. Twin outboard motors on a bracket apply this twist aft of the hull (and well aft of the hull pivot point), while twin inboards apply most of this twist to the hull at the first thrust-bearing member of the drive train (usually the reduction gear or v-drive, much closer to the pivot point). With inboards, propeller side force is transferred through strut and stern tube to the hull.

Up to a point, the greater the difference in RPMs, the greater the effect on the change in heading. Above that point, specific for each boat, type of propulsion, sea conditions and operating speed, cavitation or aeration will occur, and propulsion efficiency will decrease, at least on one drive.

Hold a course

Depending on a vessel's topside profile, wind conditions might make the bow continually fall off to leeward. Though the helmsman can compensate for this by steering with constant pressure to hold desired course, a less taxing way is to adjust the throttles so the leeward engine turns at more RPMs than the windward engine. Fine-tune the difference in RPMs until pressure is off the helm.

Changing Vessel heading Using Asymmetric or Opposed Propulsion (Twin Screw Theory)

Rotate about the pivot point

This is a low-speed maneuver. It is important because you will face situations when you need to change the boat's heading (to the weather or another vessel) or to move the bow or stern in a limited area. Oppose the engines to turn in an extremely tight space. Perform this maneuver first at clutch speed in calm conditions to learn how the vessel reacts and what type of arcs the bow and stern describe. With no way on, there is no initial advance and transfer, so depending on the boat, this maneuver might yield a tactical diameter of zero if you change heading 360 degrees (rotating the vessel in its own length).

Consider the forces involved. Vessels with propellers will develop side force from both drives during this maneuver. The rudder can use screw discharge current from the ahead engine to help pivot the stern. Because boats operate more efficiently ahead, some headway may develop.

Helm over hard to port

Put the helm over hard to port:

- Perform the same procedures as with helm amidships. When stopping and reversing direction of swing, shift the helm to starboard.
- In addition to the observations made with helm amidships, note whether the sizes of the arcs were smaller (due to directed thrust by lower unit or rudder).

Helm amidships

With helm amidships:

Step	Procedure
1	At dead in the water and throttles in neutral, simultaneously clutch ahead with starboard engine, and clutch astern with port engine (keep both engine RPMs the same, though in opposite direction).
2	Note the arcs described by bow and stern as the vessel swings through 360 degrees to determine vessel pivot point.
3	If vessel moved forward (along its centerline) during the rotation, slightly increase astern RPM to compensate.
4	Now, simultaneously shift throttles so port is clutch ahead and starboard is clutch astern; note how long it takes to stop and reverse direction of swing.
5	Again, check bow and stern arcs as vessel swings through 360 degrees, then stop the swing.

Developing skills With the basic skill in hand, practice controlling the amount of swing. Use the compass and gradually limit the degree of rotation down to 30 degrees each side of the original heading. Next, increase amount of throttle applied. Note the effect on vessel movement especially as to the rate of swing.

Develop your boat handling knowledge and skills to know the degree of throttle splitting or asymmetric thrust for best effect in any situation. Maneuvering near the face of a breaking wave may require opposing engines at one-third or more their available RPM, while maneuvering near the pier might only require a short, small burst on one engine to bring the bow through the wind.

Experiment with your vessel.

- Though rudder use should help increase the rate of swing, the increase in turn rate might not be worth the workload increase (stop-to-stop helm use). Due to rudder swing rate, full helm use may not be as effective as leaving the helm centered.
- At some level of power for each vessel and drive train arrangement, cavitation will occur with split throttles. Know at what throttle settings cavitation occurs. More power will not increase turning ability and might cause temporary loss of maneuverability until cavitation subsides. In critical situations, loss of effective power could leave a vessel vulnerable.

Reduce tactical diameter at speed An emergency maneuver at cruising speed may require a turn with reduced tactical diameter.

Turn and drag one propeller

An effective technique for a twin-propeller boat is to have one propeller act as a brake. This creates drag on the side with that propeller and reduces the turning diameter.

Step	Procedure
1	Put helm hard over.
2	Bring throttle on the engine in the direction of the turn to "clutch-ahead."

Don't put throttle to neutral position. In neutral, the propeller will "free-wheel" and rotate without any resistance. By staying at idle ahead, the marine gear and engine will keep the propeller from spinning at a rate that corresponds to the vessel's speed through the water, "braking" the vessel.

Turn and split throttles

This practice also is more effective with shaft, propeller and rudder arrangement than with directed thrust drives. One propeller will still be providing forward thrust while the other will be backing. As with opposing thrust in low speed maneuvering, propeller side force is multiplied. Cavitation will be pronounced on the backing screw, but the vessel's forward motion keeps advancing this screw into relatively undisturbed (or not-aerated) water.

Step	Procedure
1	Put helm hard over.
2	Bring throttle on the engine in the direction of the turn firmly to and through neutral, then past, the clutch-astern position, and gradually increase astern RPM.

As with the crash stop, this maneuver is extremely hard on the engine and drive train. The backing engine's power must be higher than that available at clutch speed to prevent engine stall.

Fully develop your boat handling skills and key them to the particular craft you operate. For instance, the Destroyer Turn described above (turn and split throttles) was developed for twin-screw ships operating in the open ocean. Though it has been carried into boat operations as a standard procedure for man-overboard recovery, a highly maneuverable, planning-hulled boat might be much more effective in recovery by doing a crash stop then pivoting, while staying within immediate range (and sight) of the person in the water.

Performing Single-Screw Compound Maneuvering (Single Screw Theory)

General

Apply basic maneuvering techniques in combination with a single propeller, at low speed to further boat handling skills. Learn these maneuvers as best possible in calm, no-current situations before learning to overcome environmental forces. A single-screw vessel never has the ability to use asymmetric or opposed propulsion, and its Boat Operator must develop boat handling skills with this in mind. The operator of a twin-engine vessel could easily become limited to use of one drive due to engine failure or fouling a screw, and must also become a proficient, single-screw boat handler.

For the discussion here, we will use the case of a single-engine propeller vessel with right-hand turning screw. When maneuvering a twin-engine vessel on one drive, the Boat Operator must account for the propeller rotation and side force for the particular drive used and the offset of the drive from centerline.

Back and fill

The back and fill technique, also known as casting, provides a method to turn a vessel in little more than its own length. At some point, anyone who operates a single-screw vessel will need to rely on these concepts when they operate a boat, particularly in close-quarters maneuvering. To back and fill, rely on the tendency of a vessel to back to port, and then use the rudder to direct thrust when powering ahead. Decide the radius of the circle where you want to stay (at most, 25 to 35 percent larger than the vessel's overall length), and the intended change in direction (usually no more than 180 degrees) before starting.

Step	Procedure
1	Put helm at right full and momentarily throttle ahead, being careful not to make much headway. (Rudder directs screw discharge current thrust to starboard, more than offsetting propeller side force and moves stern to port).
2	Before gaining much headway quickly throttle astern and shift helm to left full. (With throttle astern, side force much stronger than screw suction, rudder to port takes advantage of any sternway).
3	Once sternway begins, simultaneously shift helm to full right and throttle ahead as in step 1.
4	Repeat steps until vessel has come to desired heading, then put helm amidships and apply appropriate propulsion.

- A firm grasp of your vessel's maneuvering characteristics is necessary to know whether you will need to back and fill rather than just maneuver at full rudder.

- The amount of steps used will depend on size of your turning area and the desired change in heading. The smaller the area, the more backing and filling required.

- Winds will play a factor in casting. If your vessel bow is easily blown off course, your vessel probably has a tendency to back into the wind. Set up your maneuver (including direction of turn) to take advantage of this in getting the bow to change direction. Strong winds will offset both propeller side force and any rudder effect.

- A quick helm hand is a prerequisite for casting with an outboard or stern drive. To get full advantage of the lower unit's directed thrust; fully shift the helm before applying propulsion. With helm at left full, the propeller side force when backing will have an element that tries to move the stern "forward" around the pivot point.

Maneuvering Near Other Objects

Introduction

This section applies basic maneuvering principles to control your vessel with respect to other objects. Later parts will cover mooring, unmooring, and coming alongside other vessels or objects. This covers maneuvering your vessel near, but not next to, another object.

Keeping Station

General

Learn to manage the effects of environmental forces by keeping station on an object. Keeping station maintains your distance, position and aspect to or from an object. With twin propulsion, develop skills to keep station at any aspect to any object in most conditions. Though many single-drive boats are thought to be less maneuverable, fully develop single-drive station-keeping skills. Practice station-keeping in various levels of wind, seas and current.

This section includes considerations for a maneuvering zone, maneuvering on different types of objects and different maneuvers to keep station.

All Boat Operators of twin-drive vessels must frequently train for single drive operation. This includes station keeping.

Determine a maneuvering zone

Each situation requires a safe maneuvering zone to reach an optimal position near the object so an evolution can safely occur and be done effectively, i.e., equipment transfer, object recovery, surveillance, etc. Before you keep station, get the "big picture."

When station-keeping, always have a safe escape route to get clear of the object or any hazard. As you keep station, ensure the escape route stays clear. This may require changing position to establish a new escape route.

Step	Procedure
1	Evaluate environmental conditions and how they affect the situation.
2	Determine if obstructions on the object or in and above the water limit your safe maneuvering zone.
3	Account for obstructions and keep the environmental forces in mind.
4	Avoid vessel outriggers or hull protrusions, loose pier camels or broken pilings, ice guards, shoals, rocks or other submerged obstructions, low overhead cables or bridge spans.
5	Define the maneuvering zone by distance, position and aspect. Put limits on each element and maneuver to stay within those limits.

Distance

Keep station close enough to complete a mission or evolution, yet far enough to prevent collision or allusion. Minimum distance to the object will probably vary around the object or along its length. Environmental conditions and boat maneuverability play a major role in determining distance.

- Use a practiced eye and ranging techniques to keep distance.
- When able, use identifiable keys, such as a boat length. Unless well practiced, each crewmember will probably differ in how they view 25 feet or 25 yards.
- Use knowledge of your own vessel. If it has a twelve-foot beam at the transom, transpose that measurement to the gap between your boat and an object.
- If the Boat Operator station does not allow a clear view of the object, use points on your vessel (windscreen brackets, tow bitt, antennae, or fittings) to set up range-keeping clues.

Distance (continued)

- Position: the angle from the object to your vessel (or the reciprocal). To keep station on another vessel, particularly one that is disabled and adrift, use the angle your vessel is from the other vessel's centerline; on a moored or fixed object, use a geographic or compass bearing.

- Aspect: the relative angle your vessel makes to the other object (bow, beam, quarter, etc.). You may need to keep the object at a certain aspect to pass equipment or a towline, to maintain surveillance or to train a fire hose.

Differences in objects

Differences in objects determine the maneuvering situation. Become fully capable of station keeping in a variety of situations both type of object and environmental conditions.

Keep station on a free-drifting object

Object type and size ranges from small items to other vessels. Free-drifting objects will present a different drift rate from your vessel. Develop station-keeping techniques by first matching your drift rate to the object, then overcoming the difference.

Have another vessel maintain a steady course at low speed. Pace your vessel to the other vessel and then maneuver around it. Pacing your movement to the other vessel is critical before safely going alongside.

No Leeway

Practice with a floating (but ballasted) item that does not drift with the wind. A weighted mannequin with PFD or weighted duffel bag with a float in one end will work. The object's drift will be limited to the surface current, while your vessel will respond to currents and winds. This type of object simulates a person-in-the-water.

Leeway

Wind-drift is the main consideration here. Practice with paired fenders, a partially filled 6-gallon bucket or a small skiff. Though wind will have a measurable effect on object drift, current will play little role. As above, your vessel will be subject to both wind and current.

Other Vessel

Become proficient at station-keeping on a variety of vessel types including one like your own. Different vessels react differently to environmental forces. Learn how other vessels drift compared to your own. See how other vessels lie to the wind, then maneuver your vessel to an optimal position for observation, coming alongside or passing a tow rig.

Keep station on an anchored object

This limits much of the object's movement due to wind and current, but the object will often surge and swing. Your vessel will react freely to the wind and current. The object will ride with its moored end into the strongest environmental force affecting it, while the combination of forces on your vessel may cause it to take a different aspect.

Station keeping on an anchored object helps you learn where you can or cannot maneuver. Upstream of a buoy, strong current could easily carry you down on it. On the other hand, the only safe approach to a disabled vessel, anchored off a lee shore, may be from dead-to-weather.

Buoy or Float

In general, approach a moored buoy or float from down-current or downwind, bow to the object. If servicing a floating aid to navigation, the approach may require centering your stern on the buoy. To train, keep station at various distances and angles to an object. Pick something totally surrounded by safe water. Next, maneuver up-current or upwind.

A Vessel

Surveillance, personnel or equipment transfer, or fire fighting may require station-keeping on an anchored vessel. Develop skills to keep station at all distances and angles. Different sizes and types of vessels will ride their anchors differently. Deep draft or a large underbody will make a vessel ride with the current, while high freeboard and superstructure may make the vessel tend downwind. Evaluate the combination of forces as you keep station.

Note vessel interaction. If you are close aboard and upwind, a small, light vessel may ride the anchor differently than if you weren't there. A larger vessel may affect the forces on you by making a lee. Watch a vessel's motions while it "rides" anchor. Some vessels don't "steady out," but veer back and forth. Observe and plan accordingly.

Fixed Object

Keep station on a pier, seawall, or breakwater. View this as a step before mooring. Also, you may need these skills to transfer someone to a fixed aid to navigation or to remove a person stranded on rocks. Station keeping on fixed objects makes you deal with forces that affect you and not the object. Often, the fixed object affects the environmental forces by funneling, blocking, or changing direction of the current or wind.

Maneuvering

General

Station-keeping will usually require frequent to near-continuous applications of power and helm to stay in the safe maneuvering zone. As you keep station and try to stay within the maneuvering zone limits, you will find that adjusting for one of the parameters (distance, position, aspect), will almost always involve a change to one or both of the other two. While using power and helm to compensate for and to overcome wind and current, use the wind and current to your best advantage.

Stem the forces

To stem the forces means to keep the current or wind directly on the bow or stern and hold position by setting boat speed to equally oppose the speed of drift.

Crab the boat sideways

To do this, use the environmental forces to move the boat at a right angle to the forces. Put the bow at a shallow angle (20 to 30 degrees) to the prevailing force and use ahead propulsion and helm to keep from getting set backward, while staying at the shallow angle to the prevailing environmental force.

Open and close

Make your vessel "open" and "close" the distance on the object at various angles, both to leeward and to weather. With an object on the bow or stern, directly up-drift or down-drift from you, opening and closing requires only to compensate for the fore and aft drift rate and to maintain a steady heading. The more difficult scenario is opening or closing distance abeam.

Step	Procedure
1	Use a combination of control and environmental forces: side force, ahead and astern thrust, rudder force, leeway, current drift.
2	Remember to account for pivot point when moving the bow or the stern.
3	Use reasonable limits and stay within them.

Maneuvering to or from a Dock

General

The most challenging and probably most frequent maneuvering you will encounter is that associated with getting in and out of slips, dock areas, piers, boat basins or marinas.

Compensate for wind or current

Check the conditions before maneuvering. Always try to take advantage of wind and current when docking or mooring. To maintain best control, approach against the wind and current and moor on the leeward side of a mooring when possible. Chances are that when you get underway, conditions aren't the same as when you moored.

Rig and lead mooring lines and fenders early

Rig mooring lines and fenders well before the approach. Get the noise and confusion over with long before the Boat Operator must concentrate and maneuver to the dock. See *Chapter 17 - Towing*, for more information on fenders.

Control, not speed

Emphasize control, not speed, when docking. Keep just enough headway or sternway to counteract the winds and currents and allow steerage while making progress to the dock. Keep an eye on the amount of stern or bow swing. With a high foredeck, the wind can get the bow swinging much easier than it is to stop. In higher winds, a greater amount of maneuvering speed may be needed to lessen the time exposed to the winds and currents, but be careful not to overdo it.

Line handling

Line handling is extremely important when docking. Less-than-good line handling always ruins the docking at the end of a perfect approach. Ideally, try to have the boat stopped alongside the dock before putting lines over. The order in which the lines are attached depends on the boat operator's evaluation of the situation. Under most conditions the stern line is secured first.

Basic Maneuvers

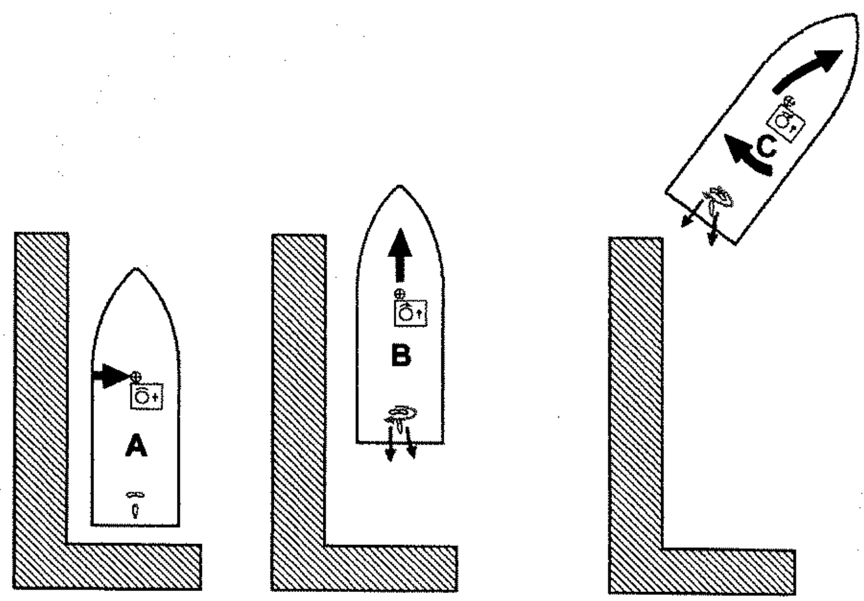
General

Often, the presence of other craft or obstructions will complicate the clearing of a berth, or any simple maneuver. Wind and/or current can also become a factor. Before maneuvering, evaluate the options in order to take full advantage of the prevailing conditions.

Clear a slip

This assumes that there is no wind or current and the vessel is a single-screw. See Figure 10-11.

Step	Procedure
1	Set rudder amidships.
2	Apply slight right rudder to offset propeller side force.
3	Use ahead throttle and move ahead slowly (b).
4	As the boat gains headway, apply additional helm to turn (c). Remember that the rudder causes the stern to swing in the opposite direction of the bow. Before starting a turn, make sure the stern will clear the pier.



