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SEAMANSHIP FOR SAILING VESSELS

DIGITAL EDITION

Captain Robert L. Figular

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SEAMANSHIP FOR SAILING VESSELS

by Captain Robert L. Figular

Mariners Learning System™
Princeton, New Jersey

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Seamanship for Sailing Vessels

Types of Sailboats

A sailboat is a boat propelled partly or entirely by sails. The term covers a variety of boats, larger than small vessels such as sailboards and smaller than sailing ships, but distinctions in size are not strictly defined nor is what constitutes a sailing ship, sailboat, or a smaller vessel.

Apart from size, sailboats may be distinguished by hull configuration (monohull, catamaran, trimarans), keel type (full, fin, wing, centerboard etc.), purpose (sport, racing, cruising), number and configuration of masts, and sail plan.

• Sloop

Today, the most common sailboat is the sloop that features one mast and two sails, a normal mainsail and a foresail. This simple configuration is very efficient for sailing towards the wind. The mainsail is attached to the mast and the boom, which is a spar capable of swinging across the boat, depending on the direction of the wind. Depending on the size and design of the foresail, it can be called a jib, genoa, or spinnaker; it is possible but not common for a sloop to carry two foresails from the one forestay at one time (wing on wing). The forestay is a line or cable running from near the top of the mast to a point near the bow.

• Fractional Rig Sloop

On a fractional rig sloop the forestay does not run to the top of the mast, rather it connects at some point below. This allows the top of the mast to be raked aft by increasing the tension of the backstay, while arching the middle of the mast forward. Without great explanation, this gives a performance advantage in some conditions by flattening the sails. The big mainsail provides most of the drive, and the small headsail is easier for a short-handed crew to manage.

• Cutters

A cutter is a small single-masted vessel, fore-and-aft rigged, with two or more headsails, a bowsprit, and a mast set further back than in a sloop. The cutter is similar to a sloop with a single mast and mainsail, but generally carries the mast further aft to allow for the use of two headsails attached to two forestays, the head stay and the inner stay, which carry the jib and staysail respectively.

Importantly, the traditional and most accurate definition of a true cutter, however, is not in the number of headsails, but rather that the outermost sails are set on stays that are not strictly structural to the rig itself. This in itself is a function of a much more complicated design set, involving mast placement, mast height, rig, boom length and fore-triangle size.

• Ketch

A ketch is a sailing craft with two masts: a main mast, and a shorter mizzen mast[1] abaft (rearward of) the main mast stepped forward of the rudder post. Both masts are rigged mainly fore-and-aft. From one to three jibs may be carried forward of the main mast when going to windward.[2]

• Yawl

A yawl is a two-masted sailing craft similar to a sloop or cutter but with an additional mizzen mast well aft of the main mast, often right on the transom. The yawl is often confused with the ketch, which also has two masts with the main mast foremost. The common view is that a ketch has the mizzen mast forward of the rudder post whereas the mizzen on a yawl is abaft of the rudder post. In practice, on a ketch the principal purpose of the mizzen mast is to help propel the vessel, while on a yawl it is mainly used for the purposes of trim and balance. The yawl was originally developed as a rig for commercial fishing boats.

• Schooner

The schooner sail plan has two or more masts with the forward mast being shorter or the same height as the rear masts. Most traditionally rigged schooners are gaff rigged,[3] sometimes carrying a square topsail on the foremast and occasionally, in addition, a square fore-course (together with the gaff foresail). Schooners carrying square sails are called square-topsail schooners. Modern schooners may be Marconi or Bermuda rigged.[4] The schooner may be distinguished from the ketch by the placement of the mainsail.

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[1] **Mizzen mast** - the third mast or the mast immediately aft of the main mast; typically shorter than the foremast.

[2] **Windward** is the direction from which the wind is blowing at the time in question. The side of a ship which is towards the windward is the **weather side**. If the vessel is heeling under the pressure of the wind, this will be the "higher side."

[3] **Gaff rig** is a sailing rig (configuration of sails) in which a sail is a four-cornered fore-and-aft rigged item controlled at its peak and, usually, its entire head by a spar (pole) called the *gaff*. The gaff enables a fore-and-aft sail to be four-sided, rather than triangular, and up to doubles the sail area that can be carried by that mast and boom (if a boom is used in the particular rig).

[4] **Bermuda rig** refers to a configuration of mast and rigging for a type of sailboat and is also known as a Marconi rig; this is the typical configuration for most modern sailboats. Developed in Bermuda in the seventeenth century, the term *Marconi* was a reference to the inventor of radio, Guglielmo Marconi, whose wireless masts the Bermuda rigs were said to resemble.