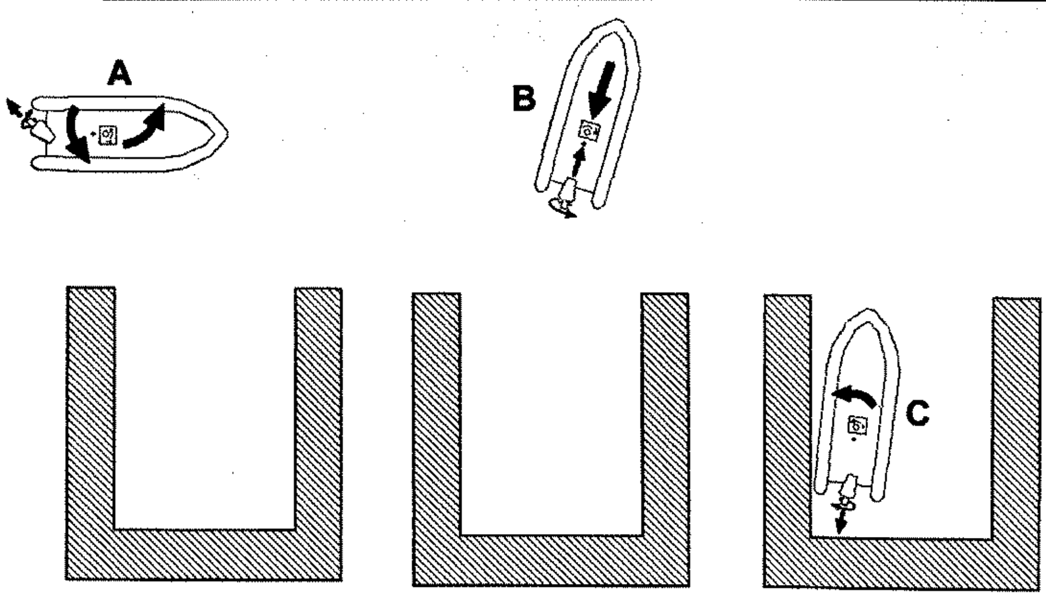
Clear a Slip (no wind or current, single screw)
Figure 10-11

Back into a slip

This assumes that there is no wind or current and the vessel is a single-screw, outboard or I/O. See Figure 10-11.

Back into a slip

Step	Procedure
1	Approach at low speed, perpendicular to slip, approximately one-half to one boat-length away.
2	As the amidships section is even with the nearest edge of the slip, apply hard left rudder and "bump" throttle ahead to swing the stern to starboard.
3	As bow swings to port, go to neutral throttle and aim lower unit at the back corner of the slip. Immediately apply astern throttle to stop headway and acquire sternway. Side force will stop swing.
4	Steer lower unit towards slip, just aft of desired final position, offsetting for side force as necessary, using astern clutch speed and neutral to keep speed down.
5	When almost alongside, apply slight left rudder and "bump" throttle ahead, then go to neutral.



Back Into a Slip (no wind or current, single outboard/stern drive)
Figure 10-12

General Rules of Thumb

Responsibility

The Boat Operator is always responsible for the boat regardless of the existing environmental conditions and situations. Care must be exercised before assigning newly qualified Boat Operators to missions in extreme weather conditions.

Slow speeds

When maneuvering at slow speeds alongside, use full left (or right) rudders. On twin-screw boats, with the rudders left amidships, use the screws at clutch (idle) speed to maneuver.

Alongside

When maneuvering alongside, speed should be kept to a minimum. Apply power in short bursts (with rudder at left or right for single screw boats) to get changes in heading; but keep the bursts short enough so you don't increase your speed.

Port side

Port side moorings are the easiest for single-screw boats with "right-hand" props.

Backing and filling

Slow speed maneuvers to starboard are best for single-screw boats with "right-hand" props in restricted areas. Do this by:

- Alternately going ahead with the rudder at left full and astern with the rudder at right full.
- When going ahead, give a quick burst to direct water past the rudder for as long as possible to get maximum twist with minimum headway.
- When going astern, gradually increase power for as long as the bow continues to go to starboard, or as room permits.

Precise control

When requiring precise control, keep the boat's heading into the predominate wind or current, or as close as possible. When maneuvering the boat so that the set from the wind or current is on either the starboard or port bow, the boat may "crab" (move sideways) in the opposite direction.

Wind and current

Wind and current are among the most important forces to consider in maneuvering. The operator should use them to advantage, if possible, rather than attempting to fight the elements.

Thrusting away from another boat

To thrust away from another boat, a camel, or a ship, use the prop wash or "screw knuckle." Just apply full power astern in a short burst then return to neutral. The prop wash will move forward between the boat and the surface alongside, pushing the boat away.

Fenders

Never attempt to fend a boat off a pier, float, etc., by hand or foot - always use a fender. Always keep the proper sized fenders handy.

When docking or taking another boat alongside, you should always rig fenders to prevent hull damage. Fenders should be secured using a clove hitch or slip clove hitch.

Mooring/ off-dock wind When mooring with an off-dock wind, the approach should be made at a sharp angle - 45° or more.

Mooring/ on-dock wind When mooring with an on-dock wind, approach parallel with the intended berth and adjust fenders to cushion the points of contact. Ensure that the boat has no fore and aft movement when contacting the dock.

Pivot point The pivot point of a boat is approximately one-third of the way aft of the bow when the boat is underway at standard speed. This point moves forward as speed is increased and aft as speed is decreased.

Protecting the stern Keep the stern away from danger. If your propellers and rudder become damaged, you are crippled. If the stern is free to maneuver, you can work your boat out of trouble.

Control of the boat The greatest amount of control over the boat is gained by maneuvering into the prevailing face of the wind or sea. Boats turn more slowly into the wind and sea than away from them. A single-screw boat will generally back into the wind when the boat has more "sail" area forward of the boat's pivot point than aft.

The wake You are responsible for the boat's wake.

Informing the crew The Boat Operator must keep the crew informed. Never assume the crew knows everything that you are thinking.

Sea conditions The most experienced Boat Operator knows what sea conditions they can operate in and in what conditions they cannot.

Forethought Think ahead. Don't take chances.

Maneuvering Alongside Another Vessel

Overview Many missions will require going alongside, in contact with another vessel. Activity can vary from a RIB going alongside a large merchant vessel to a large twin-screw boat going alongside a small canoe. Comparative vessel size, mission requirements and prevailing conditions all dictate maneuvering practices. For many recreational and commercial mariners, your maneuvering alongside their vessel is often the first "up close and personal" look they get of the Sheriff's Department Boats.

Determining Approach

General

When you determine your approach, consider prevailing weather and currents, location, vessel sizes, traffic density. Discuss your intentions with the other vessel's master.

If going alongside a disabled vessel or one that is underway but dead-in-the water, compare relative drift rates. When approaching a larger vessel with a low drift rate, approach from leeward. If approaching a smaller vessel, determine if your vessel makes a wind shadow that will slow the other vessel's drift. In this case an approach from windward may be better and the smaller vessel will then be protected from winds and waves by your vessel. See Chapter 17, *Towing*, for more information.

Do not approach from leeward **if** it will put your vessel and crew in jeopardy, whether from shoal water or obstructions farther to leeward or from smoke or hazardous fumes.

Course and speed

If prudent, have the vessel maintain a course and speed to make your approach as smooth as possible for both vessels.

Altering course

Most large vessels will not be able to alter course significantly in a limited area to provide ideal alongside conditions. If it is not practical for the large vessel to change course, have it reduce speed so the effects of bow and stern waves are reduced.

Small vessels

Small vessels don't ride well when not making way in any kind of winds or seas. Unless the weather is perfectly calm, have a small vessel maintain a course and speed that makes for safe, comfortable navigation while allowing mission completion. Ensure speed is slow enough for safely coming alongside, but enough for both vessels to maintain steerageway when alongside one another.

Stability

Many sailing vessels are much more stable while under sail than when powering or drifting. Consider coming alongside while the other vessel is under sail. Be sure that spars, standing or running rigging or control lines don't foul either vessel. Discuss the situation with the other vessel's master.

Make sure the other vessel does not begin to change course while you are approaching or coming alongside. If this happens, break off and start the approach over once the other vessel is on a steady course.

Approach from leeward and astern

A large vessel will create a wind shadow and block most of the seas. Take advantage of this as in mooring to the leeward side of a pier. Though a small vessel will probably not block the elements to any degree, approach from leeward to control rate of closure and limit any effect your vessel would have on the small vessel drift.

If an approach from leeward is not possible (due to sea room or other condition like smoke or hazardous vapors), use caution to prevent being pinned up against the side of another vessel. A bow-in approach might provide the most maneuverability.

Line and fenders

Rig lines and fenders as needed. Remember that the more fenders you use, the better.

Going Alongside

After completing your approach preparations, go alongside. Determine where you want to make contact on both vessels.

Pick a contact point well clear of a larger vessel's propeller (including in the area of suction screw current), rudder, and quarter wave. Forces from these could cause loss of control.

Begin to close

Conditions permitting, match your speed to the other vessel, then start closing in from the side.

Angle

Close at a 15 to 30 degree angle to the other vessel's heading. This should provide a comfortable rate of lateral closure at no more than one-half the forward speed.

If your initial heading was parallel to the other vessel, you will have to increase speed slightly when you start to close at an angle.

Conduct the mission

When alongside, do what has to be done. Minimize time alongside. If necessary, "make-up" to the other vessel rather than relying on helm and power to maintain contact.

Maneuvering in Rough Weather

Introduction

At some time, every boat and crew will encounter wind or sea conditions that challenge safe, successful boat operation. Due to size and design differences, extreme weather for one vessel is not necessarily challenging for another. Also, crew training, experience, and skill more often than not make the difference between safety and danger, regardless of the vessel.

Size, stability, and power are vessel characteristics that enhance safety and allow some forgiveness in large waves and high winds or due to the occasional lapse in skill or judgment. On the other hand, light weight, speed, and agility give a means to avoid or to outrun conditions, but offer little protection or forgiveness for the slightest miscalculation.

Learn to operate your vessel through the full range of conditions you can expect. Begin in light winds and small waves and work up to varied conditions that build your knowledge and confidence.

General

Use caution at all times. Never underestimate the power of winds and waves and what they can do to your vessel or crew. The following concepts will increase the level of safety at which you operate.

Know your vessel

Be familiar with your vessel's operating characteristics and limitations to safely and confidently handle conditions that approach those limits.

Learn your vessel's motions and peculiarities

Operate your vessel frequently and develop a working knowledge of its response to waves and winds. Excessive boat motion is very fatiguing and could cause motion sickness.

- Learn the motions your boat makes in response to the seas. Find out if your vessel has any distinctive tendencies, for instance, attaining a dangerous heel while cresting a wave in high winds, burying the bow in all but the longest swells, or "lightness" to the stern in quartering conditions.
- Learn and develop techniques to minimize vessel motion in all conditions. A small tweak of the throttle or a smooth helm-hand can make the ride much smoother and less fatiguing.
- On smaller vessels, keep crew weight centered around the helm position. This is usually near the boat's center of gravity. It will make the ride more comfortable for the crew and will allow the hull to ride as designed, with more stability, than if weight is in the ends or at the extreme beam.

Common Motions	Description
Roll	The side to side motion as each side goes up and down. This is associated with beam seas. A round-bottomed vessel will roll even in near-calm conditions. Reduce roll by setting a course that does not have the seas directly on the beam.
Heave	The vertical motion the entire boat makes. Though frequently hidden by combined pitch and roll, it is felt as a boat encounters large waves or a heavy swell.

Know your vessel's limits

Know what wind speed puts the boat "in irons" with loss of maneuverability. Learn how to heave to and ride out the worst winds or seas.

Ensure proper operation

Don't use a vessel in rough weather when it is not operationally ready. A small discrepancy can lead to serious consequences. Properly stow all required gear and remove everything else. Rough weather will dislodge things.

Know your area

Learn to handle your vessel in the types of winds and seas found in your area. Learn their interaction with local geography and hydrography.

Observe all areas beforehand

Learn your area's tide rips, bars, coastal currents and local waters before you must maneuver there in rough weather.

Observe before you act

Evaluate on scene conditions before committing to a maneuver.

Step	Procedure
1	Time the series of waves, note relative lulls between the large ones, any places where the waves don't curl and break with intensity, or where they seem to peak and break continuously.
2	Note if an approaching thunderstorm has a wall cloud or if a "downburst" is visible.
3	Determine the best way to lessen the effect of a sudden, extreme gust of wind.

Know yourself and your crew

You and your crew have limitations. Know what they are. Be aware of the human factors and clues associated with risk management. False bravado or over-confidence in rough weather will not compensate for inexperience or fear. The following are common sense guidelines to follow:

- **When in doubt, don't**. Experience helps hone good judgment in risk assessment.
- **Understand your responsibility**. Rough weather is not a game or a sport. Use your head.
- **Know when to end an evolution**. This is particularly true in training. Damage or injury during training removes resources and people from operational availability.
- **Perform as a team**. While the Boat Operator concentrates on the detailed maneuvering, the crew must act as an additional eyes and ears.

Negotiating Head Seas

General

Use your vessel's inherent capabilities. Bow flare provides additional buoyancy to help lift the bow, but you must meet larger seas much slower than you would smaller ones. A slower speed of approach gives the bow time to rise and meet the waves.

The following parts on maneuvering are general in nature. Remember that each specific boat type will perform differently. Keep in mind that aerated, broken, sloughing, or "white" water will not provide as much buoyancy as "green" water. Also, propulsion and helm response will be sluggish. Aerated water favors cavitation.

Maneuver constantly

Look and drive for the path of least resistance. The best way to get through waves is to avoid as many as possible. Anticipate patterns and take advantage of them.

Breaking waves

Pick your way around breaking waves. Take advantage of any lulls between the higher series of waves. Look for gaps or windows in the breaking waves, but watch them to see if they close out before you approach. Don't try to steer a perfectly straight course, steer the smoothest course.

Crests

Avoid the highest crests. Stay away from waves that begin to peak in a triangular fashion. A "square" wave leaves no room to maneuver, and the trough behind is much deeper than others.

Working over waves

Work your way over each wave individually. Vary speed and angle of approach to account for differences in each wave.

If you must go through a breaking wave, keep headway. Just as the breaking sea hits the bow, increase power to lift the bow so the sea will not spill on deck, then immediately reduce power.

Step	Procedure
1	Slow down, approach at an angle. Too much speed could "launch" a boat as it leaves a crest and result in a severe drop. Approach at a 10-25 degree angle to the wave rather than straight into it. Cross the crest at this angle to stay in the water and keep the propellers and rudders working.
2	Stay ready to maneuver. You may have to straighten out quickly or to "fall off" to avoid a forming break.
3	Continually adjust boat speed. Increase speed to keep the screw and rudder or drive in the water and working, but then immediately reduce it to minimize wave impact.
4	Don't drive the bow into the wave.

If the sea is about to break directly ahead and plunge onto the bow, back down squarely and quickly to avoid the plunging water. The boat will settle as the aerated froth passes, and propulsion and steering will lose some effectiveness until the white water passes.

Don't use so much power to cause cavitation when backing away from a wave. If you cavitate, you will lose all thrust and maneuverability.

If your vessel is a single-screw, don't attempt this if you were originally going to take the wave on the port bow. Backing down will throw the stern to port and the vessel could end up beam-to the crashing wave.

Manage your power Keep one hand constantly on the throttle control(s).

Heavier vessels Use the following procedures when managing the power of heavier vessels.

Step	Procedure
1	Use only enough power to get the bow sections safely over or through the crest.
2	Let momentum carry, and cut back power to let the boat slide down the back side of the swell. When the stern is high, gravity pulls the boat downward and the engines may race somewhat, but stay in gear. Don't decrease RPMs to the point where the engines need time to "spool up" to regain enough power to deal with the next wave.
3	Increase speed in the trough to counteract the reversed water flow and maintain directional control as the next wave approaches.
4	Slow down again and approach the next wave.

Stay in the water Don't "fly through" the crest. **Avoid this at all costs**.

- If airborne coming through a wave with a large vessel, you threaten your crew with serious injury and could damage the vessel when it lands.
- With lighter craft, ensure the after sections stay in contact with the water, but don't let the bow sections get too high. If the bow sections get too high while going through a crest, the apparent wind or the break can carry the bow over backward. On the other hand, if forward way is lost with the stern at the crest, the bow might fall downward, requiring you to redevelop speed and bow-up attitude before the next wave approaches.

Hold on but stay flexed Keep a firm grasp on controls or hand holds, but don't rigidly brace yourself. Staying rigid and tense will quickly sap your strength. If standing, keep your knees flexed.

Running Before a Sea

A following sea does not present the high relative closure rate of head seas, but keeping vessel control and stability is probably more challenging.

Operation in a following sea, especially a breaking sea, involves the risk of having the stern lifted up and forced forward by the onrushing swell or breaker. Surfing down the face of a wave is extremely dangerous and nearly impossible to control. Quite often, surfing will force the boat to "broach" and capsize or to "pitchpole" end over end. Through proper boat handling, a skilled Boat Operator may be able to keep a vessel ahead of breaking seas while maintaining control of both direction and speed.

Use extreme caution Be very careful when running in a large following sea. Some boats slip down the back of seas and heel strongly. In large stern seas, the rudder may get sluggish. Depending on the vessel, make your down-swell heading anywhere from directly down-swell to a 15 degree angle to the swells.

A great deal of skill is needed to maintain a heading in large, quartering seas (30- 45 degrees off the stern), especially in restricted waters. In addition to the action from astern, the forces from abeam will set up a rolling action that causes large changes in the vessel's underwater hull shape (on anything except a round-bottomed, displacement hull). This causes asymmetric forces that increase steering difficulty, could set up "chine-riding," loss of effective helm, and a pronounced veer to the side as the vessel begins to surf along the face of the wave. Even in open water, quartering seas present a challenge.

Ride the backs of the swells

In waves with a wide regular pattern, ride the back of the swell. Never ride on the front of a wave. On most vessels, wider and flatter after hull sections are more buoyant than the bow. On the front of a wave, the boat may begin to surf, pushed along by the wave. As the bow nears the wave trough, it will tend to "dig in" while stern continues to be pushed. This sets up either a broadside "broach" or an end-for-end "pitchpole" as the breaking crest acts on the boat.

Don't let a wave break over the transom and poop the boat. Be extremely careful in small craft with outboard motors, the relatively low transom-well offers little protection from even a small, breaking wave. A wave that breaks over the transom could fill the cockpit with water and swamp the boat. Without self-bailing, this leaves you vulnerable to capsize by the next wave.

Where to look

Keep an eye both ahead and astern. If you totally concentrate on the wave ahead, you let your guard down on waves from astern. Since larger waves travel faster than smaller ones, one much larger than the one you are on may move up quickly from astern and catch you unaware.

Speed

Adjust your speed to stay on the back of the swell. Pay extremely close attention to the way the crest ahead of you breaks. If you keep gaining on the crest ahead, slow down.

Many small craft can travel faster than the largest waves. Don't keep climbing the back of a large wave ahead to its crest. The boat could go over the crest just as it breaks and falls into the trough under the plunging water.

Keep reserve power

Large seas run at over 20 knots. If the boat is being pulled back towards a following sea, open the throttle. If the boat is still pulled back, watch for "mushy" helm response and engine racing. If either happens, reduce throttle, then apply full throttle to try to kick out of the wave.

Slow, back or come about

If running with the seas and one is gaining astern, avoid it breaking on the transom.

Coming about in large seas can be dangerous. It puts the boat beam-to the seas. Don't try this unless well trained and experienced. Any close, steep swells will test all your skills. Sluggish rudder, sail area, and irregular waves may cause the stern to slew off and result in a broach.

Step	Procedure
1	Slow Down: with a well-found vessel, you may be able to just slow enough so the crest passes by before it breaks. This will cause some loss of positive steering and propulsion control as the crest passes because the water in the crest will be moving forward faster than the boat.
2	Back Down: you may need to back and gain sternway to steer before the crest reaches the screws and rudder, particularly if the wave breaks and aerated water will slough past.
3	Come About: the safest point for most vessels to take a breaking sea is nearly bow-on. Always stay aware of the time and distance between crests. If time and distance allow, come about and present the bow to the sea with headway.

If you must come about before a wave, use judicious helm and throttle. Too much throttle, especially when splitting throttles, could easily result in cavitation and leave no positive control in the face of the oncoming sea.

Traversing Beam Seas

General

In large beam seas, the wave action will cause the boat to roll. The rolling will cause asymmetric hydrodynamic forces and will affect steering. Do your best to keep drive and rudder immersed.

Breaking waves

Minimize the number of breaking waves you encounter. If traversing near a surf zone, go farther out into deeper water.

Use your local knowledge

Avoid areas that break when no other areas do. Offset your transit from areas of shifting bars.

If you must operate in the surf zone, complete wave avoidance is not possible. The Boat Operator must be totally involved in operating the boat while the crew carries out the details of the mission (search, recovery, etc.).

Keep a weather eye to the waves

As with head seas and following seas, the boat will be pulled towards the next, oncoming wave while in the trough, and set down-swell by the crest.

Waves

1 Look for a lull in the series to cross seas. If necessary, slow to allow a large series of waves to cross ahead.

2 Use caution to avoid a forming break. Watch how the waves break. Plan to cross an oncoming wave well before it begins to break. Don't get caught racing a break to cross at a particular point. Use procedures for negotiating head seas to cross oncoming waves. As with head seas, cross them at the lowest part.

3 Never get caught broadside to a breaking sea. A breaking swell taken on the beam can easily capsize the most well found vessel.

4 Don't get trapped. If the boat gets into closer and closer seas, look for an out. If shallow water or a current against the seas is on one side, work your way in the other direction.

Coping with High Winds

General

Though preceding discussions dealt with encountering severe wave action, high winds don't always accompany large swells. Also, there will be instances when extreme winds occur without sufficient duration to make large waves. Much of the time, though, high winds and building seas will coincide

Crab through steady winds

Depending on the vessel's sail area, you may need to steadily apply helm or asymmetric propulsion to hold a course in high winds. Learn to "read" the water for stronger gusts. The amount of chop on the surface will increase in gusts, and extremely powerful gusts may even blow the tops off waves. Anticipate the effect of a gust before it hits your vessel.

Step	Procedure
1	In large waves, the wave crest will block much of the wind when the boat is in the trough. Plan to offset its full force at the crest. The force of the wind may accentuate a breaking crest, and require you steer into the wind as you near the crest in head seas. Depending on the vessel, winds may force the bow off to one side as you cross the crest.
2	For light vessels, the force of the wind at the wave crest could easily get under the bow sections (or sponson on a RIB), lift the bow to an unsafe angle, or force it sideways. Though a light vessel must keep some speed to get over or through the crest of a large wave, don't use so much speed that as you clear the crest, most of the bottom is exposed to a high wind. Be particularly cautious in gusty conditions and stay ready for a sudden large gust when clearing a wave.
3	With twin-engine craft, be ready to use asymmetric propulsion to get the bow into or through the wind. As with all other maneuvers, early and steady application of power is much more effective than a "catch-up" burst of power.
4	Vessels with large sail area and superstructures will develop an almost constant list during high winds. In a gust, sudden heel, at times becoming extreme, may develop. This could cause handling difficulties at the crest of high waves. If your vessel exhibits theses tendencies, exercise extreme caution when cresting waves. You must learn to safely balance available power and steering against the effects of winds and waves.

Boats that show extreme motion and minimal control in high winds and seas, regardless of size and power are not well suited for missions in these conditions. If caught in marginal conditions, safety of your own vessel and crew must be the only concern. Other, more capable resources must conduct the mission.

Avoiding severe weather

Avoid thunderstorms, downbursts, squalls and waterspouts. Many areas regularly get severe weather with localized winds in excess of fifty knots. As these conditions often arise at peak times in the recreational boating season, chances are that you may find yourself underway in them. Since numerous cells can occur in one thunderstorm, you may be faced with maneuvering among many, different storms. Keep an eye on what is approaching.

Gusts

Try to avoid the highest gusts. Some storm cells have their own gust fronts that precede them. Look for what appears to be a layer of steam on the water. A fifty-knot gust front will actually turn the surface of the water into spray, with the highest gusts mixing with the relative heat of the water to lift the spray vertically.

Drifting stern-to the winds

If sea-room permits, move away from (perpendicular to) the direction of the gust.

Consider drifting stern-to the winds. At the speed these gusts move, they often don't have time to develop much of a sea. If so, you may be able to lie safely, stern-to the wind, engines in neutral. This way, you will not have to fight the overpowering force to keep the bow directly into the wind.

Getting between a storm and shore

Don't get between a severe storm and a near, lee shore. Work your way across a gust front, before it arrives, as best possible to safe haven or open water.

Laying stern-to is not safe if an approaching storm has enough open water to develop fetch and build seas. A strong thunderstorm needs as few as five miles of open water to build a three- to four-foot chop. In combination with fifty-knot winds, this chop can easily swamp small vessels.

Heaving-To

General

Heave-to when necessary. If unable to reach safe haven in extreme weather, heaving-to might be the only option to ride out conditions. Basically, heaving to is putting the bow into the wind or seas, and holding it there with helm and throttle. For vessels with a large sail area or superstructure, this might not be possible, as every wave or gust of wind may cause the vessel to "fall-off" the wind and lie beam-to or stern-to.

Maneuvering

Maneuver only to keep a bow-on aspect to the weather. Heave-to only because you cannot safely make progress in a desired direction.

Only heave-to when there is adequate sea room to leeward. Drift will be downwind and down sea.

Step	Procedure
1	Offset for the strongest force. Wind and seas might not be from exactly the same direction.
2	Try to keep seas between 10 and 25 degrees off the bow as if negotiating head seas and note the compass heading. You will still negotiate the seas, but not make any progress. If the wind allows holding this angle, it will give the best ride. Determine a mix of helm and throttle to hold the heading, try not to use full rudder or throttle as it leaves no reserve for an emergency maneuver.
3	If the winds are gusty and have frequent shifts, they can easily force the bow off the desired heading. Listen for signs of an approaching gust and start to counteract its effect before it actually strikes the boat.
4	If seas are not the strongest force, keep the bow directly into the wind.

Sea Anchor

Use a sea anchor if necessary. If unable to hold a heading, use a drogue as a sea anchor, made fast to the bow, to hold it into the weather. Use as much scope as available up to 300 feet. Let the rode pay out and see whether the vessel motions settle down. The bow may continue to "sail" back and forth. Counteract this by using some ahead power and helm to hold the bow at a constant compass angle.

Anchoring

Introduction

Anchoring must be performed correctly in order to be effective. This section discusses the techniques necessary to properly anchor a boat.

Basic elements

The basic elements to proper anchoring include:

- Proper equipment availability
- Knowledge to use that equipment
- Ability to select good anchoring areas

Terms and definitions

The Anchoring System is all the gear used in conjunction with the anchor. The table below defines several of the terms used to describe the different parts of most modern types of anchors.

Term	Definition
Anchor	A device designed to engage the bottom of a waterway and through its resistance to drag maintain a vessel within a given radius.
Anchor chocks	Fittings on the deck of a vessel used to stow an anchor when it is not in use.
Bow chocks	Fittings, usually on the rail of a vessel near its stem, having jaws that serve as fairleads for anchor rodes and other lines.
Ground tackle	A general term for the anchor, anchor rodes, fittings, etc., used for securing a vessel at anchor.
Hawspipe	A cylindrical or elliptical pipe or casting in a vessel's hull through which the anchor rode runs.
Horizontal load	The horizontal force placed on an anchoring device by the vessel to which it is connected.
Mooring bitt	A post or cleat through or on the deck of a vessel used to secure an anchor rode or other line to the vessel.
Rode	The line connecting an anchor with a vessel.
Scope	The ratio of the length of the anchor rode to the vertical distance from the bow chocks to the bottom (depth plus height of bow chocks above water).
Vertical load	The lifting force placed on the bow of the vessel by its anchor rode.

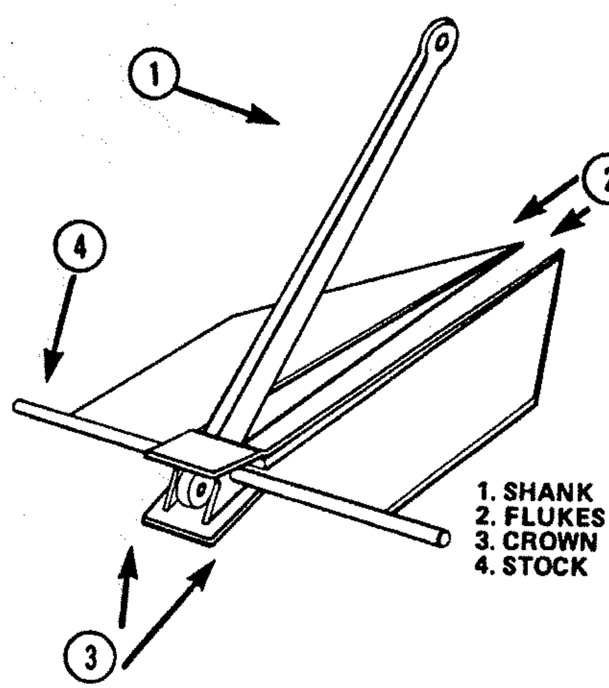
Anchor types

There are different types of anchors with specific advantages of each type. The type of anchor and size (weight) of anchor a boat uses depends upon the size of the boat.

Main parts of the Danforth anchor

Since most Law Enforcement patrol boats use a Danforth type anchor, it is described below (See figure 10-13).

Part	Description
Shank	Aids in setting and weighing the anchor. Attachment point for the anchor line.
Flukes	Dig in the bottom and bury the anchor, providing holding power.
Stock	Prevents the anchor from rolling or rotating.
Crown	Lifts the rear of the flukes, and forces the flukes into the bottom.



Main Parts of a Danforth Anchor
Figure 10-13

Ground Tackle

General

The complete anchor system consists of the anchor, the rode, and the various fittings connecting the rode to the anchor.

Anchor rode

The rode is the line from the boat to the anchor and is usually made up of a length of line plus a short length of chain. Large boats may use an all-chain rode. Each element of the system must be connected to its neighbor in a strong and dependable manner.

Type of line used

The most commonly used line for rode is nylon. The line may be either cable laid or braided, and be free of cuts and abrasions. Foot or fathom markers may be placed in the line to aid in paying out the proper amount of anchor rode.

Nylon and chain

Chain added with the rode has several advantages:

- Lowers the angle of pull (the chain tends to lie on the bottom)
- Helps to prevent chafing of the line on a coral or rocky bottom
- Sand has less chance to penetrate strands of the fiber line higher up
- Sand doesn't stick to the chain
- Mud is easily washed off (without the chain, nylon gets very dirty in mud)

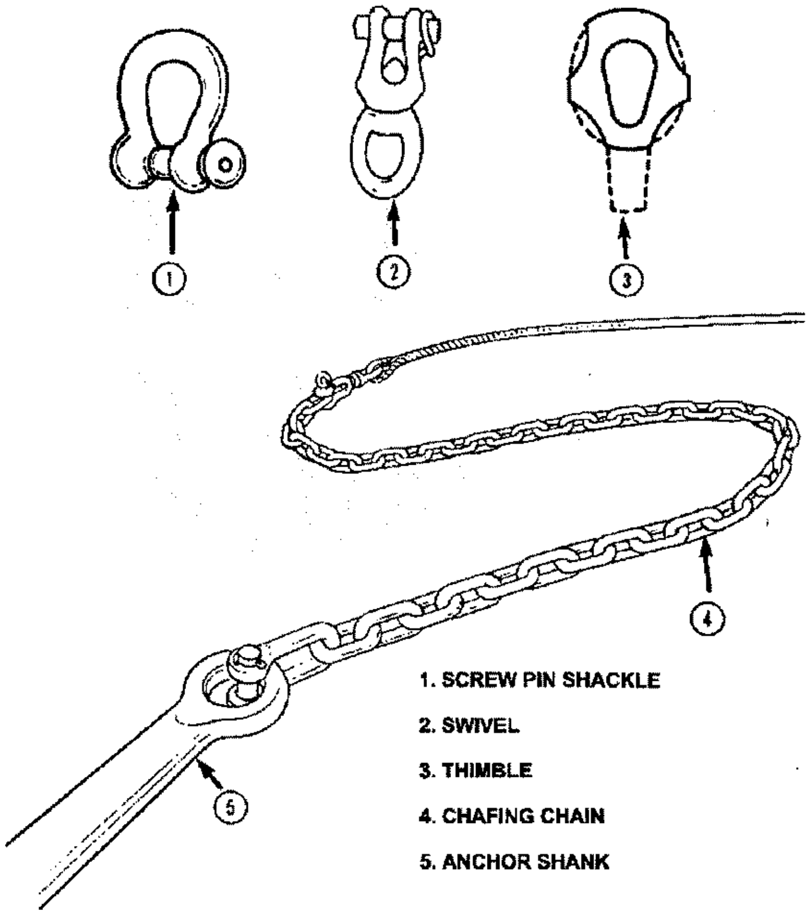
The chain used may vary from 1/4-inch diameter for 20-footers up. It should be galvanized to protect against rust. Neoprene-coated chain has the benefit of not marring the boat, but such coating has a limited life in active use. Generally, anchors such as the Danforth and Northill, because of their greater holding power per anchor weight, need more anchor scope than a Navy or yachtsman anchor.

SCOPE of the anchor rode should have a ratio range between 5:1 and 7:1. For heavy weather use 10:1.

Fittings

General

There are various methods for securing the rode to the anchor ring. With fiber line, the preferred practice is to work an eye splice around a thimble and use a shackle to joint the thimble and ring.
(See figure 10-14)



Anchor Fittings
Figure 10-14

Description

The following table describes the different fittings used to connect the rode to the anchor.

Part	Description
Shackle	Bends the length of chafing chain to the shank of the anchor.
Swivel	Attaches the chafing chain to the detachable link. Allows the line to spin freely.

Thimble Protects the anchor line from chafing at the connection point. Use synthetic line thimbles for lines 2 3/4" in circumference ($^7/_8$" diameter) and larger.

Chafing chain Tends to lower the angle of pull of the anchor and assists in preventing chafing of the anchor line on the bottom.

Detachable link Attaches the anchor and associated ground tackle to the anchor line (not mandatory).

Eye splice Used around a thimble to connect it to a ring on the anchor by a shackle.

Anchoring

General

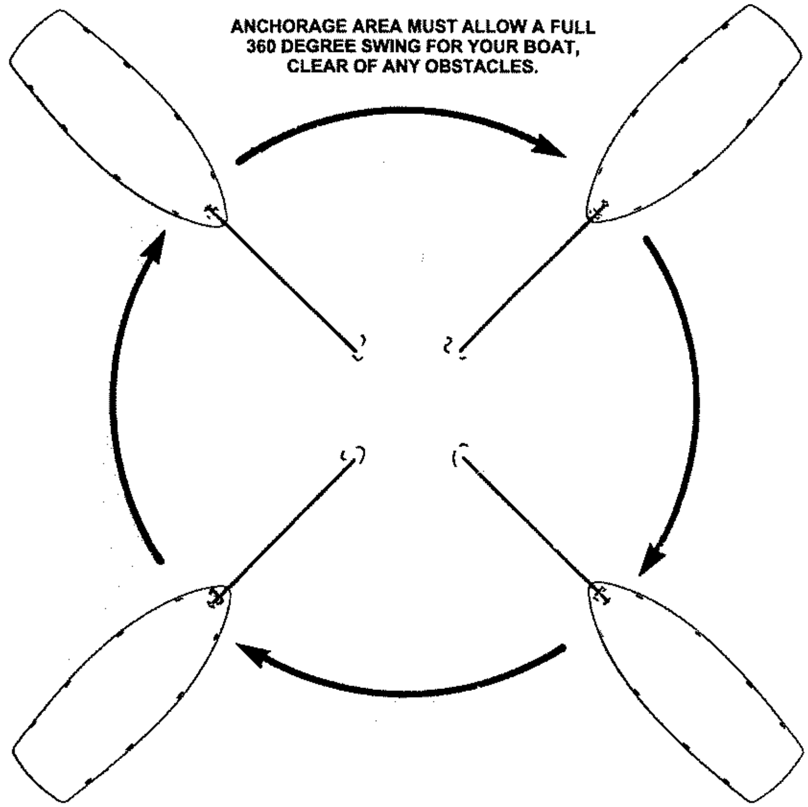
Before the need arises, the Boat Operator should brief the crew members on procedures for anchoring.

Anchoring involves good communication between the Boat Operator and the crew. With noise from the engine and exhaust, and sometimes the wind, it is usually difficult to hear voice communication. Have a pre-arranged set of hand signals that both of you understand. Keep the signals as simple as possible.

Precautions for selecting anchorage area

Sometimes it may be possible to choose a sheltered anchorage area in shallow water (40' or less).

- Check charts to ensure that the anchorage area avoids any submerged cables or other obstructions.
- If other boats are in the same area, be careful not to anchor too close by the boats.
- Never drop within the swing area of another boat (See figure 10-15).
- Always approach the anchorage into the wind or current.



Anchorage Swing Area
Figure 10-15

Approaching the anchorage

Having selected a suitable spot, run in *slowly*, preferably on some range ashore selected from marks identified on the chart, or referring to your position to visible buoys and landmarks to aid you in locating a chosen spot. Use of *two* ranges will give the most precise positioning. Later these aids will be helpful in determining whether the anchor is holding or dragging.

Bottom characteristics

Bottom characteristics are of prime importance. Characteristics of the bottom are normally shown on charts.

Type	Description
Firm sand	Excellent holding quality and is consistent.
Clay	Excellent holding quality if quite dense, but sufficiently pliable to allow good anchor engagement.

Type	Description
Mud	Varies greatly from sticky, which holds well, to soft or silt that is of questionable holding power.
Loose sand	Fair, if the anchor engages deeply.
Rock and coral	Less desirable for holding an anchor unless the anchor becomes hooked in a crevice.
Grass	Often prevents the anchor from digging into the bottom, and so provides very questionable holding for most anchors.

Lowering the anchor

As the anchor is lowered into the water, it is important to know how much rode is paid out when the anchor hits the bottom. It is advisable to take a round turn on the forward bitt or cleat to maintain control of the rode. If anchoring in a strong wind or current, the anchor rode may not be held with hands alone.

Steps	Procedure
1	Station one person on the forward deck.
2	Haul out enough line from the locker so as to run freely without kinking or fouling. If previously detached, the line must be shackled to the ring, and the stock set up (if of the stock type) and keyed.

Never stand in the coils of line on the deck and don't attempt to "heave" the anchor by casting it as far as possible from the side of the boat. Lower hand over hand until it reaches the bottom.

Many anchors have been lost for failure to attach the rode properly. Rodes too, have gone with the anchor when not secured at the bitter end.
Lightweight anchors are always ready for use and do not have to be set up, but always check to see that the shackle is properly fastened.