Physics of Sailing

Sailing Dynamics

The energy that drives a sailboat is harnessed by manipulating the relative movement of wind and water speed; if there is no difference in movement, such as on a calm day or when the wind and water current are moving in the same direction, there is no energy to be extracted and the sailboat will not be able to do anything but drift. Where there is a difference in motion, then there is energy to be extracted at the interface, and the sailboat does this by placing the sail(s) in the air and the hull(s) in the water.

• Aerodynamic Force

Sails are airfoils and work by using an airflow set up by the wind and motion of the boat. This is the apparent wind, which is the relative velocity of the wind relative to the sailboat's motion. They generate lift using the air that flows around them. The air flowing at the sail surface is not the true wind. The leading edge is the major lift-producing part of the sail. The sail alone is not sufficient to drive the boat in any desired direction, as a sail by itself would be able to push a boat only in the same direction as the wind.

• True Wind

True wind is the actual speed and direction of the wind when standing still. Once your vessel begins to move, the wind speed and direction have now changed from true to apparent wind.

There are a number of ways to determine the direction of true wind:

- Flags onshore will fly in the direction of the true wind.
- The Windex on a stationary sailboat will point in the direction from which the true wind is blowing.

• Apparent Wind

The wind that a sailboat experiences is the combination of the true wind (i.e., the wind relative to a stationary object) and the wind that occurs due to the forward motion of the boat. This combination is the apparent wind, which is the relative velocity of the wind relative to the sailboat.

When moving, the motion of the sailboat creates its own apparent wind. Apparent wind is what is experienced onboard and is the wind that the boat is actually sailing by. Sailing into the wind causes the apparent wind to be greater than the true wind and the direction of the apparent wind will be forward of the true wind. The apparent wind speed is what the anemometer on top of the mast indicates.

- **Wind Shifts**

  The wind never maintains a constant direction and will shift frequently. One method of detecting these shifts is to keep an eye on the surface of the water where you may see dark wrinkle patches indicating an increase in wind speed in the form of a gust or light grey glassy areas indicating a decrease in wind speed called a lull.

Hydrodynamic Force

Sailboats overcome being pushed by the wind sideways by having another physical object below the water line. These include a keel, centerboard, or some other form of underwater foil or even the hull itself. You can think of the physical portion of the boat which is below water as functioning as a "second sail." Having two surfaces against the wind and water enables the sailor to travel in almost any direction and to generate an additional source of lift from the water. The flow of water over the underwater hull portions creates a hydrodynamic force. A deep keel on a sailing vessel increases the resistance to lateral movement.

Combination of Forces

The combination of the aerodynamic force from the sails and the hydrodynamic force from the underwater hull section allows motion in almost any direction, except straight into the wind. This can be likened, in simple terms, to squeezing a wet bar of soap with two hands which causes it to shoot out in a direction perpendicular to both opposing forces.

Center of Lateral Resistance

The relationship of the aerodynamic center of pressure on the sails of a sailboat to the hydrodynamic center of lateral resistance on the hull determines the behavior of the sailboat in the wind. This behavior is known as the "helm" and is either a weather helm or lee helm. A slight amount of weather helm is thought by some sailors to be a desirable situation, both from the standpoint of the "feel" of the helm, and the tendency of the sailboat to head slightly to windward in stronger gusts, to some extent self-feathering the sails. Other sailors disagree and prefer a neutral helm.

The fundamental cause of helm, whether it be weather or lee, is the relationship of the center of pressure of the sail plan to the center of lateral resistance of the hull. If the center of pressure is astern of the center of lateral resistance—weather helm—the tendency of the vessel is to want to turn into the wind.

If the situation is reversed, with the center of pressure forward of the center of lateral resistance of the hull, a lee helm will result, which is generally considered undesirable, if not dangerous. Too much of either helm is not good, since it forces the helmsman to hold the rudder deflected to counter it, thus inducing extra drag beyond what a vessel with neutral or minimal helm would experience.

Trim

An important aspect of sailing is keeping the sailboat in "trim." A sailor needs to control not only the shape of the sail but also the hull's fore-and-aft attitude. A series of constant adjustments are necessary to maintain proper trim.

Sail Trim

Sail trimming is a large subject and a topic of much debate. Basic control of the mainsail consists of setting the sail so that it is at an optimum angle to the wind, (i.e. no flapping at the front, and telltales flowing evenly off the rear of the sail). Two or more sails are frequently combined to maximize the smooth flow of air. The sails are adjusted to create a smooth airflow over the sail surfaces. This is called the "slot effect." The combined sails fit into an imaginary aerofoil outline, so that the most forward sails are more in line with the wind, whereas the more aft sails are more in line with the course followed. The combined efficiency of this sail plan is greater than the sum of each sail used on its own.

An important safety aspect of sail trim is to adjust the amount of sail to suit the wind conditions. As the wind speed increases, the crew should progressively reduce the amount of sail. When experiencing heavy winds, you should reef sails to reduce the sail area exposed to the wind.

On a small sailboat with only a jib and mainsail, this is done by furling the jib and by partially lowering the mainsail, a process called "reefing the main." Reefing means reducing the area of a sail without actually changing it for a smaller sail.

Ideally, reefing results not only in a reduced sail area but also in a lower center of effort from the sails, reducing the heeling moment and keeping the sailboat more upright.

There are three common methods of reefing the mainsail:

- Slab reefing. This method involves lowering the sail by about one-quarter to one-third of its luff length and tightening the lower part of the sail using an outhaul or a pre-loaded reef line through a cringle[5] at the new clew, and hooking through a cringle at the new tack.
- In-mast (or on-mast) roller reefing. This method rolls the sail up around a vertical foil either inside a slot in the mast or affixed to the outside of the mast. It requires a mainsail with either no battens or newly developed vertical battens.
- In-boom roller reefing with a horizontal foil inside the boom. This method allows for standard- or full-length horizontal battens.

[5] A **cringle** is an eye through which to pass a rope. In nautical settings, the word refers to a small hole anywhere along the edge or in the corner of a sail, rimmed with stranded cordage and worked into the boltrope. Typically it encloses a metal grommet for reinforcement and to reduce wear. In this context, *cringle* and *grommet* coincide enough that the two are sometimes used interchangeably.

• Hull Trim

Hull trim is the adjustment of a sailboat's loading so as to change its fore-and-aft attitude in the water. On small sailboats, proper hull trim is maintained by positioning the crew. In larger sailboats, the weight of a person has less effect on the hull trim, but it can be adjusted by shifting gear, fuel, water, or supplies.

Different hull trim efforts are required for different kinds of sailboats and different conditions. In heavy winds, a sailboat with its bow too low may capsize by pitching forward over its bow (pitch-pole) or dive under the waves (submarine). On a run in heavy winds, the forces on the sails tend to drive a sailboat's bow down, so the crew weight is moved far aft.

When a sailboat rolls over to one side under wind pressure, it's called "heeling." As a sailboat heels over beyond a certain angle, it begins to sail less efficiently.

Several forces can counteract this movement:

- The buoyancy of that part of the hull that is being submerged tends to bring the sailboat upright.
- A weighted keel, which can, in larger sailboats, be canted from side to side, provides additional force to right the sailboat.
- The underwater shape of the hull relative to the sails can be designed to make the sailboat tend to turn upwind when it heels excessively. This reduces the force on the sails and allows the sailing vessel to right itself. This is known as rounding up.

Points of Sailing

Points of Sailing

The angle between a sailboat's heading and true wind is referred to as points of sailing. The points of sailing can be broken down into three main categories—running, reaching and sailing upwind. There are various sub-categories within the main points of sail—close haul, close reach, beam reach, and broad reach.

• Running

Sailing the boat within roughly 30 degrees either side of dead downwind is called a run. This is the easiest point of sail in terms of comfort, but it can also be the most dangerous.

Severe rolling and yawing are more likely when running as there is less resistance provided by the sails. A loss of attention by the helmsman could lead the sailboat to jibe accidentally, causing injury to the boat or crew. (A preventer can be rigged to prevent damage from an accidental jibe.) If there is a sudden increase in wind strength, the sailboat can round up very suddenly and heel excessively (this is called broaching).

When sailing with the wind aft, a vessel may carry sails on both sides at the same time. While sails are carried in such a manner, you are said to be sailing wing on wing.

• Reaching

When the sailboat is traveling approximately perpendicular to the wind, it is called reaching. A "reaching course" is one which the wind comes over an area extending from broad on the bow to the quarter. A "close reach" is halfway between beating and a beam reach, and a "broad reach" is a little bit away from the wind (a "beam reach" is with the wind precisely at right angles to the sailboat).

For most sailboats, reaching is the fastest way to travel because it will maximize the lift generated on the sails in the forward direction of the boat, giving the best sailboat speed. Also, when reaching, the sailboat can be steered exactly in the direction that is most desirable, and the sails can be trimmed for that direction.

Reaching may put the sailboat on a parallel course with the waves, however. When the waves are steep, it may be necessary to sail closer to the wind to avoid waves directly on the beam.