Length of rope (Scope)

The scope is a ratio of the length of rode paid out to the depth of the water. Pay out enough rode so the lower end of the rode forms an angle of 8° (or less) with the bottom. This helps the anchor dig-in and give good holding power. Suggested scope ratio for nylon line in favorable conditions is 5:1 minimum. Under average conditions, 7 or 8:1 is regarded as satisfactory and up to 10:1 for heavy weather. All-chain rodes under normal conditions, 3 to 5:1 is adequate.

Setting the anchor

An anchor must be "set" properly if it is to yield its full holding power. The best techniques for setting an anchor will vary from type to type; only general guidelines can be given here. Experiment to determine the best procedures for your boat, your anchors, and your cruising waters.

Steps	Procedure
1	With the anchor on the bottom and the boat backing down slowly, pay out line as the boat takes it, preferably with a turn of line around the bitt or cleat.
2	When the predetermined scope has been paid out, snub the line quickly and the anchor will probably get a quick bite into the bottom.

If the anchor becomes shod with mud or bottom grass adhering to the flukes, lift it, wash it off by dunking at the surface, and try again.

After anchor is set

After the anchor is set, you can pay out or take in rode to the proper length for the anchorage, and for the prevailing and expected weather conditions. Scope must be adequate for holding, but in a crowded anchorage you must also consider the other boats.

Attach chafing gear to the rode at the point where it passes through the chocks and over the side to prevent abrasion, wear, and tear on the rode and boat.

Checking the anchor holding

Make a positive check that the anchor is holding, and not dragging. There are several ways to do this.

- If the water is clear enough that you can see the bottom, you can detect any movement easily.
- If there is a jerk, or a vibration, the anchor is most likely not holding.
- Monitor bearings taken on at least two landmarks (if available) that are a minimum of 45° apart or use radar ranges and bearings. Small changes usually mean that the wind, tide, or current has caused the boat to swing around the anchor. If the compass heading is constant, but the bearings change, the anchor is dragging.
- If using a buoyed trip line from the crown of your anchor, apply reverse power to test the anchor's holding. The float on this line should continue to bob up and down in one spot unaffected by the pull on the anchor rode.

Making fast After the anchor has gotten a good bite, with proper scope paid out, make the line fast and shut off the motor. The fundamental idea in making fast is to secure in such a manner that the line can neither slip nor jam.

Forward bitt On boats with a forward bitt (sampson post), an excellent way to secure the anchor line is to make two full turns around the bitt, and then finish off with a half-hitch around each end of the pin through the bitt. The bitt takes the load and the pin secures the line, and the line is more easily taken off the bitt than with any other hitch.

Stout cleat Where a stout cleat is used to make fast, take a full turn around the base, one turn over each horn crossing diagonally over the center of the cleat, and finish with a half hitch around one horn.

Night anchoring Put extra line (scope) out before securing for the night, just in case the wind increases. Also, check the weather report before retiring. Don't forget anchor lights where required.

Anchor Watch Whenever the situation is questionable (forecast weather, potentially hazardous location, extreme tide range, etc.), an anchor watch should be assigned to protect against disaster. See Chapter 1 - *Boat Crew Duties and Responsibilities* for a description of the duties of an anchor watch.

Weighing anchor When you are ready to weigh anchor and get underway under power, go forward slowly and take in the anchor rode to prevent fouling the screws. Fake the line on the deck as it comes on board. When the boat approaches the spot directly over the anchor, and the rode is tending straight up and down, the anchor will usually free itself from the bottom.

Clearing a fouled anchor If the anchor refuses to break free, snub the anchor line around the forward bitt or cleat and advance the boat a few feet. Sometimes even this will not free the anchor, and the operator should run in a wide circle, slowly, to change the angle of pull. Take extreme care to ensure the anchor line does not tangle in the screws during this operation.

Another way to break out an anchor is with a "trip line," if one was rigged during anchoring. A "trip line" is a line strong enough to stand the pull of a snagged anchor (a $^3/_8$-inch line is a typical size). Attach the "trip line" to the crown of the anchor (some anchors have a hole for this purpose). The "trip line" should be long enough to reach the surface in normal anchoring waters, with allowance for tidal changes. Pass the "trip line" through a float and end the line in a small eye-splice that can be caught with a boathook. If the anchor doesn't trip in the normal manner, pick up the trip line and haul the anchor up crown first.

Clean the anchor

Clean the anchor before bringing it on board. The anchor may have some "bottom" on it. Check the condition of the equipment and, before departure from the area, be sure the anchor is adequately secured to prevent shifting and damage to the boat.

Anchor Stowage

General

Stowage of ground tackle depends upon the size of the boat. In smaller boats, it may be on deck, with the anchor secured in chocks to prevent shifting as waves cause the boat to roll. Some boats have the working anchor attached to a pulpit and the rode in a forward locker. The ground tackle should always be ready for use when the boat is underway.

Maintenance

After anchoring in salt water, rinse ground tackle off with fresh water before stowing it, if possible.

Nylon - Nylon rode dries quickly and can be stowed while damp.

All-chain rode - If using an all-chain rode, drying on deck before stowing will help to prevent rust.

Vessels under Sail

General

Although Law Enforcement agencies do not patrol or operate sailboats as part of their daily routine, they commonly are tasked with assisting these vessels and their crew, such as medical emergencies, disabled, capsized or investigating boating accidents involving vessels under sail. This section is designed to present basic information about sailboats. Topics include:

- Parts of a Sailboat
- Points of Sail
- Rules of Sailing

Part of a Sailboat

Sailing Terms

Ease To let out the sails.

Luffing (1) The flapping of the whole sail, flogging
(2) The forming of a "bubble" in the front part (near the luff) of a sail.

Trim To pull the sails in towards the wind.

Spar Any pole or mast to secure rigging or sails to.

Head up Change the boat's course toward the wind

Head down Change the boat's course away from the wind.

Heel The degree of sideways tilt.

Windward Towards the wind.

Leeward Away from the wind.

Bear Away To head away or off from the wind.

Tack (1) The front lower corner of the sail.
(2) A direction of sail - i.e. a starboard tack.
(3) Coming About.

Rigging

(See Figure 10-16)

Mast The main and highest spar in the center of the boat to which the jib and mainsail are attached.

Boom The horizontal spar which extends aft (backwards) from the mast to which the foot of the mainsail abuts.

Standing Rigging Supports the mast and includes the Backstay, Headstay, Shrouds.

Shroud Lines or cables which give lateral stability to the mast.

Spreaders Horizontal spars which spread the shrouds from the mast.

Headstay A line or cable which supports the mast from the bow of the boat. If the line does not reach the top of the mast then it is also called a forestay.

Backstay A line or cable that supports the mast from the stern of the boat.

Boom Topping Lift A line that extends from the boom to the mast. Supports the boom when the mainsail is taken down.

Running Rigging Lines that control and adjust the sails.

Halyard A line used to raise a sail.

Sheet The chief line that is used to adjust a sail against the force of the wind. The mainsail has one sheet. The jib has two, a working (leeward) sheet and a lazy (windward) sheet.

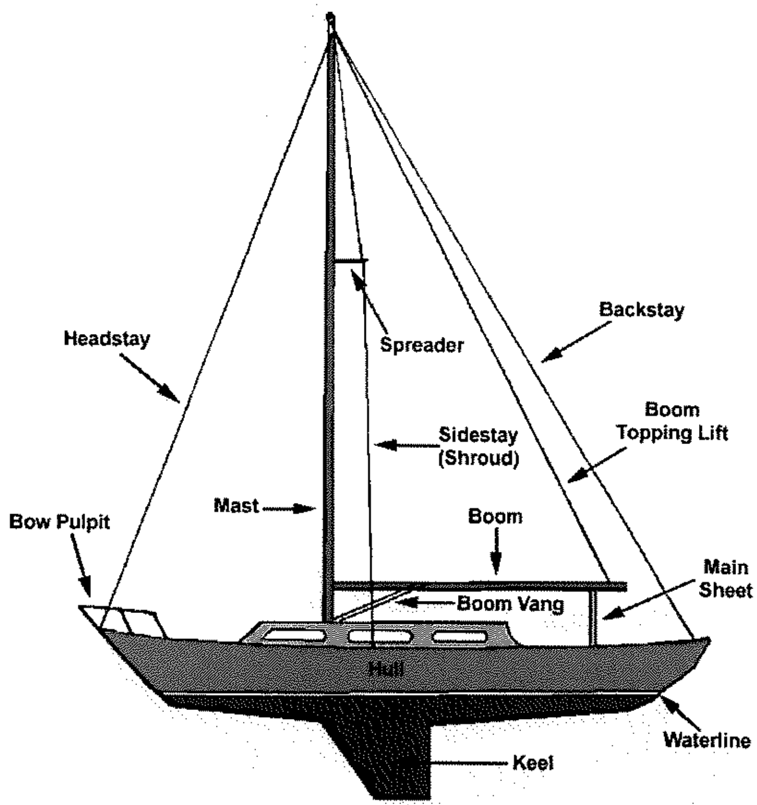
Boom Vang A line that places downward tension on the boom.

Outhaul Places backward tension on the clew of the mainsail. When tightened it will flatten the lower one-third of the mainsail.

Reefing Lines A line used to shorten the sail.

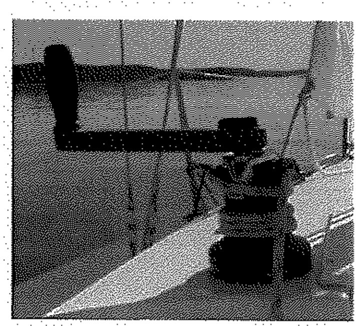
Mizzen The smaller aft mast on a yawl or ketch.

Chain Plate A metal plate to which a shroud is attached.



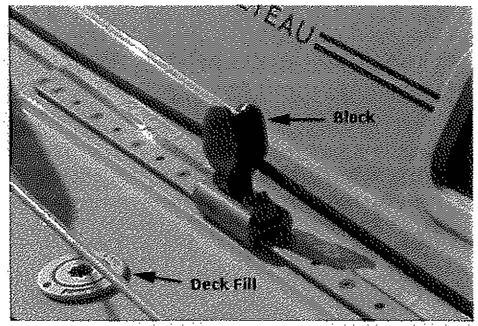
Parts of a Sailboat
Figure 10-16

Winch A device used to tighten a line. See Figure 10-17



Winch
Figure 10-17

Block A device used to change a line's direction. See Figure 10-18



Block
Figure 10-18

Sails

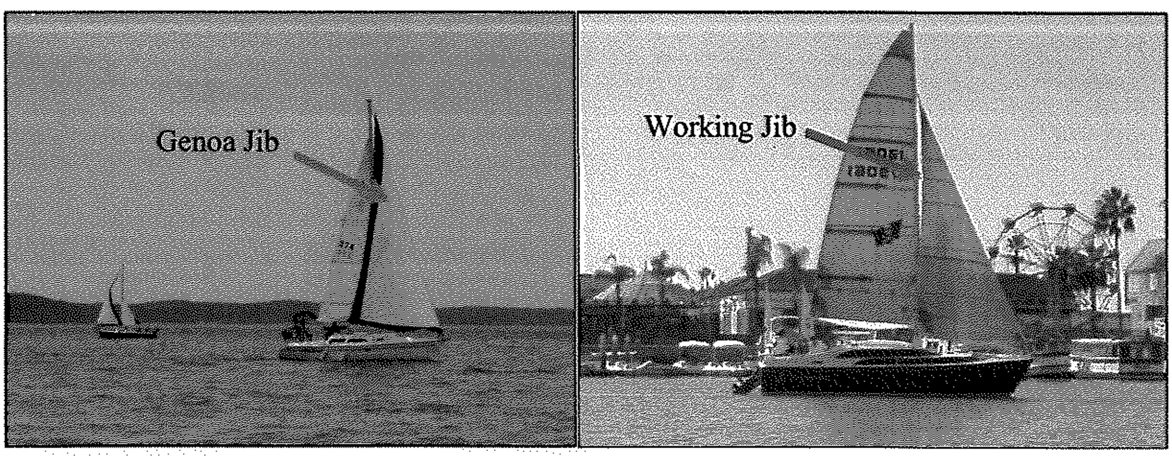
Main Sail The sail aft of the mast which is attached to the mast and the boom.

Jib The sail between the headstay and the mast. Also called the headsail. There are several sizes of Jibs. (See Figure 10-19)

Genoa Jib (Number 1 Jib) overlaps the mainsail and is used to provide maximum power in light winds. Commonly referred to as a percent of overlap of the mainsail, i.e. 120, 150, 190, etc.

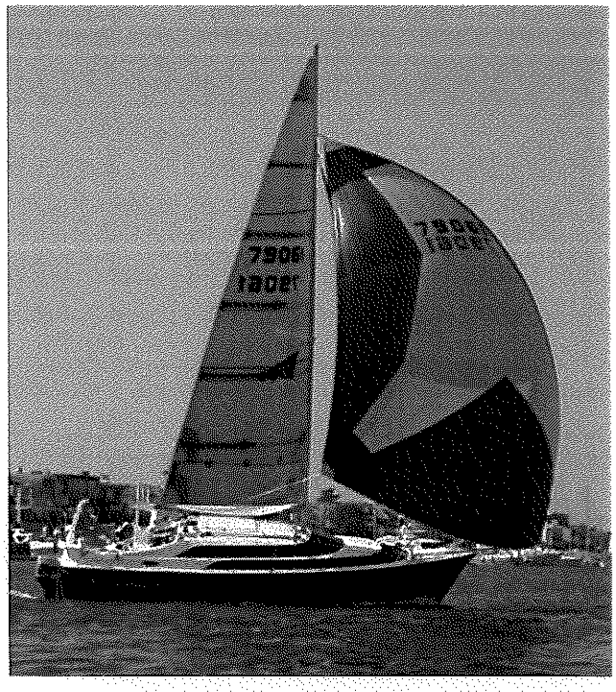
Working Jib (Number 2 Jib) is a smaller jib, which fills the space between the mast and headstay. It is used in stronger winds.

Storm Jib A Storm Jib is a small jib (even smaller than a Number 4 Jib) used in heavy weather and gales.



Jib Sail
Figure 10-19

Spinnaker A large balloon sail attached to the mast at the front of the boat. It is used when sailing directly downwind (running with the wind) (See Figure 10-20)



Spinnaker
Figure 10-20

Parts of the Sail (See Figure 10-21)

Clew Bottom aft (back) corner of the sail. (The clew is by the crew)

Cringle A grommet or metal ring in a sail though which a line is usually attached.

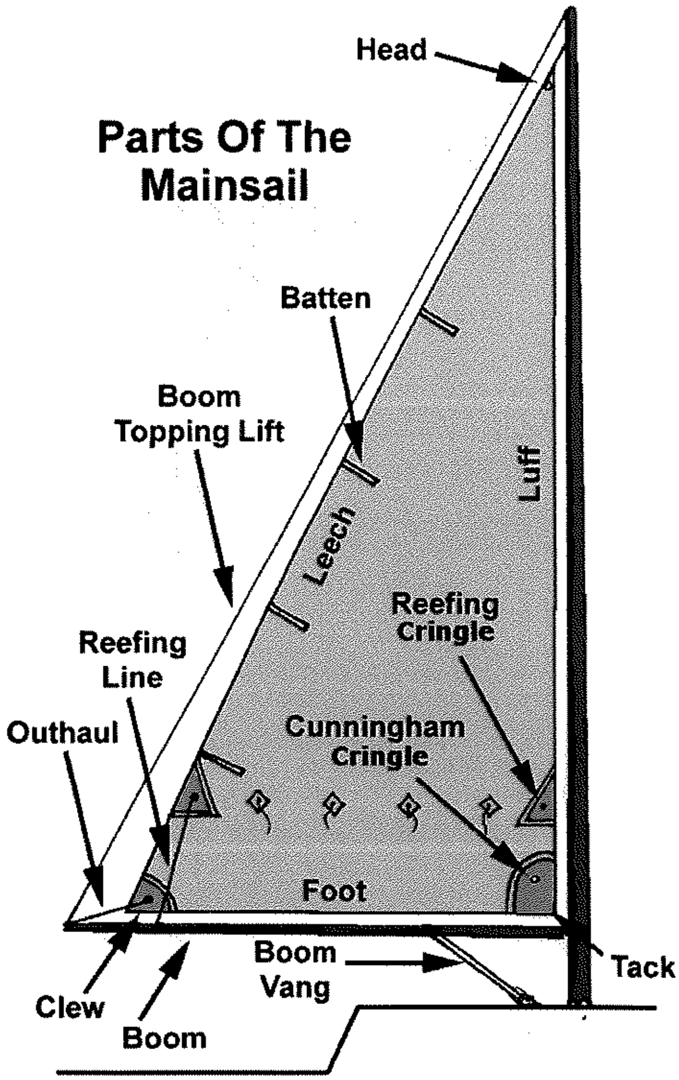
Head Top of the Sail.

Tack (1) The front lower corner of the sail.
(2) A direction of sail - i.e. a starboard tack.
(3) Coming About.

Luff (1) The forward edge of the sail.
(2) The flapping of a sail when it is not trimmed properly.

Leech The aft or back edge of the sail.

Battens Plastic or wooden slats inserted in the leech of the mainsail to help stabilize the roach.