• Sailing Upwind

A basic rule of sailing is that it is not possible to sail directly into the wind—at least not for long. Generally speaking, a sailboat can sail 45 degrees off the wind. When a sailboat is sailing this close to the wind, it is close-hauled or beating (beating to weather).

Since a sailboat cannot sail directly into the wind, but the destination is often upwind, one can get there only by sailing close-hauled with the wind coming from the port side (the sailboat is on port tack), then tacking (turning the sailboat through the eye of the wind) and sailing with the wind coming from the starboard side (the sailboat is on starboard tack).

Using this method, it is possible to reach that destination directly upwind. The heavier the wind, the rougher the seas, thus sailboat movement can be more uncomfortable. This can feel like the boat is beating its hull into the waves, hence the term beating.

For a yacht beating upwind to a mark at a distance upwind of one mile, it will cover a distance through the water of over 1.42 miles, if it can tack through an angle of 90 degrees. An old adage describes beating as sailing for twice the distance at half the speed and three times the discomfort. How closely a boat can sail into the wind depends on the sailboat's design, sail trim, the sea state, and the wind speed. You can slow or stop a sailing vessel by bringing the vessel's head into the wind and let the sails luff.

• Close Haul

A boat is sailing close-hauled when its sails are trimmed in tightly and it is sailing as close to the wind as it can. This point of sail lets the sailboat travel diagonally upwind. This is a precise point of sail. However, the exact angle relative to the wind direction varies from boat to boat. A sailboat is considered to be "pinching" if the helmsman tries to sail above an efficient close-hauled course and the sails begin to luff slightly. If the thrust on a sail becomes excessive when close-hauled, it is likely to capsize the vessel rather than drive it.

As a vessel falls off the wind from a close-hauled to a beam reach, the tendency for the vessel to move sideways through the water will decrease.

• Close Reach

This is any upwind angle between close-hauled and a beam reach where the wind is coming over the forward part of the boat and sails are slightly eased. In order to maintain speed while changing from a close reach to a broad reach, the sails should be eased out.

If you are sailing on a close reach when a strong wind suddenly heels the vessel hard over, you should ease the mainsheet and bear more away from the wind to reduce heeling and maintain speed.

- **Beam Reach**

  This is a course steered at right angles to the wind. This is a precise point of sail. Sails are put out at roughly 45 degrees. If the sails are properly set and trimmed as the vessel heads up from a beam reach to close-hauled, the apparent wind moves forward, healing moment increases and speed decreases.

- **Broad Reach**

  The wind is coming from behind the sailboat at an angle. This represents a range of wind angles between beam reach and running downwind. The sails are eased out away from the boat, but not as much as on a run or dead run (downwind run).

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Sailing Maneuvers

Tacking

Tacking (or coming about), one of the basic turning techniques, requires bringing the bow of the boat through the wind so that the wind then comes across the opposite side of the sailboat, and the boat sails away on the opposite tack. Tacking is essential when sailing upwind. The sails, when properly adjusted, will generate aerodynamic lift. When the wind comes over your starboard side, you are considered to be on a starboard tack, and when it comes over the port side of the vessel, you are on a port tack.

To get the best speed when tacking and using a mainsail and jib, the sails should be trimmed such that an air slot is formed between the two sails.

Jibing

Changing direction by bringing the stern of the vessel through the eye of the wind is known as jibing. Jibing or gybing is the turning maneuver in which the sailboat heads down past the point where the wind crosses the vessel's stern, which causes the sails and boom to swing to the opposite side before the boat sails off on the opposite tack.

A jibe can be a dangerous operation in a fore-and-aft rigged sailboat because, as the direction of the wind crosses the sailboats centerline, the "old" leeward side of the mainsail and boom suddenly becomes the new windward side, and the sails are always fully exposed to the wind. Load on the sail and mainsheet can remain high throughout the maneuver, and, if uncontrolled, the boom and mainsail can swing across the deck with great force, injuring anyone standing in the path of the boom, the mainsheet, or its tackle as they sweep across the sailboat. An uncontrolled boom slamming to the limit of its range may also put excessive stress on the rigging and can break the boom or standing rigging, perhaps even bringing the mast down.

A jibe can also result in a sudden change in the direction of heeling, which can cause unwary passengers or crew to lose their balance or even go overboard. On a larger sailboat a preventer[6] can be used during the turn to limit the range of movement of the boom.

It is usually safer to sail nearly directly downwind briefly before and after the jibe and make a small boat direction change so that there is less heeling force on the boat during the jibe. Then, you can continue a course change to higher points of sail (broad or beam reach) after the jibe is complete. Once on the new course, the mainsheet is used to ease and/or trim the mainsail. These techniques prevent the boom from swinging unexpectedly. Accidental jibes may occur when sailing on a course that is running dead downwind if the wind catches the leeward side of the sail.

Heading up

Heading up means steering so the wind is closer to coming from directly in front or "on the bow." Heading closer to the wind requires trimming the sails (pulling them toward the vessel's center). Heading up so the wind is nearly or directly ahead causes sails to luff (to flutter without achieving lift). If the sailboat loses maneuverability because of this, it is said to be "in irons."

[6] A **preventer** is a mechanical device on a sailing vessel that limits the boom's ability to swing dangerously across the boat during an accidental jibe. The preventer with the most mechanical advantage is a line, from the end of the boom, led outside of the shrouds and a long way forward—perhaps right up to the bow—through a block, back to the cockpit, and secured within the reach of the mainsheet.

Falling Off

Heading down, bearing away, or falling off mean steering so the wind comes from closer to the vessel's aft. This requires easing sails, or letting them out away from the vessel's center.

Rounding Up

Rounding up is a phenomenon that occurs in sailing when the helmsman or tiller-handler is no longer able to control the direction of the boat, and it heads up (or "rounds up") into the wind, causing the sailboat to slow down or stall out. This occurs when the wind overpowers the ability of the rudder to maintain a straight course. For example, the sailboat may heel over so far that the rudder no longer engages in the water, or only to such a small extent that it can no longer steer the sailboat. When this happens is dependent on a number of factors, such as the velocity of the wind, design of the sailboat hull and rudder, and shape of the sails.

While not usually dangerous, the occurrence of rounding up can be startling to the skipper or helmsman of the boat. The sailboat turns into the eye of the wind with all sails fluttering. Rounding up is a safety design of most sailboats that can help prevent a knockdown and allow the helmsman to regain control of the boat. An occasional round up may simply be the result of a strong gust of wind. If it occurs regularly, this may be a sign that too much sail is raised, and the crew may need to lower one or more sails, change to smaller sails, or reef in the mainsail.

Broach

A sailboat broaches when its heading suddenly changes toward the wind due to wind/sail interactions for which hull hydrodynamic reactions cannot compensate. This happens when the aerodynamic force on the rig greatly exceeds the hydrodynamic force on the hull, usually due to a sudden increase in wind strength. Sailing in variable, gusty winds is a common cause of broaching when sailing on a close reach and in strong gusty winds on a broad reach.

When sailing on a broad reach, the helmsman must be careful to make sure that the wind is not allowed to cross the stern. If this happens, then the sails may fill from the leeward side, resulting in a sudden reversal of the direction of thrust as the sail moves from one side of the sailboat to the other. This is called a jibe, and it can be a dangerous maneuver even when performed under controlled circumstances. When it happens unexpectedly, the boom may live up to its name, as it crosses the sailboat under full load and may sweep unwary crew members overboard, unless a preventer is rigged on the boom.

Another cause of broaching is encountered in heavy seas and high winds. If the bow of the sailboat is not kept pointed into the waves, then the waves will push the bow aside, turning the boat side-on to the waves. Once side-on to the waves, the waves will roll the yacht side to side violently, causing severe discomfort to the crew, and the boat may broach and may even capsize.

Heaving To

Heaving to (also heave-to) is a way of slowing the boat's forward progress, fixing the helm and foresail position so that the boat doesn't have to be actively steered, thereby allowing the crew to attend other tasks. It is commonly used for a "break" while waiting out a storm, or by the solo sailor as a way to provide time to go below deck or attend to issues elsewhere on the boat.

Safety Equipment

Sailing Safety

Sailing requires respect for the risks of being on the water. All sailors, therefore, should be sensibly prepared. Every state has certain minimum regulations that must be met as to equipment.

When engaged in publicly organized activities, you may be required to take additional precautions as detailed by the authority that regulates the training or racing.

Safety measures may include:

- Having appropriate floatation aids, including life preservers onboard
- Having appropriate first-aid and firefighting equipment
- Carrying a knife suitable for cutting rigging or netting in an emergency
- Installing jacklines and having the crew wear harnesses connected to them, to secure the crew to the vessel
- Ensuring visibility by using the required running lights and mounting at least one radar reflector

Personal Flotation Devices

Personal flotation device (PFD) is a general name for various devices designed to keep a person 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.

• Type I PFD

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. The PFD must be international orange in color.

A Type I 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. Its buoyancy will allow the wearer to relax and save energy while in the water, thus extending survival time.