Parts of a Main Sail
Figure 10-21

Points of Sail

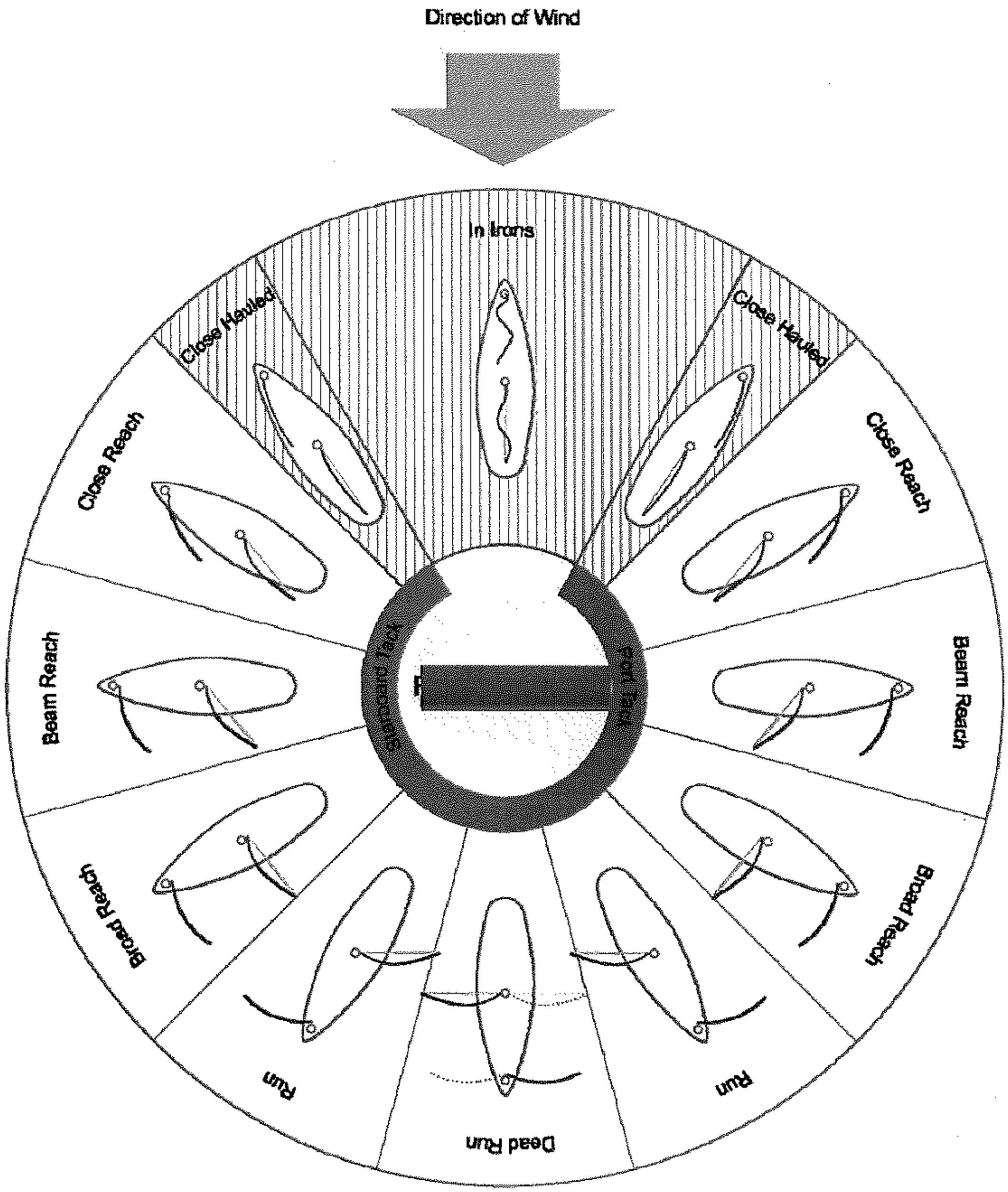
General

A point of sail is basically the direction the boat is pointing in relation to the direction the wind is coming from. This information is important in any vessel accident investigation involving vessels under sail.

When we talk about port tack or starboard tack this is all about the position of the boom. In the past sails had four sides, like a square sail. So the boom would be on both the starboard and port sides of the boat, with the mast holding the boom in the middle. The tack of the sail would be the side nearest to the wind. So if the wind were coming from the port, the tack of the sail would be on the port side of the boat. In this instance the boat would be called "On a Port Tack".

In the newer sail arrangements the sails are triangular and in this instance the tack of the sail is the edge closest to the mast or the forestay if it is a Jib or Genoa. So to calculate the tack we think of the boom. If the boom is on the starboard side of the boat, the boat is on a port tack. If the boom is on the port side of the boat, the boat is on a starboard tack. So it is better and makes more sense to think about where the wind is coming from. So if the wind is coming from the port side the boat will be on a port tack, if the boom is positioned correctly. If the wind is coming from the starboard side, then the boat will be on a starboard tack.

For the purpose of International Regulations for Preventing Collisions at Sea and the Racing Rules of Sailing, the boom is the only indication of the side of tack the boat is on. (See Figure 10-22)



Points of Sail
Figure 10-22

6 Points of Sail The points of sail are normally named for the positions of the boat and sails. Each position is about 30 degrees apart running from 30-45 degrees towards the wind, all the way to 180 degrees with the wind directly behind the boat

Close Haul This point of sail is generally between 30 degrees and 45 degrees towards the wind, but is fully dependent on the boat and sailing equipment. In this point of sail you are sailing "close to the wind" and trying to make your way windward. The main sail and the fore sail are sheeted in as much as possible. This is not the fastest point of sail, so you are compromising the speed against the direction.

Close Reach This point of sail is generally between 45 degrees and 60 degrees towards the wind. In this point of sail you are sailing you are making your way windward. The main sail and the fore sail are not sheeted in hard. This is not the fastest point of sail, so you are compromising the speed against the direction, but you are making more speed then a Close Haul position. In light winds this point of sail is used to make progress toward the windward direction while maintaining enough speed to keep steerage.

Beam Reach On this point of sail the wind is directly onto the beam (the side of the boat). The boat can make good speed, but the wind will tend to heel the boat over, especially in strong windy conditions. Also is bad weather the beam is exposed to the wind and therefore normally the waves. This is not ideal and in bad conditions is very dangerous as it can lead to a capsize.

Broad Reach This is the fastest point of sail. The wind travels effectively over the airfoil shape of the sails and the resistance of the keel is minimal.

Run In a run, the sail looses the airfoil effect. The wind pushes the sail which is presented square on to the wind to expose as much as possible. In this position the boat is unstable and will normally bob from side to side. The boat has no apparent wind speed to harness and therefore the speed will be a lot less then the speed of the wind. The fore sail is pulled to the opposite side to the main sail in what is called a wing n' wing position.

Dead Run In a dead run, the sail has no airfoil effect. The wind pushes the sail which is presented square on to the wind to expose as much as possible. In this position the boat is at its most unstable and will normally bob from side to side. The boat has no apparent wind speed to harness and therefore the speed will be a lot less then the speed of the wind. In this position the risk of the main sail accidentally gibing is at it's highest. To reduce this risk you should always have a preventer on the boom to stop the mainsail for crashing from one side to the other. The fore sail is pulled to the opposite side to the main sail in what is called a wing n' wing position.

Rules of Sailing

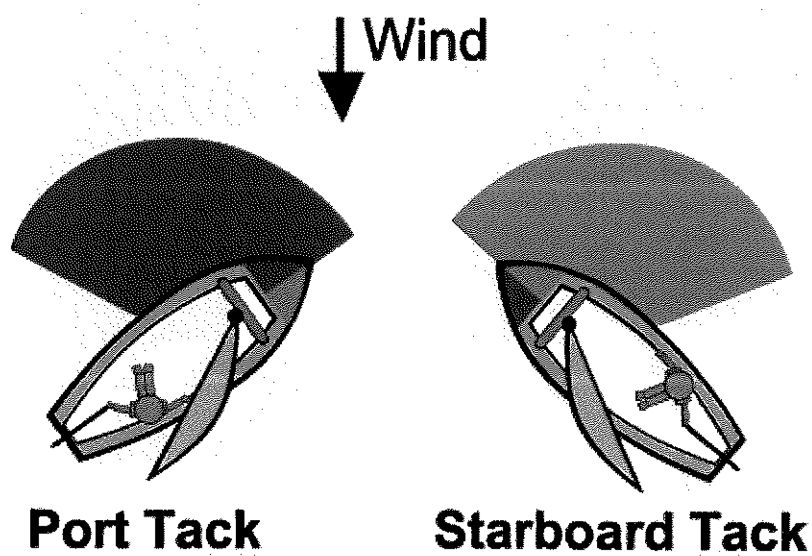
Rules of the Road

There are separate rules for sailboats and powerboats. If a sailboat is being propelled by a motor, they are no longer considered a sailboat, and must obey the powerboat rules.

A sailboat does have the right-of-way over a powerboat **unless** the sailboat is overtaking the powerboat. A sailboat must also keep out of the way of large vessels in narrow channels, and ferryboats.

There are a few basic right-of-way rules regarding sailing that every Boat Operator should be familiar with. These four rules deal with two sailboats in sight of one another and what they should do to avoid a collision. It is important to understand the difference between a port tack and a starboard tack (See Figure 10-23)

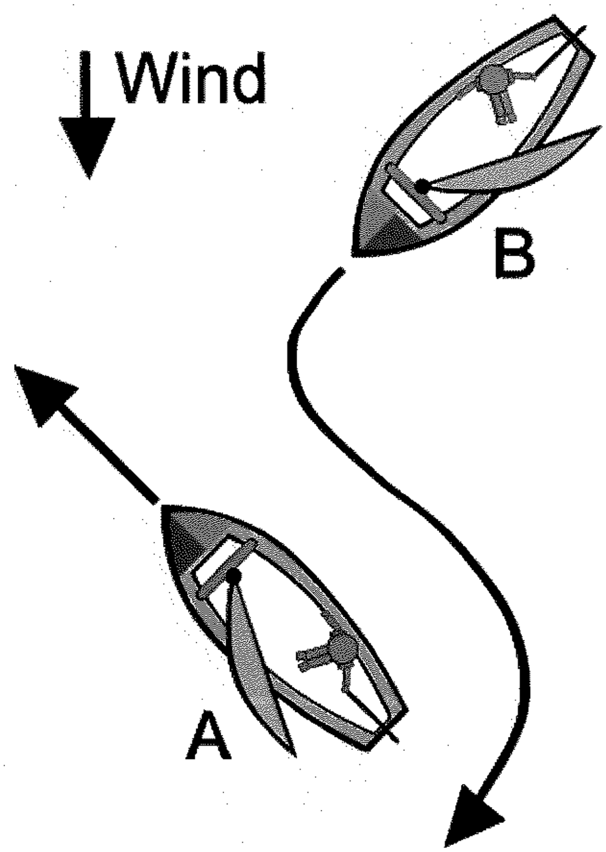
The four rules listed on the following pages give a basic overview of who has the right-of-way.



Port vs. Starboard Tack
Figure 1-23

Rule 1 The arrow indicates the direction of the wind. When two sailboats are approaching each other and are on the same tack, the leeward boat has the right-of-way over the windward boat. Another way to say this is to say that the boat closer to the wind source must keep clear. The boat further from the wind source has the right-of-way.

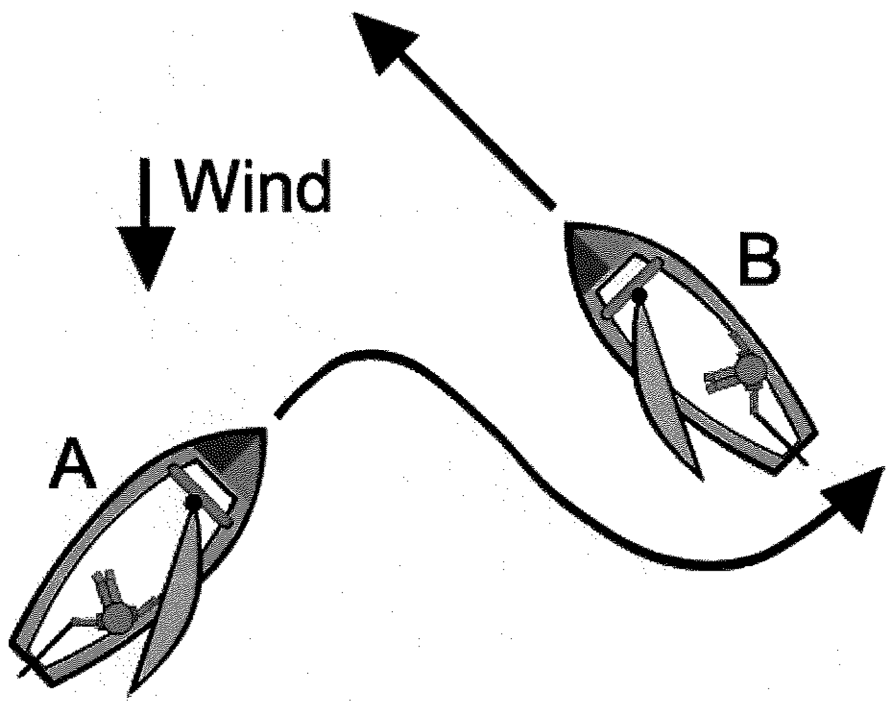
In the illustration below, boat "B" is the windward boat and must turn to avoid boat "A" which is leeward (See Figure 10-24)



Rule 1
Figure 1-24

Rule 2 When two sailboats are approaching each other and are on different tacks, the boat on the starboard tack has the right-of-way over the boat which is in the port tack.

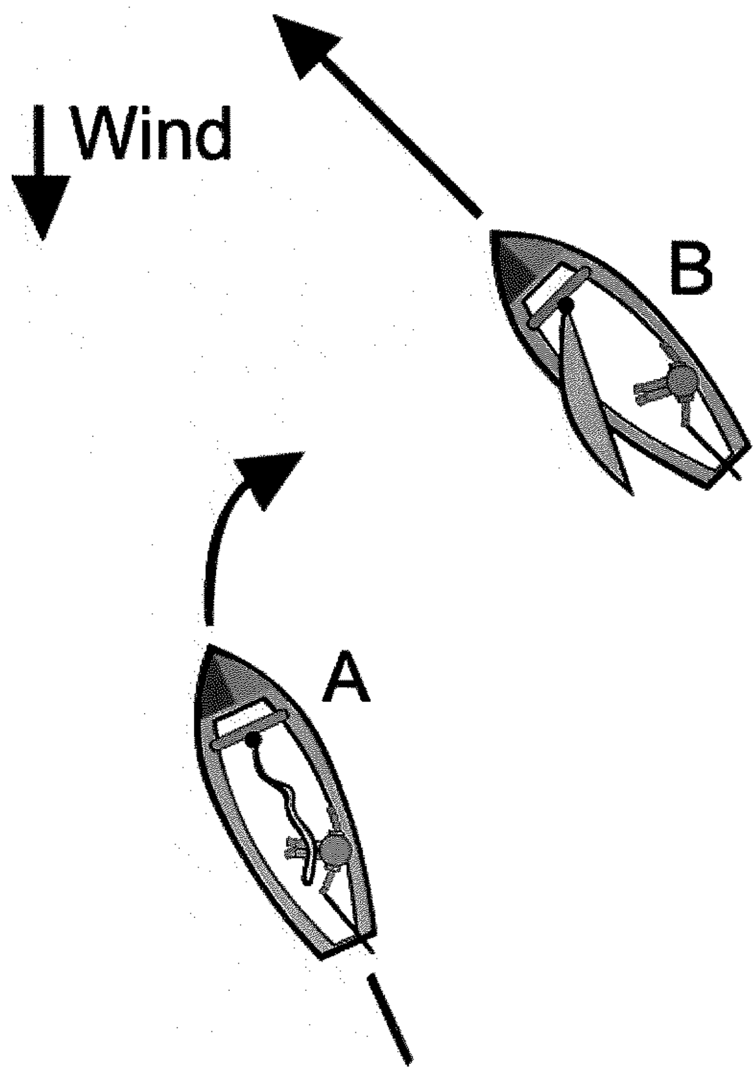
In the illustration below, boat "A" on the port tack, must turn to avoid boat "B" on the starboard tack. (See Figure 10-25).



Rule 2
Figure 1-25

Rule 3 A sailboat that is staying on a tack has the right-of-way over a sailboat that is tacking or gybing. They must have room to complete a tack or a gybe without interfering with any other boats before doing so". They must make sure that they can see clearly in all directions to ensure enough room.

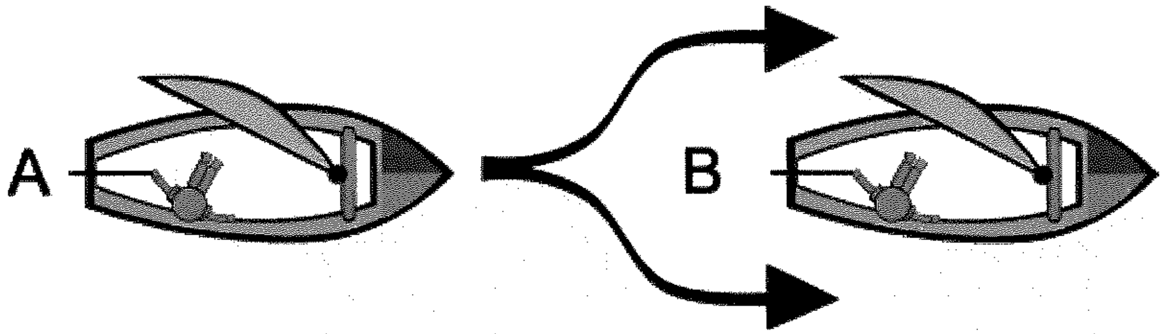
In the illustration below, boat "A" must ensure that it leaves plenty of room to avoid boat "B", who has the right-of-way, since boat "B" is continuing on its tack. However, in the event that boat "A" was unable to tack due to the proximity of "B", remember that "A" is the leeward boat so therefore could tell boat "B" to give room to tack, but would lose this right of way as soon as they actually began to tack (Figure 1-26).



Rule 3
Figure 1-26

Rule 4 Any sailboat that is overtaking a slower boat from behind must steer clear of the slower boat and give right-of-way. The slower boat should hold its course and allow the faster boat to pass (See Figure 1-27).

In the illustration below, boat "A" is a faster boat, and must steer around the slower boat "B", who should remain on the same course.



Rule 4
Figure 1-27

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Chapter 11: Communications

Overview

Communication between mariners has long been recognized as a necessity. Using the radio proficiently and knowing proper radio protocol reflects well upon the boat crew's and the radio operator's professionalism. It is essential that each boat crew member is completely aware of the common distress signals and how they are used in emergencies. This chapter will provide you with the basic knowledge of voice communication conventions, procedures, and the various distress signals.

Most marine communications are done by using voice radio transmissions. These are very much like two people talking on the telephone, but with significant differences that boat crew members must understand.

Typically, voice radio communications are "simplex," or one way at a time - when one person is speaking, the second person must wait. This differs from face-to-face and telephone conversations where voices may overlap. Simplex communication is the reason for many of the procedural regulations for voice radio communications.

All operators should check all of their radio equipment for proper operation before getting underway and immediately report any malfunctions.

Radio Signal Characteristics

There are three radio systems that are generally found aboard vessels; Marine Very High Frequency (VHF), High Frequency Single Side Band (SSB) and Frequency Modulated 2 meter (FM). Of these systems VHF is the most prevalent with SSB running second.

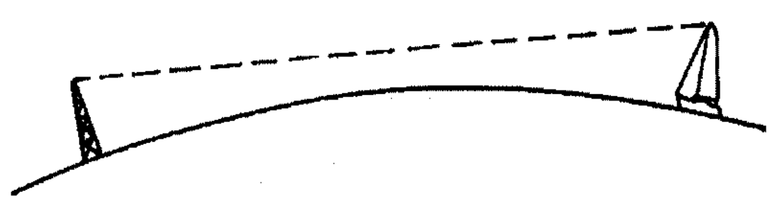
There are differences in characteristics of each system with the use and usefulness of each being determined principally by the needed operating range.

VHF

No FCC license required. Their effective range is 20-30 miles, with a maximum allowable power output of 25 watts. These radios operate on a band between 156-163 MHz with 104 channels being available. The VHF calling and distress channel is 16 and it is monitored by the U.S. Coast Guard.

VHF is used for local, short-range marine communications. Frequencies in this band operate on the line-of-sight principle (LOS); its range depends mainly on the height of antennas for both the receiving and transmitting stations and somewhat on the power output of the transmitting station. VHF equipment is called "line-of-sight radio" because its radio waves travel in nearly a straight line, meaning, if one antenna can "see" another antenna, communications between the two is possible (see Figure 11-1). Occasionally, atmospheric conditions allow VHF signals to bounce or bend in their line of travel, increasing the transmission's range farther than normal.

The Coast Guard VHF-FM National Distress System (NDS) provides distress, safety, and command and control communications coverage in most areas of boating activity.