There are three major disadvantages to this type of PFD:

- It is bulky and restricts movement.
- Its buoyancy restricts underwater swimming needed to escape from a capsized boat or to avoid burning oil or other hazards on the surface of the water.
- It provides minimal protection against hypothermia.

• Type II PFD

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

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.

The capability of a Type II PFD to turn an unconscious wearer to a face-up position is not as strong as with a Type I because of the Type II's lesser amount of flotation material.

• Type III PFD

The Type III PFD, also known as a "flotation aid," is routinely worn aboard boats when freedom of movement is required and the risk of falling over the side is minimal. It is not designed to turn an unconscious wearer to a face-up position; the design is such that conscious wearers can place themselves in a vertical or slightly backward position. It has a minimum of 15.5 pounds of buoyancy and comes in many sizes and colors. Most approved flotation coats ("float coats") are also Type III PFDs.

The Type III PFD allows greater wearing comfort and is particularly useful when waterskiing, sailing, hunting from a boat, or other water activities.

Some disadvantages to the Type III PFD include:

- 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 posture 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 turning capability.

- **Type IV PFD**

  The Type IV PFD is a Coast Guard approved device thrown to a person in the water and grasped by that person 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.

  An advantage of the Type IV PFD is that, because it is not worn like other PFDs, there are no size restrictions. This type of PFD can be stored on deck for easy deployment should someone fall overboard. The Type IV PFD also acts as a marker, assisting in returning to the area where the person originally fell overboard. A disadvantage 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**

  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 be acceptable only during commercial rafting. It is not acceptable for other activities unless specified on the label. Some Type V devices provide significant hypothermia protection. The Type V inflatable PFD offers greater comfort and maneuverability compared to the typical Type III vest. Lightweight and not as bulky, the Type V inflatable is especially beneficial in warmer climates. When inflated, the Type V provides more buoyancy as well as the positive righting feature found in a Type II PFD. The initial purchase price and preventive maintenance costs of the Type V inflatable are greater than that of the typical Type III vest. It also requires more frequent and complicated preventive maintenance. As with any other automated feature, if the autoinflate mechanism were inoperative, the PFD would have to be manually inflated. This could be a problem if a crewmember were knocked unconscious while falling overboard.

PFD Storage and Care

Despite the mildew-inhibitor treatment required by manufacturers of PFDs, stowing them in moist locations will increase deterioration of the fabric. Heat, moisture, and sunlight will also speed the deterioration of parts of PFDs. PFDs should be stored 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. 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. If a PFD requires cleaning, it should be washed in fresh, warm water with a mild detergent, and then rinsed in clean, fresh water.

Retroreflective Material (46 CFR 25.25-15)

Retroreflective material reflects in the opposite direction of a beam of light that hits it. Since 1980, the Coast Guard has required retroreflective material to be attached to all life jackets used on commercial vessels. Each life jacket must have 31 square inches of retroreflective material attached on the front and back. The retroreflective material attached on each side must be divided equally between the upper quadrants of the side, and the material in each quadrant must be attached as closely as possible to the shoulder area of the jacket.

Life Jacket Lights (46 CFR 180.75)

A life jacket light is a small light source designed for the personal use of the person wearing the life jacket. Some models act as strobe lights that activate once submersed in water (specifications for life jacket lights appear in 46 CFR 161.012). Life jacket lights are required on vessels in ocean, coast, or Great Lakes service (46 CFR 180.75(b)). When a life jacket light is required, it must be securely attached at the front area of the shoulder. The Master is required to ensure that each life jacket light that has a nonreplaceable power source is replaced on or before its expiration date (46 CFR 185.726 (d)(e)).

Immersion Suits

The immersion suit is a one-piece international orange garment constructed of nylon-lined neoprene or polyvinyl chloride foam. Prior to abandonment, the suit allows body movement such as walking, climbing a ladder, and picking up small objects. It is also equipped with an inflatable pillow to help keep the wearer's head out of the water. The suit has a built-in hood, boots, and gloves.

The immersion suit is used when extended exposure to the elements is expected. It is the recommended PFD when abandoning ship. Even if boarding the life raft directly from the ship is possible, the immersion suit should still be worn. It is not to be used as a working outfit because of the wearer's limited dexterity when wearing the suit.

The suit must, without assistance, turn an unconscious person's mouth clear of the water within 5 seconds (46 CFR 160.171-9). An immersion suit must be equipped with a whistle, light, and reflective material (46 CFR 160.171-9(h). Containers used for storing immersion suits may not be locked (46 CFR 199.70(c)).

Tests done by the U.S. Navy indicate that a person can expect to survive 13 hours or more in water temperatures of 35° F when wearing an immersion suit over normal clothing. By comparison, normal survival for a victim not wearing an immersion suit in 35° F water is usually less than 30 minutes.

Installed Inflatable Liferafts

An inflatable liferaft is stowed in a capsule. Although closed by a rubber gasket, this capsule generally is not watertight. Condensation and water that leaks in must be drained through a drain hole in the lower half of the capsule's shell.

Metal bands that are designed to break and pop off when the painter line is jerked and the liferaft is inflated hold the capsule together. A hydrostatic release mechanism automatically allows lifesaving devices to float off sinking vessels. It is activated by water pressure at a predetermined depth.

All USCG approved liferafts have a 100-foot combination painter and operation cord line. The operation cord is attached to a strong point aboard ship by a "float-free link" (weak link). The purpose is to release the lifesaving equipment from a vessel that is sinking in deep water. Each link is designed to break by the buoyant force exerted by a liferaft so this equipment can break free from a vessel that sinks in water deeper than the length of its painter. If the ship sinks, the link will break and the raft will float free. The buoyancy of the packed raft will put enough tension on the painter to pull all 100 feet out of the container and then trigger inflation.

Emergency Position Indicating Radiobeacons

Emergency Position Indicating Radio Beacons (EPIRBs) are small transmitters that send out emergency signals to rescue services. Owner registration allows automatic distressed vessel identification. Their use is limited to Mayday-type emergencies where a vessel is in danger of sinking or there is a medical emergency and all other means of rescue have been exhausted.

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.

Different 406-MHz EPIRB models exist, so the device should be tested routinely by following manufacturer instructions printed on the beacon.

Requirements for Carrying Flares and Smoke Signals

Uninspected Vessels (33 CFR 175.139)

- Day: 3 floating orange smoke, or 3 handheld orange smoke, or 1 orange with a black square and circle.
- Day and Night: 3 rocket parachute red flares, or 3 aerial pyrotechnic red flares, or 3 handheld red flares.

Inspected Vessels – Lakes, Bays, Sounds, and Rivers (46 CFR 180.68 (b))

- Day: 3 handheld orange smoke and 3 handheld red flares, or 3 rocket parachute red flares.
- Night: 3 handheld red flares, or 3 rocket parachute red flares.

Inspected Vessels – Oceans and Coastwise (46 CFR 180.68(a))

- Day: 6 handheld orange smoke and 6 handheld red flares, or 6 pocket parachute red flares.
- Night: 6 rocket parachute red flares.

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Person in the Water Recovery

Man Overboard

All crewmembers must be prepared when someone falls overboard. Rehearsing how to react is vital to a successful and safe recovery of the individual. When someone falls overboard, crewmembers should always assume the worst has happened. The person could be suffering from shock, may be unconscious, and possibly injured. Rapid recovery of the person is a must.

“MAN OVERBOARD!” is one of the worst alarms to hear while underway. Even the best swimmers can become disoriented when unexpectedly falling into the water. Prolonged exposure to rough seas or cold weather can quickly weaken a swimmer.

The information here is a general guideline. Actual situations will vary and all details are beyond the scope of this publication. A professional understands and rehearses each possibility remembering that the key to a successful rescue is preparation, practice, and alertness.

General Man Overboard Procedures

The action taken in the first few seconds after a person falls overboard determines the success of the recovery. An alert crew can do much to save the life of someone who might otherwise drown. First actions should be swift and certain.

The first thing every crewmember needs to learn about recovering a person in the water (PIW) is how to prevent it in the first place.

It is everyone's responsibility to protect themselves and their fellow crew from falling overboard. Some things to pay particular attention to are:

- Ensure that lifelines are up and in good condition.
- Keep decks clear of trip/slip hazards.
- Repair/replace cracked or damaged stanchions.
- Ensure that two persons are involved when conducting an evolution that might result in falling overboard (anchoring, towing, etc.).

If a person enters the water, the first crewmember to realize that someone has fallen overboard should follow these procedures:

1. Spread the alarm in a loud voice by repeatedly calling out, "MAN OVERBOARD!" It is also very important to shout out the location where the person fell overboard (port/starboard side, the bow, the stern). For example, if the person fell over the port side, the alarm should be, "MAN OVERBOARD, PORT SIDE!"
2. Throw a ring buoy with strobe light (or anything that floats) over the side as quickly as possible. It does not necessarily have to be thrown towards PIW, just get it in the water as soon as possible.
3. Maintain sight of and continuously point (open handed) to the individual in the water while carefully moving to a position in sight of the helmsman or operator. Give clear, loud verbal directions as well as the condition of the PIW (conscious/unconscious, injured, etc.) to the helmsman.