Line-of-Sight
Figure 11-1

SSB

No FCC license required (See note). SSB radios are more complex and are used in long-range communications. These radios can have a power output up to 150 watts. They operate on a series of 7 frequency bands from 2-22 MHz. The U.S. Coast Guard monitors the calling frequency 2182 kHz. This frequency is always referred to as 2182 kHz. The 7 bands have different range capabilities at different times of the day. Given the right conditions you can talk around the world on SSB radio.

FM

Licensed by the FCC. These radios share similar characteristics with VHF, but are capable of greater range. This range is enhanced by, output power and the use of "sky waves" unlike VHF which uses "ground waves" the FM "sky waves" bounce off the ionosphere and return to the earth's surface with sufficient power to continue this process worldwide.

The FCC no longer requires a Restricted Radio Operator's License for the operation of marine SSB within the U.S. on "voluntarily equipped" vessels that do not travel to foreign ports. It is still required for operation of the radio in International waters.

VHF Radios

LAPD has a wide variety of radio equipment and frequencies. The marine VHF radio gives those officers working in the marine environment an alternative method of communicating with other marine enforcement and/or rescue units.

In addition the marine VHF gives law enforcement officers the ability to:

- Manage vessel traffic. (safety)
- Listen for distress, safety incidents and call for assistance.
- Receive up to date weather information.
- Tie into ship to shore telephone system
- Contact civilian boaters and U.S. Coast Guard.

Features of VHF radios

All marine VHF radios are required to have a single button selection of channel 16, and must have switchable power output from high power (25 watts) to low power (1 watt or less). In addition, many marine VHF radios have these additional features:

- Capable of being tuned to all marine VHF channels.
- Dual Watch - This feature automatically monitors channel 16 and any other channel selected.
- Scan – This feature will monitor a series of channels and is generally programmable.
- Loud Hailer – Allows the unit to be used as a PA speaker if equipped with an external speaker.
- Fog Signal – Allows the unit to play specified restricted visibility sound signals at the required intervals over the unit's PA speaker.

Radio Channels and Frequencies

VHF-FM

This is a list of the most common VHF-FM channels used for marine operations. It is organized by channel followed by their use.

Channel	Use
6	Intership safety: Use this channel for ship-to-ship safety messages, search and rescue messages and Coast Guard ships and aircraft.
9	Alternate calling channel for non-commercial vessels (Some Coast Guard districts have high level radio sites with Channel 9 capability) and often used for vehicle and railroad bridge operator communications.
12	Used for port operations. This is the working frequency for LASD Marina del Rey Harbor Patrol.
13	Bridge-to-Bridge VHF-FM frequency. Transmissions on this frequency are limited to one watt output, with few exceptions. This frequency is to clarify a vessel's intent in meeting and passing situations, as described in the Navigation Rules (COLREGS). Do not use for communications between Coast Guard boats and stations.

16

International calling and distress frequency use by vessels in emergencies or to establish contact with others. Shore stations use it to announce broadcasts of general information on other frequencies, boat crew use Channel 16 to:

- Transmit/receive distress calls and distress messages.
- Transmit/receive urgent safety broadcasts and messages.
- Identify vessel traffic concerns.
- Place a preliminary call to other units in order to establish communications and shift to a working frequency to after contact.

Do not use this channel to deliver general information messages.

17

MARITIME CONTROL- This channel may be used to talk to ships and coast stations operated by state or local governments. Messages must pertain to regulation and control, booting activities, or assistance to ships. Use this channel for low power communications with vessels in close proximity. This frequency is referred to as the Search and Rescue (SAR) frequency.

21A

Intra-Coast Guard VHF-FM working frequency for units in maritime mobile operations.

22A

Primary VHF-FM liaison frequency for communications between Coast Guard units and civilian stations. It is also used for making Coast Guard Marine Information and Marine Assistance Request Broadcasts (MARBs).The Coast Guard may permit non-government use to conduct short business transactions on 22A on a not-to-interfere basis with Coast Guard communications.

23A

Intra-Coast Guard VHF-FM working frequency used for communications between Coast Guard units working in maritime mobile operations.

68,69,71,72,78

NONCOMMERCIAL - Working channels for voluntary boats. Messages must be about the needs of the ship. Typical uses include fishing reports, rendezvous, scheduling repairs and berthing information. Use Channels 67 and 72 only for ship-to-ship messages.

81A

Intra-Coast Guard VHF-FM working frequency for units in maritime mobile operations.

83A

Intra-Coast Guard VHF-FM working frequency for units in maritime mobile operations.

All vessels equipped with a VHF-FM radio are required to monitor Channel 16.

Radio Operating Procedures

General

As a boat crew member, operating a voice radio will be a frequent task for you, so you should be familiar and comfortable with using a radio. It is important to learn basic procedures and ways for properly using the radio so that messages are sent and received in the most effective and professional manner.

Basic radio discipline

Learning and understanding the following will help you use voice radios effectively:

Check setting

Be certain the radio is set on the proper frequency. This should be checked prior to the start of any patrol.

Squelch control

Squelch control blocks out weak signals. Adjust the squelch control until the static can be heard, then adjust it slightly in the opposite direction until the static stops. Setting the squelch control adjusts the receiver so only signals strong enough to pass the level selected will be heard and reduces the amount of static noise on the speaker.

Do not interrupt others

Before beginning a transmission, listen for a few seconds to avoid interrupting other communications that are already in progress.

Microphone placement

Keep the microphone about 1 to 2 inches from your lips. When transmitting, shield the microphone by keeping your head and body between noise generating sources (such as engine noise, wind, helicopter, etc.) and the microphone.

Know what you will say

Before keying the transmitter, know how to say what you are going to say. Keep all transmissions short and to the point. Never "chit-chat" or make unnecessary transmissions on any frequency.

Speaking

Speak clearly, concisely, and in a normal tone of voice, maintaining a natural speaking rhythm.

Phonetic Alphabet

Use the Phonetic Alphabet to spell out a word or a group of letters.

Speak slow so others can write

Send transmitting messages only as fast as the receiving operator can write.

Proper Prowords

Use proper prowords, ending each transmission with "over" and the last with "out." Never say "over and out."

Proword for pauses

In cases where a pause for a few seconds between transmissions is necessary, use the proword "wait." If the pause is to be longer than a few seconds, use prowords "wait, out." Do not use "wait one" or "stand by."

Messages are not Private

Remember, your transmission may be heard by anyone with a radio or scanner.

When transmitting, the microphone may pick up the conversations of people talking near you.

Use of appropriate radio language

The following is a list of things **not** to do while using the radio. Items on this list are either not protocol, they are illegal, or they cause misunderstandings of messages.

Do not...

- Break Radio Silence! Break it only for emergencies or ensuring safe navigation under the Bridge-to-Bridge Radiotelephone Act.
- Use profane or obscene language.
- Use unauthorized prowords, abbreviations, and procedures.
- Speak using extremes of voice pitch, this will cause distortion.
- Slur syllables or clip your speech, they are hard to understand.
- Use phrases such as "would you believe," "be informed," or "be advised". They are unprofessional and not correct procedure.
- Key the microphone unless you are ready to transmit. Keying the microphone also transmits a signal, causing interference on that frequency.

Verbal Communications

Letters and numbers spoken over a radio are often difficult for others to understand. Spelling out words and numbers that may be easily confused over the radio help clarify their meaning. Knowing how to pronounce the Phonetic Alphabet and numbers over the radio increases the chance that all voice communications between your boat and others are successful. The phonetic alphabet used on the marine radio may be different from what the Sheriff's department use on their dispatch frequency. Care must be taken not to confuse the two.

Speaking the phonetic alphabet

The Phonetic Alphabet is based on the assumption that it is easier to understand a word than a letter. The Phonetic Alphabet is a series of words, each standing for a letter in the alphabet. Boat crew members should memorize each word of the Phonetic Alphabet listed below and always be ready to pair them to the correct letter in the alphabet.

The phonetic alphabet used in the maritime environment is based on the military phonetic alphabet and prowords. This is different from the phonetic alphabet and prowords of the Los Angeles County Sheriff's Department. Deputies must be able to switch from both methods depending on which radio is in use.

Alphabet	Phonetic Alphabet	Pronounced
A	ALPHA	AL-FA
B	BRAVO	BRAH-VOH
C	CHARLIE	CHAR-LEE
D	DELTA	DEL-TAH
E	ECHO	ECK-O
F	FOXTROT	FOKS-TROT
G	GOLF	GOLF
H	HOTEL	HOH-TEL
I	INDIA	IN-DEE-AH
J	JULIETT	JEW-LEE-ETT
K	KILO	KEY-LOH

L	LIMA	LEE-MAH
M	MIKE	MIKE
N	NOVEMBER	NO-VEM-BER
O	OSCAR	OSS-CAR
P	PAPA	PAH-PAH
Q	QUEBEC	KAY-BECK
R	ROMEO	ROW-ME-OH
S	SIERRA	SEE-AIR-RAH
T	TANGO	TANG-GO
U	UNIFORM	YOU-NEE-FORM
V	VICTOR	VIK-TAH
W	WHISKEY	WISS-KEY
X	XRAY	ECKS-RAY
Y	YANKEE	YANG-KEY
Z	ZULU	ZOO-LOO

Using the phonetic alphabet

To use the phonetic alphabet to spell out difficult words within a message, always precede the actual spelling with the procedural words (prowords) "I spell."

Example: "Search from Farnsworth bank, I spell, Farnsworth - FOXTROT, ALPHA, ROMEO, NOVEMBER, SIERRA, WHISKEY, OSCAR, ROMEO, TANGO, HOTEL - Farnsworth to Eagle rock."

Prowords and Common Abbreviations

Prowords speed the handling of radio messages by abbreviating single words or phrases to replace common words, phrases, sentences, and even paragraphs. Among other things, knowing and using Prowords help to reduce radio traffic by performing radio transmissions efficiently. The following table contains the most common Prowords used.

Proword	Meaning
AFFIRMATIVE	Yes.
ALL AFTER	The portion of the message to which I make reference is all which follows.
ALL BEFORE	The portion of the message to which I make reference is all which comes before.
BREAK	I hereby indicate the separation of text from other portions of the message.
CORRECT	You are correct, or what you have transmitted is correct.
CORRECTION	An error has been made in this transmission. Transmission will continue with the last word correctly sent. The correct version is...
ETA	Estimated time of arrival.
ETD	Estimated time of departure.
ETR	Estimated time of return or repair.
FIGURES	Indicates numbers or numerals to follow. Used when numbers occur in the text of a message.
FROM	The originator of this message.
I SPELL	I shall spell the next word phonetically.
OPS NORMAL	Used to say the patrol is normal in all respects, "operations normal".
OUT	Used following the last line of the message transmitted, signifying the end of the transmission and nothing follows. No reply is required or expected.
OVER	Used following a transmission when a response from the other station is necessary. It is an invitation to the other station to transmit.
NEGATIVE	No.
ROGER	I have received your transmission satisfactorily.
I SAY AGAIN, or REQUEST YOU SAY AGAIN	I am repeating transmission or the portion indicated, or you should repeat your transmission or the portion indicated.

SILENCE (Spoken 3 times and pronounced SEE LONS)	Cease all transmissions immediately. Silence will be maintained until lifted. Used to clear routine transmissions from a channel only when an emergency is in progress.
SILENCE FINI (Pronounced SEE LONS FEE NEE)	Silence is lifted. Indicates the end of an emergency and resumption of normal traffic.
THIS IS	This transmission is from the station whose designator immediately follows.
TO	The addressees immediately following are addressed for action.
UNKNOWN STATION	The identity of the station which you are trying to establish communications with is unknown.
WAIT	I must pause for a few seconds.
WAIT OUT	I must pause longer than a few seconds.
WILCO	Will comply with your last order or request.
WORD AFTER	The word to which I have reference is that which follows.
WORD	The word to which make reference is that which
BEFORE	Precedes.
WRONG	Your last transmission was not correct. The correct version is...

Voice call sign

Communicating with other units within your Area Of Responsibility (AOR) will be a common task required of you. Knowing proper call signs and reporting procedures will become "second-nature" to you, even so, be careful to always use the military message formats. Radio communications are an official record, they reflect upon the ability of the entire boat crew, and the information you report to other units is important, especially in emergencies.

General

Voice call signs are used to identify the craft that is calling or being called over voice radio. A Sheriff boat's number serves as the voice call sign for radio communications. This table summarizes some of the different facilities and how to state each call sign you may encounter in the field.
During initial communication with a vessel, quickly determine the situation details just in case communication breaks off and cannot be reestablished. These are listed here in order of priority:

- Position and nature of difficulty.
- Boat description and number of people onboard.

Facility	Call Sign Examples
LA City Fire	"LA City Fire Boat 5".
Port Police	"Port Police Boat 31"
Baywatch	"Baywatch Cabrillo".
Coast Guard Halibut	"COAST GUARD CUTTER HALIBUT"
Coast Guard boat	"COAST GUARD FOUR ONE THREE ZERO ZERO" (41300)
Aircraft	"COAST GUARD SIX FIVE ZERO EIGHT" (6508)

"COAST GUARD" may be dropped once establishing communications with Coast Guard. Number call signs may be shortened to the last three digits, if it doesn't cause confusion. For example, Coast Guard Boat 41357, already communicating with your unit, could be referred to simply as "THUH-REE FI-YIV SEVEN."

Emergency Voice Communications and Distress Signals

Overview

Whether you are providing emergency assistance or in need of it yourself, your knowledge of the correct procedures and available equipment can save lives.

Standard Voice Radio Urgency Calls

General

When an emergency occurs, use the proper prowords to show the degree of urgency. Hearing one of these urgency calls should trigger specific responses in a listener, such as, preparing to collect information on an emergency or refraining from transmitting on the frequency until all is clear. The meaning of each urgency call is outlined below.

MAYDAY

MAYDAY is a distress call of the highest priority. Spoken three times, it shows that a person, boat, or aircraft is threatened by grave or imminent danger and requires immediate assistance. Broadcast on Channel 16.

Priority

A MAYDAY call has absolute priority over all other transmissions

Station responses

All units hearing a MAYDAY call should immediately cease transmissions that may interfere with the distress traffic, and continue to listen on the distress message's frequency.

If the unit transmitting the distress call is determined to be some distance from you, pause a few moments to allow ships or stations nearer the scene to answer.

When working a distress situation on Channel 16, do not attempt to change (shift) to a working channel until enough information is obtained to handle the distress in case communications are lost during the act of shifting.

PAN-PAN

Broadcast on Channel 16, this urgency signal consists of three repetitions of the group of words "PAN-PAN" (*PAHN-PAHN*). It means that the calling station has a very urgent message to transmit concerning the safety of a ship, aircraft, vehicle, or person.

(Example) "PAN-PAN","PAN-PAN", "PAN-PAN", Hello all stations, Hello all stations. This is LAPD vessel "*Centurion, etc,*" advising of " *possible person in the water, possible aircraft down, possible flare sighting or anything else you need mariners to keep a look out for*" in position "*give exact longitude/latitude if known and a geographical location*" all mariners are requested to keep a sharp lookout and report any sightings to the Sheriff or US Coast Guard on Channel 16, Break "*Listen for emergency traffic a second or two*" This is LAPD vessel "*Centurion*" OUT.

SECURITÉ

"SECURITÉ" (*SEE-CURE-IT-TAY*) is a safety signal spoken three times and transmitted on Channel 16. It indicates a message on the safety of navigation, or important weather warnings.

(Example) " SECURITÉ "," SECURITÉ ", " SECURITÉ", Hello all stations, Hello all stations. This is LAPD vessel "*Centurion,etc,*" advising of " *Entering the harbor with a 300 foot tow, severe breaking waves at the entrance, debris that can impede safe navigation, vessel entering the harbor restricted in its ability to maneuver or anything else you need to advise mariners of to be safe*" in position "*give exact longitude/latitude if known and a geographical location*" all mariners are requested to keep a sharp lookout and navigate this area with caution, Break "*Listen for emergency traffic a second or two*" This is LAPD vessel "*Centurion*" OUT.

Radio alarm signal

The radio alarm signal consists of two audible tones of different pitch sent alternately, producing a warbling sound. If used, the alarm continuously sends the signal for not less than 30 seconds or more than one minute, and the recipient of the signal should follow the signal by the radio distress signal and message. There are two primary reasons to use a radio alarm signal:

- To attract the attention of listeners on the frequency
- To actuate the automatic listening devices found on large ships and occasionally at shore stations.

Receipt of distress messages

When a distressed unit is in your vicinity, acknowledge receipt for the message immediately. However, if the unit is determined to be some distance from you, pause a few moments to allow ships or stations nearer the scene to answer. In the areas where communications with one or more shore stations are practicable, ships should wait a short period of time to allow them to acknowledge receipt.

Receipt procedure

The receipt of distress messages should be in the following manner.

- The distress signal MAYDAY
- The call sign of the unit in distress (spoken three (3) times)
- The words THIS IS (spoken once)
- The call sign of your unit (spoken three (3) times)
- The words RECEIVED MAYDAY
- Request essential information needed to effect assistance, (position, number of people on board, nature of distress, vessel's description) obtain less important information in a later transmission.
- The proword OVER.

Inform distressed unit of Sheriff rescue assistance

Inform THE DISTRESSED UNIT of any Sheriff rescue assistance being dispatched and to stand by.

Vessel and shore stations

Vessels and shore stations receiving distress traffic should by the most rapid means:

- Set a continuous radio watch on frequencies of the distress unit.
- Maintain communications with the distressed unit.
- Place additional people on watch if necessary.
- Obtain radio direction finder bearing of distressed unit if equipment and conditions permit.

Transmit information

Every LAPD boat which acknowledges receipt of distress messages, ensuring it will not interfere with vessels in a better position to render immediate assistance, shall notify the Communications and the Coast Guard.

Keeping distressed unit informed

Keep the distressed unit informed of any circumstances that may affect your assistance to him such as speed, sea conditions, etc. Speak in a tone of voice that expresses confidence. After receiving a distress call or information pertaining to one, Sheriff units shall, within equipment capabilities, set a continuous radio guard on the frequency of the distressed.

Needless shifting of frequencies by you or the distressed unit may end in a loss of communications.

Emergency Position Indicating Radiobeacon (EPIRB) and Emergency Locator Transmitter (ELT)

General

The emergency position-indicating radio beacon (EPIRB) is carried on vessels to give a distress alert. Aircraft have a similar device called an emergency locator transmitter (ELT). The original EPIRB and ELT transmitted on 121.5 MHz frequency. However, the 406.025 MHz EPIRB and ELT were developed for satellites to detect these distress alerts. A global satellite detection network, COSPAS-SARSAT, has been established for detecting 406 MHz distress beacons.

All EPIRB, GPIRB and PLB must be registered with NOAA.

End of 121.5 MHz

Beginning January 1, 2007, both 121.5 and 243 MHz Emergency Position Indicating Radio Beacons (EPIRBs) were prohibited from use in both commercial and recreational watercraft. Boaters wishing to have an emergency rescue beacon aboard their vessel must have a digital 406 MHz model.

On February 1st 2009, the COSPAS-SARSAT system stopped processing and reporting 121.5 distress signals. Only one out of fifty 121.5 alerts have been genuine distress situations.

Many Radio Direction Finding (RDF) equipment contain special functions for detecting 121.5 MHz homing signals. For this reason all 406MHz EPIRBs are equipped with a low power 121.5 MHz homing beacon.

406 MHz

The EPIRB transmits a digital signal with a beacon-unique identifier. Owner registration allows automatic distressed vessel identification and provides case prosecution critical information. 406 MHz EPIRBs generate positions accurate to within about 3 nautical miles. 406 MHz EPIRBs have a 121.5 MHz homing signal and strobe. The false alarm rate is much lower for 406 MHz EPIRBs and registration makes it possible to identify false alarms, often before resources launch. 406 MHz EPIRBs are categorized as follows:

- Category I 406 MHz EPIRBs are designed to float free and may be activated automatically or manually.
- Category II 406 MHz EPIRBs must be manually activated.

GPIRB

GPIRBs (Global Position Indicating Radio Beacon) combine the latest in GPS and 406MHz EPIRB. A GPS enabled EPIRB or GPIRB is a 406 Mhz beacon that provides instant positioning information when the unit is activated in conjunction with a GPS. The GPS is either an internal component of the EPIRB or connected to the EPIRB via an interface. The location of a transmitting 406 beacon with GPS can be determined within approximately 45 feet.

PLB

Personal Locator Beacons, or PLBs are compact emergency equipment that also relies on the 406Mhz satellite signal. These units can also have GPS integration. Battery life is only required to transmit for 24 hours and most are not water activated. The compact design of these units makes them ideal for attaching to PFD. PLB must be registered as with all 406 MHz EPIRB.

EPIRB testing

406 MHz EPIRBs can be tested through its self-test function, which is an integral part of the device. 406 MHz EPIRBs can also be tested inside a container designed to prevent its reception by the satellite. Testing a 406 MHz EPIRB by allowing it to radiate outside such a container is illegal.

Distress Signals

General

If voice communication is not possible or not effective, you will have to use other means of communication. These may include signals using pyrotechnics, flag hoist signals, hand signals, or a flashing light S-O-S (see Figure 11-2). These signals can be found in the publication called *Navigation Rules*.

Pyrotechnics

The following are some pyrotechnic emergency signals you may encounter:

- Gun or explosive signal fired at about one minute intervals
- Red or orange flare fired one at a time in short intervals
- Rocket parachute showing a red light
- Smoke
- Any flame on a vessel may be used for signaling

Flag hoists

Flag hoists are a quick way of emergency signaling, but can only be used in the daytime. These are some of the best known examples:

- A square flag with a ball, or ball-shaped object above or below the flag
- Hoisting an orange flag
- November Charlie Flag

Hand signals

Possibly the oldest form of signaling are hand signals, but like other methods of visual communications, the signals are not standardized and can be easily misunderstood. Boat crew members must be constantly alert for hand signals from other mariners that are not standard distress signals, but that may be attempts to indicate an emergency situation. These are three standard hand signals that are used as distress signals:

- Slowly raising and lowering an outstretched arm
- Signaling with an oar raised in the vertical position
- Holding a life jacket aloft

Flashing light/strobe (50-70/min.)

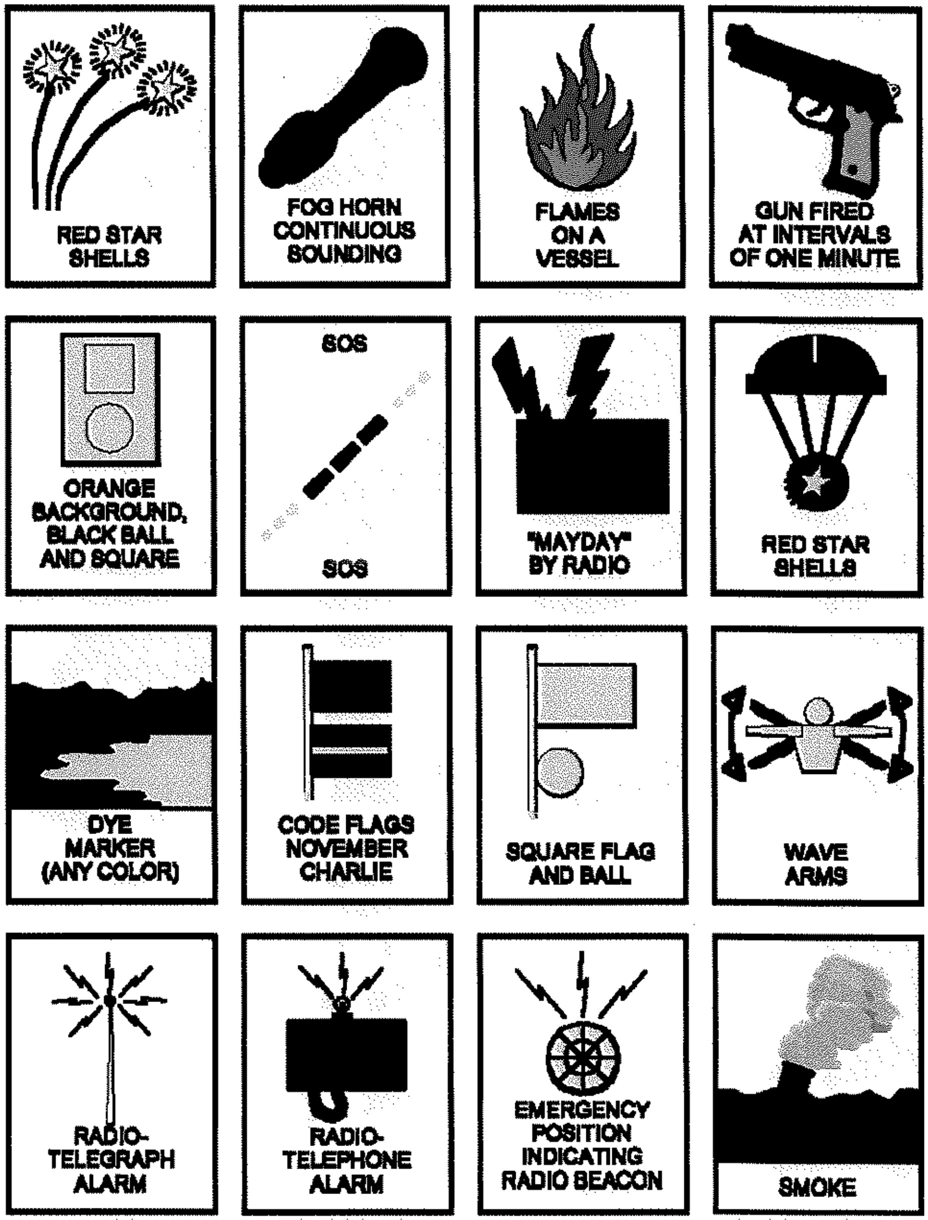
The Morse Code symbols 'SOS' (Save Our Ship) transmitted by a flashing light may be used to communicate distress.

S O S

... --- ...

A strobe light (may be attached to a personal flotation device).

Any unusual signal or action you see could be a signal that a craft is in trouble. You should investigate any peculiar or suspicious signals such as, the U.S. flag flown upside down or continuous sounding of a horn or fog signaling device.



Distress Signals
Figure 11-2

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Chapter 12: Weather

Overview

Boat crews operate in constantly changing environments. Weather and sea conditions interact causing many different types of situations. It is important to understand these conditions and how to operate in them. The information in this chapter will concentrate on the effects the environment has on the water and the problems these effects can cause. It will not provide an explanation of advanced meteorology or oceanography.

Wind, fog, rain, and cold temperatures (sea and air) can be very dangerous. Any of these can complicate the simplest mission, not only increasing the danger, but also lessening the survival probability of persons in distress.

Effects of wind, current, and tide can also dramatically affect a boat's behavior. Boat operators must understand how outside influences cause the boat to react in different ways.

Weather

Introduction

One of the greatest hazards to the boat crew occurs when its members must work close inshore or in heavy weather. The waves, seas, and surf can present the greatest challenges to seamanship and survival skills. Your operating area of responsibility will provide its own unique weather characteristics. Some major distinct conditions occur in various regions of the United States in predictable patterns. For example:

- *Santa Ana Wind.* On the southern California coast, a dry, warm wind that blows through a pass and down the Santa Ana valley. It may blow so strongly that it threatens small craft near the coast.

Identify Sources of Weather Information

The marine patrol officer can obtain weather information from a variety of sources.

Internet

The Internet has become and will continue to be the most important source for weather information of all types. The NWS implements a graphic forecast as well as a word forecast in a detailed marine product. The place to start is the homepage of the National Weather Service at:

From here you can get information such as:

- Current Conditions
- Local and Marine Forecasts
- Offshore conditions
- Weather Maps
- Radar Scans
- Satellite images
- Past weather and Climate data

Many smart phones (cell phones) have the ability to load internet sites or have applications available to get the latest weather information from almost any location.

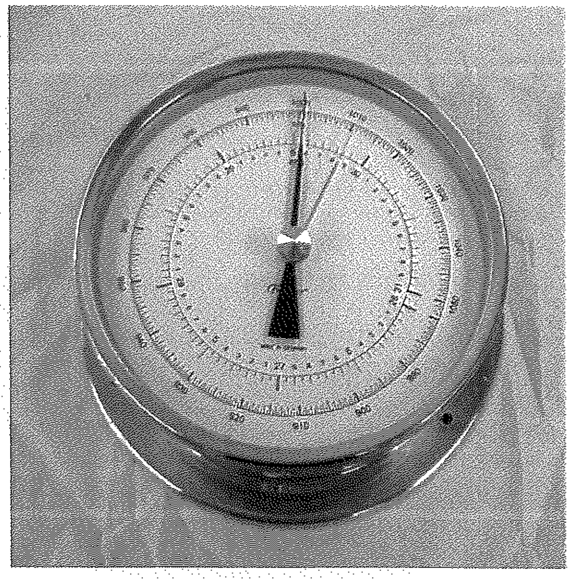
VHF Radio Weather reports

Weather broadcasts are also made on Marine VHF radio. NWS usually updates these broadcasts every three to six hours. Marine VHF radios will usually have a weather button labeled (WX) with weather channels 1-9. Monitor each channel to determine the channel appropriate for your area.

In addition, the U.S. Coast Guard broadcasts severe weather bulletins on VHF marine channel 22A. These broadcasts begin with the safety pro-word "SECURITE" transmitted on VHF channel 16 and then advise the mariner to switch to 22A for details.

Barometer

A barometer is an instrument for determining atmospheric pressure. Many mariners use barometers to help them forecast weather. See Figure 12-1. There is a pressure scale that is usually graduated in both INCHES OF MERCURY and in MILLIBARS.



Aneroid Barometer
Figure 12-1

Standard Pressure

"Standard atmospheric pressure" of 29.92 inches of mercury is equal to 1013.2 millibars; 1 inch equals 33.86 millibars, or 1 millibar equals 0.03 inches of mercury.

General Pressure Rules

It is not the actual barometric pressure but the **direction and rate of change of pressure** that is important in forecasting weather.

- **Falling barometer** usually forecasts that bad weather is approaching.
- **Rising barometer** usually forecasts clear and fair weather.
- **Rapid falling barometer** generally forecasts strong winds.
- A **falling barometer and a rising thermometer** often forecast precipitation.
- **Barometer and temperature rising** together often forecasts fine weather.

Wind

General

High winds account for considerable destruction in the marine environment every year. Everyone knows water seeks its own level; the same is true with air. Air tends to equalize its pressure by flowing from a high-pressure area to a low-pressure area, producing wind.

Afternoon wind increases

Wind direction is the compass heading from which the wind blows.

Members of the boating public often get underway in the calm waters of the cool early morning. By afternoon, when they try to get home, the bay or ocean is so choppy that they may find themselves in need of assistance. The wind changes so drastically because the sun warms the Earth. The land warms faster than the surface of the water and radiates heat to the overlying air, warming it. This warm air rises, reducing the atmospheric pressure in that area. The air offshore over the ocean is cool, and cool air is dense and heavy.

The cool air from offshore flows inland in an attempt to equalize the pressure differential caused by the rising warm air. This flow produces wind, known as sea breeze. After sunset, the inland area cools more quickly than the water, and the wind diminishes.

Sea breezes typically reach their highest speeds during the period of maximum heating (i.e., during mid-afternoon). In some areas a land breeze can be established late at night or early in the morning. For this breeze to occur, the sea surface temperature must be higher than the air temperature over land, along with weak winds prior to the breeze.

Beaufort wind scale

The Beaufort Wind Scale (See Figure 12-2) numbers define a particular state of wind and wave. The scale allows mariners to estimate the wind speed based on the sea state.

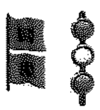
The Beaufort Scale extends to force 18. For boat operating purposes, Figure 12-2 is limited to force 10.

BEAUFORT SCALE	WIND SPEED (KNOTS)	INDICATIONS	APPROXIMATE WAVE HEIGHT
0	calm	Mirror like.	0
1	1-3	Ripples with appearance of scales.	0.25
2	4-6	Small wavelets that do not break. Glassy appearance.	0.5-1
3	7-10	Large wavelets. Some crests begin to break. Scattered whitecaps.	2-3
4	11-16	Small waves becoming longer. Fairly frequent whitecaps.	3.5-5
5	17-21	Moderate waves. Pronounced long form. Many whitecaps.	6-8
6	22-27	Large waves begin to form. White foam crests are more extensive. Some spray.	9.5-13
7	28-33	Sea heaps up. White foam from breaking waves begins to blow in streaks along the direction of the waves.	13.5-19
8	34-40	Moderately high waves of greater length. Edges of crests break into spindrift foam blown in well marked streaks in the direction of the waves.	18-25
9	41-47	High waves. Dense streaks of foam. Sea begins to roll. Spray affects visibility.	23-32
10	48-55	Very high waves with over-hanging crests. Foam in great patches blown in dense white streaks. Whole surface of sea takes on a white appearance. Visibility affected.	29-41

Beaufort Wind Scale
Figure 12-2

Weather warning signals

The National Weather Service provides radio weather broadcasts. Although no longer required to be displayed, various shore activities may still use a system of flag and light signals to announce weather warnings. These weather warnings and their flags and lights signals are summarized below.

	STORM WARNINGS	WINDS	DAY SIGNAL ONSHORE	NIGHT SIGNAL ON SHORE
	**Small craft advisory** (conditions dangerous to small craft operations)	Up to 33 knots	Red pennant	Red-over-white light
	**Gale**	34-47 knots	Two red pennants	White-over-red lights
	**Storm**	48-63 knots	Square red flag with black center	Two red lights
	**Hurricane**	64 knots and above	Two square red flags with black centers	Three vertical lights - red, white, red

Thunderstorms and Lightning

Thunderstorms

Thunderstorms have violent vertical movement of air. They usually form when air currents rise over locally warmed areas or a cold front forces warm moist air aloft. Thunderstorms are dangerous not only because of lightning, but also because of the strong winds and the rough, confused seas that accompany them. Sharp intermittent static on the AM radio often indicates a thunderstorm.

Lightning

Lightning is a potentially life-threatening phenomenon associated with some storms. Not all storms are thunderstorms, but all thunderstorms have lightning. Lightning occurs when opposite electrical charges within a thundercloud, or between a cloud and the earth, attract. It is actually a rapid equalization of the large static charges built up by air motion within the clouds. Lightning is very unpredictable and has immense power. A lightning "bolt" usually strikes the highest object on the boat, generally the mast or radio antenna. A mast with a full grounding harness affords excellent protection.

Distance from a thunderstorm

The boat's distance from a thunderstorm can be estimated by knowing it takes about five seconds for the sound of thunder to travel each mile.

- Observe the lightning flash.
- Count the number of seconds it takes for the sound of its thunder to arrive.
- Convert to miles by dividing the number of seconds by 5.

Safety

If caught in a lightning strike area, head for shore or the nearest shelter. While underway, stay inside the boat, keep crew members low, and stay dry. Avoid touching metal, such as metal shift and throttle levers and metal steering wheels. Avoid contact with the radio. If lightning strikes, expect your compass to be inaccurate and onboard electronics to suffer extensive damage.

Waterspouts

A **waterspout** is a small, whirling storm over water or inland waters. There are two types of waterspouts:

- Violent convective storms over land moving seaward (tornadoes)
- Storms formed over sea with fair or foul weather (more common than tornadoes)

Waterspouts develop as a funnel-shaped cloud and when fully developed extends from the water's surface to the base of a cumulus cloud. The water in a waterspout is mostly confined to its lower portion. The air in waterspouts may rotate clockwise or counter-clockwise, depending on the manner of formation. Waterspouts vary in diameter, height, strength and duration and are found most frequently in tropical regions.

FOG

General

Fog is a multitude of minute water droplets hanging in the atmosphere, sufficiently dense to scatter light rays and reduce visibility. Fog makes locating anything more difficult. and also makes the voyage to and from the scene more hazardous.

Advection fog

The most troublesome type of fog to mariners is **advection fog**. Advection means horizontal movement. This type of fog occurs when warm air moves over colder land or water surfaces. The greater the difference between the air temperature and the underlying surface temperature, the denser the fog. Sunlight hardly affects advection fog. It can occur during either the day or night. An increase in wind speed or change in direction may disperse advection fog; however, a slight increase in wind speed can actually make the fog layer thicker.

Radiation (ground) fog

Radiation fog occurs mainly at night with the cooling of the earth's surface and the air, which is then cooled below its dew point as it touches the ground. It is most common in middle and high latitudes, near the inland lakes and rivers which add water vapor to the fog. It clears slowly over water because the water warms less from night to day than does land. Sunlight burns off radiation fog.

Fog frequency

The United States' Pacific Coast fog appears most frequently in areas from the northern tip of Washington State to around Santa Barbara, California. The nation's Atlantic Coast fog is most common from the northern tip of Maine to the southern tip of New York. Fog appears, on the average, more than 10% of the time in these waters. Off the coasts of Maine and Northern California it averages more than 20%. The fog frequency near Los Angeles, California, on the other hand, is about three times that of Wilmington, North Carolina.

Operating in fog

When in fog, slow down to allow enough time to maneuver or stop (i.e., operate your boat at a safe speed). When engaged in towing extra caution should be exercised. Display the proper navigation lights and sound appropriate sound signals. Employ all available navigation aids.

Oceanography

Introduction

Oceanography is a broad field encompassing the study of waves, currents, and tides. It includes the biology and chemistry of the oceans and the geological formations that affect the water. Boat crew members must have an appreciation of all these factors to safely operate in an ever-changing environment. Some major distinct conditions occur in various regions of the United States. For example:

- The West Coast, in general, has a narrow continental shelf (a gentle bottom slope) followed by a sharp drop into great ocean depth.

Waves

General

By understanding how **waves** form and behave, boat crew members know what to expect and how to minimize danger to both boat and crew.

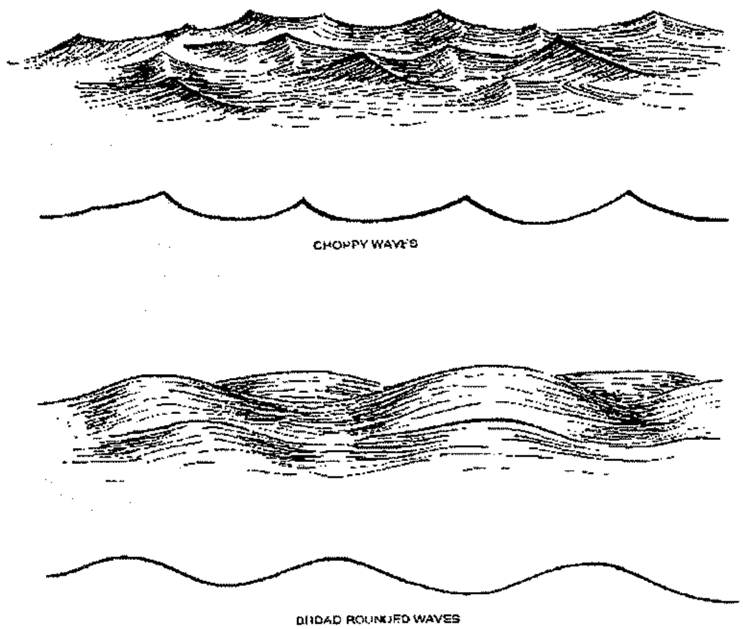
Definitions

The following definitions will help in understanding waves:

Term	Definition
Waves	Waves are periodic disturbances of the sea surface, caused by wind (and sometimes by earthquakes).
Crest	The top of a wave, breaker, or swell.
Foam Crest	Top of the foaming water that speeds toward the beach after the wave has broken, popularly known as **white water**.
Wave Length	The distance from one wave crest to the next in the same wave group or series.
Trough	The valley between waves.
Wave Height	The height from the bottom of a wave's trough to the top of its crest; measured in the vertical, not diagonal.

Term	Definition
Fetch	The unobstructed distance over which the wind blows across the surface of the water.
Series	A group of waves that seem to travel together, at the same speed.
Period	The time, in seconds, it takes for two successive crests to pass a fixed point.
Frequency	The number of crests passing a fixed point in a given time.
Wave Refraction	Refraction means bending. Wave refraction occurs when the wave moves into shoaling water, interacts with the bottom and slows. The first part of the wave slows, causing the crest of the wave to bend toward the shallower water. As a result the waves tend to become parallel to the underwater contours. The key to the amount of refraction that occurs is the bottom terrain. This can also occur when a wave passes around a point of land, jetty, or an island. While different segments of the wave travel in different depths of water, the crests bend and the waves change direction constantly. This is why wave fronts become parallel to the underwater contours and the shoreline, and why an observer on the beach sees larger waves coming in directly toward the beach while offshore they approach at an angle.
Wave Reflection	Any obstacle can reflect part of a wave. This includes under water barriers (e.g., submerged reefs or bars), although the main waves may seem to pass over them without change. These reflected waves move back towards the incoming waves. When the obstacles are vertical or nearly so, the waves may be reflected in their entirety.
Interference	Waves refracted or reflected can interact with other waves. This action may increase or decrease wave height, often resulting in unnaturally high waves. Interference may even result in standing-wave patterns (waves that consistently appear to peak in the same spot). Interference can be of particular concern because it may result in a boat being subjected to waves from unexpected directions and of unexpected size.

Term	Definition
Swell	Swells are the waves that have moved out of the area in which they were created. The crests have become lower, more rounded, and symmetrical. They can travel for thousands of miles across deep water without much loss of energy. Generally, a swell's direction of travel differs from the wind direction by at least 30°.
Breaker	A breaking wave.
Surf	Several breakers in a continuous line.
Surf Zone	The area near shore in which breaking occurs continuously in various intensities.
Breaker Line	The outer limit of the surf. All breakers may not present themselves in a line. Breakers can occur outside the breaker line and seem to come from nowhere.
Comber	A wave on the point of breaking. A comber has a thin line of white water upon its crest, called **feathering**.
Wave types	The wind generates waves by moving over the water's surface. As wind speed increases white caps appear. As the wind continues, the waves become higher and longer. The Beaufort wind scale (See Figure 12-1) shows the size of waves in open water for a given wind strength. There are two major types of waves: the broad, rounded waves associated with deep water, and the more choppy waves found in shallow water (e.g., in bays and inland lakes) (see Figure 12-4).



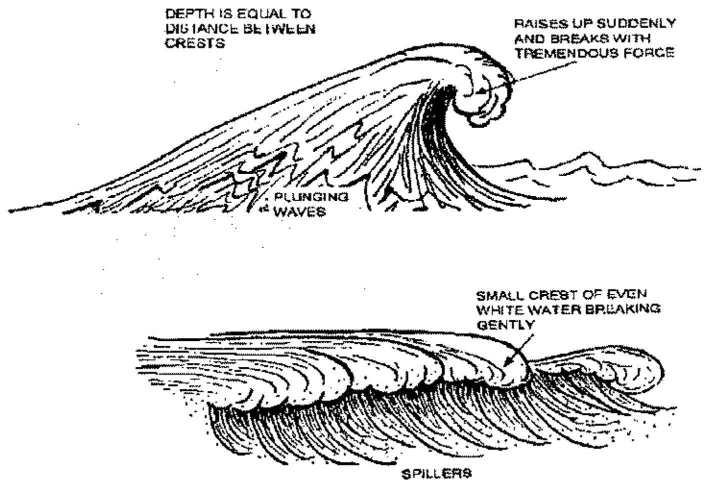
The Two Major Types of Waves
Figure 12-4

Breaking waves

Breaking waves are the most dangerous kind of wave for boat operations. How dangerous the wave is depends on the ratio of wave height to length, and on wave frequency. Steep sloped waves are the most dangerous. There are three main types of breaking waves: **plunging, spilling, and surging breakers**.

Plunging waves

Plunging waves result when there is a sudden lack of water ahead of the wave, such as in a steep rise of the ocean floor. This situation prevents the wave from traveling along, and causes the crest to be hurled ahead of the front of the wave and break with tremendous force (see Figure 12-5).



Plunging and Spilling Waves
Figure 12-5

Spilling breakers

Spilling breakers result from waves of low steepness moving over a gentle sloping ocean floor. They normally have a small crest of white water spreading evenly down the wave, and break slowly without violence (see Figure 12-5).

Surging breakers

A surging break occurs on very steep beaches. The wave builds very quickly and expends its energy on the beach. It is very unlikely that you will encounter a surging break while aboard a boat unless you are beaching it on a very steep beach.

Deep water waves

A **deep water wave** is a wind wave where the depth of the water is greater than one-half the wave length.

Shallow water waves

A shallow water wave travels in water where the depth is less than one-half the wave length. If the depth of water is small in comparison to the wave length, the bottom will change the character of the wave.

As the waves travel out from their origin, they become swells developing into a series of waves equidistant apart which track more or less at a constant speed. Consequently, it is possible to time series of breakers.

Wave series

Wave series are irregular because of constant shifting of wind direction and speed. Storms at sea create masses of waves that build up in groups higher than other waves. Breakers vary in size and that there is no regular pattern or sequence to their height. But while the space or interval between series of breakers may vary, it is fairly regular. Despite the interval, breakers tend to stay the same for hours at a time.

Tidal currents going against the waves will make the waves steeper.

The height and period of a wave depends on:

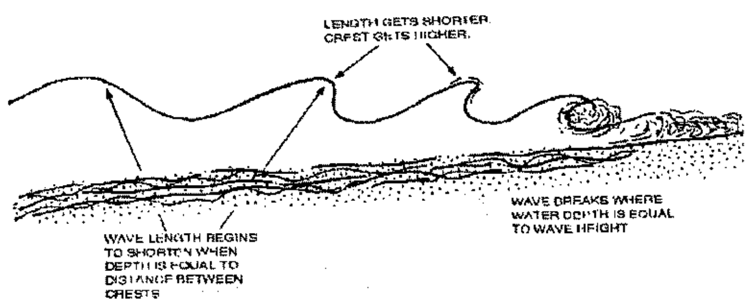
- The speed of the wind.
- The amount of time the wind has been blowing.
- The unobstructed distance over which the wind travels, known as fetch. Nearness to land will limit fetch, if the wind is blowing offshore.

The **lifecycle** of a wave consists of its:

- Generation by a wind.
- Gradual growth to maximum size.
- Distance traveled across the sea.
- Dissipation as wind decreases or when the wave impacts against the shore or an object.

Surf

Irregular waves of deep water become organized by the effects of the contact with the bottom. They move in the same direction at similar speeds. As the depth of water decreases to very shallow, the waves break and the crests tumble forward. They fall into the trough ahead usually as a mass of foaming white water. This forward momentum carries the broken water forward until the wave's last remaining energy becomes a wash rushing up the beach. The zone where the wave gives up this energy and the systematic water motions, is the **surf** (see Figure 12-6).



Surf
Figure 12-6

Operators can size up the surf situation by comparing the swell height and length with the water depth.

Sometimes there are two breaks of surf between the beach and the outer surf line. These breaks result from an outer sand bar or reef working against the wave causing the seas to pile up. The movement of water over such outer bars forms the inner surf belt as the water rolls toward the shore. The surf that forms around an inlet depends on the size of approaching swells and the bottom contours. The waves' speed and shape change as they approach shallow coastal waters. They become closer together (as their speed slows) and steeper as they contact the bottom. This change typically happens at a point where the water is approximately one half as deep as the wave's length. The momentum caused by the breaking top of a wave will cause the water to fall ahead or curl because the water mass is not actually going forward. Momentum is what gives the curl of breakers its tremendous force.

Currents

General

Current direction is the compass heading toward which the water moves.

Tide is the vertical rise and fall of the ocean water level caused by the gravitational attraction of the sun and moon. A **tidal current** is the horizontal motion of water resulting from the change in the tide. It is different from ocean currents, river currents, or those created by the wind. Tidal currents are of particular concern in boat operations.

Flood, ebb, and slack currents

Flood current is the horizontal motion of water toward the land, caused by a rising tide. **Ebb current** is the horizontal motion away from the land, caused by a falling tide. **Slack water** is the period that occurs while the current is changing direction and has no horizontal motion.

An outgoing or ebb current running across a bar builds up a more intense sea than the incoming or flood current. The intense sea results because the rush of water out against the incoming ground swell slows the wave speed and steepens the wave prematurely.

Longshore currents

Longshore currents run parallel to the shore and inside the breakers. They are the result of the water transported to the beach by the waves.

Pay close attention to longshore currents - they can cause a boat to broach or the object of a search to move further than expected.

Wind effects on current

Wind affects the speed of currents. Sustained wind in the same direction as the current, increases the speed of the current by a small amount. Wind in the opposite direction slows it down and may create a chop. A very strong wind, blowing directly into the mouth of an inlet or bay, can produce an unusually high tide by piling up the water. Similarly, a very strong wind blowing out of a bay can cause an unusually low tide and change the time of the high or low tide.

Effects on boat speed

When going with the current, a boat's speed over ground is faster than the speed/rpm indication. When going against the current, a boat's speed over ground is slower than the speed/rpm indication.

Effects on boat maneuverability

When working in current, the boat's maneuverability depends on its speed through the water. Although a boat has significant speed in relation to fixed objects (e.g., a pier) when going with the current, a boat lacks maneuverability unless there is sufficient water flow past the rudder. When going into the current, maneuverability is usually improved as long as enough headway is maintained. However, at slow speeds, even a small change in course can have the bow swing greatly as the water flow pushes on one side of the bow.

Crossing the current

When crossing the current to compensate for the set, a boat may be put into a **crab**, i.e., the boat may be forced off course by the current or wind. Because of this maneuver, the boat heading and the actual course made good will be different. When the boat is crabbing, the heading will not be the intended course of the boat. Therefore, navigate the current or wind by sighting on a fixed object (such as a range) or by marking the bearing drift on an object in line with the destination. Piloting in currents is covered in more detail in the *Navigation* chapter.

Tide and tidal current changes

The change of direction of the tidal current always lags behind the turning of the tide. This difference occurs by a time period that varies according to the physical characteristics of the land around the body of water, as well as the bottom topography. For instance, with a straight coast and only shallow indentations, there is little difference between the time of high or low tide and the time of slack water. However, where a large body of water connects with the ocean through a narrow channel, the tide and the current may be out of phase by as much as several hours. In a situation such as this, the current in the channel may be running at its greatest velocity when it is high or low water outside.

Section 13: Aids to Navigation

Overview

This chapter introduces the aids to navigation (ATON) used in the United States. ATON are devices or marks that assist mariners in determining their vessel's position, or course, or to warn of dangers, obstructions, or regulatory requirements affecting safe navigation. In the U.S., the Coast Guard is responsible for servicing and maintaining ATON under federal jurisdiction. This includes both short and long range navigation systems found in the navigable waters, along the U.S. coast.

Buoys, beacons, and other short range ATON are used the same way signs, lane separations, and traffic lights guide motor vehicle drivers. Together, these ATON make up the short range ATON system, which uses charted reference marks to provide information for safely navigating waterways. In the U.S. this is called the U.S. Aids to Navigation System. The short range aids provide:

- Daytime visual system of daymarks, beacons and buoys;
- Nighttime visual system of lights and retro-reflective signals;
- Radar system of radar reflectors and RACONs (radar beacons); and
- A sound system of various non-directional sound producing devices.

Lateral System

In the Lateral System, buoys and beacons indicate the sides of the channel or route relative to a conventional direction of buoyage (usually upstream). They also mark junctions, a point where two channels meet when proceeding seaward; or bifurcations, the point where a channel divides when proceeding from seaward, or the place where two tributaries meet.

In U.S. waters, ATON use the IALA-B system of lateral marks arranged in geographic order known as the “conventional direction of buoyage”. Under this, the memory aid 3R rule of "Red, Right, Returning" applies when a vessel is returning from seaward. This means, when returning from sea, keep red markers to the right of the vessel from:

- north to south along the Atlantic Coast.
- south to north and east to west along the Gulf Coast.
- south to north and east to west along the Pacific Coast.
- east to west in the Great Lakes except for Lake Michigan which is north to south.

General Characteristics of Short Range ATON

Aids to navigation have many different characteristics. An aid's color, size, light, or sound signifies what mariners should do when they see it. Characteristics of short range aids used in the U.S. are described in the following paragraphs.

While reading the following section, refer to Appendix 13-A to see how the characteristics of color, numbering, lighting, and light rhythms are used on ATON to mark a waterway.

Type

The location and the intended use determine which one of the two types of ATON will be placed in a spot or waterway:

- Floating (buoy); or
- Fixed (beacon).

Numbering

Solid red ATON buoys and beacons bear even numbers and all solid green ATON bear odd numbers. No other ATON are numbered. When proceeding from seaward toward the direction of conventional navigation, the numbers increase. Numbers are kept in approximate sequence on both sides of the channel. Letters may be used to augment numbers when lateral ATON are added to channels with previously completed numerical sequences. For instance, a buoy added between R"4" and R"6" in a channel would be numbered R"4A" Letters will also increase in alphabetical order.

Preferred channel, safe water, isolated danger, special marks, and information/ regulatory ATON use only letters.

Color

During daylight hours, the color of an ATON indicates the port or starboard side of a channel, preferred channels, safe water, isolated dangers, and special features. Only red or green buoys, or beacons fitted with red or green dayboards, have lateral significance.

Shape

Shapes of buoys and beacons help identify them from a distance or at dawn or dusk, when colors may be hard to see. Like other characteristics of ATON, mariners should not rely solely on shape to identify an aid.

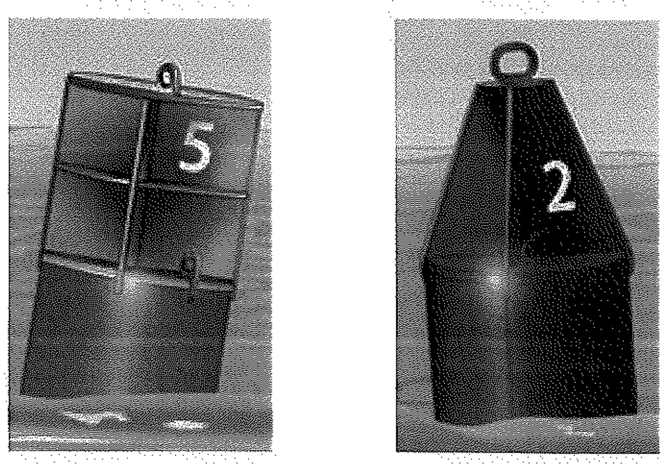
Cylindrical buoys (Can)

Cylindrical buoys, often referred to as "can buoys," are unlighted ATON. When used as a lateral mark, they indicate the left side of a channel or of the preferred channel when returning from seaward. They are painted solid green or have green and red horizontal bands, the topmost band is always green. Can buoys are also used as unlighted special marks and will be colored based on their use. (See Figure 13-1.)

Conical buoys (Nun)

Conical buoys, often referred to as "nun buoys," are unlighted ATON. When used as a lateral mark, nun buoys indicate the right side of a channel or of the preferred channel when returning from seaward. They are painted solid red or red and green with horizontal bands and always with a red topmost band. Nun buoys are also used as unlighted special marks and will be colored based on their use. (See Figure 13-1.)

Buoys other than a "can" and "nun" or buoys fitted with a top mark, such as isolated danger or safewater buoys, have no shape significance. Their meanings are shown by numbers, colors, top marks, lights and sound signal.



Can Buoy (left) Nun Buoy (right)
"When Returning From Sea"
Figure 13-1

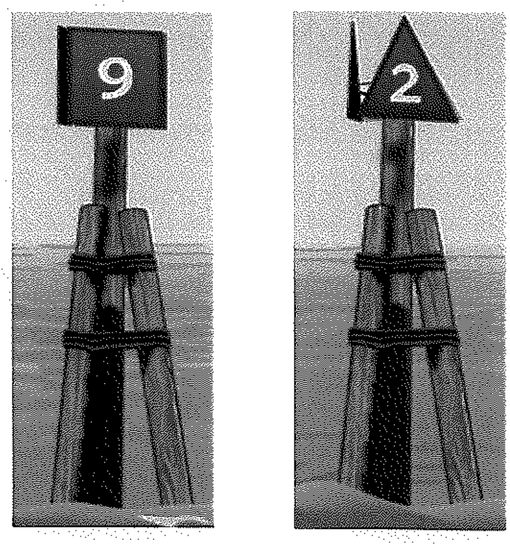
Miscellaneous buoys

The Coast Guard and other agencies place (station) specialty buoys for operational and developmental uses, and for research purposes. In many instances, the buoy used is a standard buoy modified for specialized use. There are several examples of specialty buoys:

- Fast water buoys
- Discrepancy buoys
- Weather/oceanographic buoys
- Mooring buoys

Day Beacons

Day Beacons have dayboards attached to a permanent structure. When returning from sea, a triangular shaped dayboard marks the starboard side, and a rectangular shaped dayboard marks the port side of the channel. (See Figure 13-2.)



Daybeacon
"When Returning From Sea"
Figure 13-2

Light colors

Though you will see white and yellow lights, only ATON with green or red lights have lateral significance. When proceeding in the conventional direction of buoyage, ATON will display the following light colors.

Green

Green lights mark port sides of channels and wrecks or obstructions. When proceeding from seaward, these aids are passed by keeping them on your port side. Green lights are also used on preferred channel marks where the preferred channel is to starboard. When proceeding along the conventional direction of buoyage (from seaward), a preferred channel mark fitted with a green light would be kept on your port side.