Once the alarm has been sounded, the person at the helm has several tasks to complete in order to successfully recover the PIW. Though a quick recovery is preferred, at times it is better to slow down, assess the situation, and ensure that everything is done properly the first time. Not every MOB/PIW recovery is the same. It is always better to make a correct approach slowly and recover the person on the first attempt rather than an incorrect fast approach resulting in the need for a second try.

There is no single correct order in which the steps below should be executed. Everything depends on the situation at hand. Starting a turn to maneuver back to the PIW is a common first step, but if boat traffic in the area is heavy, turning the vessel might endanger others. Each task is important in its own way and needs to be conducted to ensure a successful recovery.

Maneuvering Boat to Recover PIW

If someone falls overboard, the sailboat may have to be maneuvered for a pickup. In many cases, it starts by turning in the same direction as the person who fell overboard. Turning towards the same side as the person overboard will "kick" the stern away preventing the propellers (if engaged) from injuring the PIW. If the person falls off the bow, the turn should be in either direction to kick the stern clear.

Mark Position

An important step in the MOB recovery evolution is to mark the sailboat's position by pressing the "Memory" or "Man Overboard" button on the GPS receiver (if so equipped) to mark the exact position (datum) of the distress electronically. This will give a position to return to if unable to locate the PIW and the search must be started. All possible means must be used to identify the position (dead reckoning, visual landmarks, radar, etc.) if the vessel is not equipped with a GPS receiver.

The helmsman should ensure a marker pole or ring buoy with strobe light and sea anchor attached (or anything that floats) is thrown over the side as quickly as possible. The longer it takes to get the ring buoy into the water, the greater the distance will be from the point the person fell overboard. It does not matter if the person is visible at this time or not. The PIW may see the flotation device and be able to get to it. Additionally, the ring buoy or any floating object thrown over the side (if a ring buoy is not available) serves as a reference point (datum) marking the general location of the incident and for maneuvering the sailboat during the search. Do not throw the floatable object(s) at the person overboard. It could cause further injury if it hits the individual.

PAN-PAN Broadcasts

If the person overboard has not been located and immediately recovered, and assistance from other boats is needed, the emergency call signal Pan (pronounced *pahn*) should be transmitted in sets of two for three sets (PAN-PAN…PAN-PAN… PAN-PAN…) on channel 16 or 2182 kHz. This should be followed with the boat's identification, position, and a brief description of the situation. "Mayday" should not be used. A boat uses a Mayday call only when threatened by grave and imminent danger.

Sounding five or more short blasts on the sound signal, horn, or whistle alerts boats in the immediate area that a danger exists (i.e., a MOB is occurring). Vessels in the vicinity may not be aware of what the signal means but at least they will realize something unusual is happening.

The Approach

The helmsman must select an approach suitable for existing conditions. There are two basic approaches:

- A leeward approach (against the wind and current)
- A windward approach (with the wind and current)

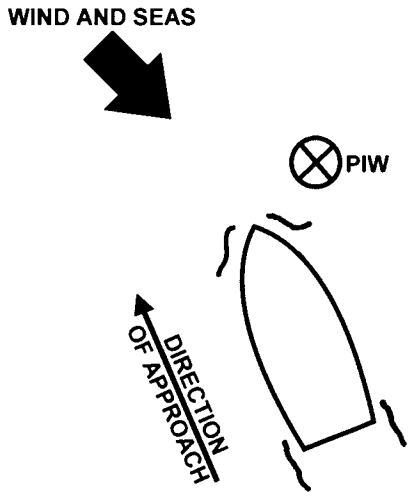
For the purpose of the two approaches, the assumption that your vessel's sails have been properly stowed and that you are operating under auxiliary power has been made.

• Leeward Approach

The leeward approach is performed with the bow facing into the greatest force of oncoming resistance at the time of pickup. This may be the wind, current, seas, or any combination of the three. There are times when the wind and current are from different directions.

The following procedures should be used with a leeward approach:

1. Select the heading that will best ease the approach, and balance the effect of any swell that might be present.
2. Make the approach rapidly, but as the sailboat nears the person, reduce wake and slow the sailboat enough to stop headway with a short backing down burst. The PIW should be next to the recovery area and the sailboat should be dead in the water.
3. Place the engines in *neutral* and, when the person overboard is alongside, have the crew make the recovery.
4. For better control during the approach, try to make all pickups with your sailboat heading into the prevailing weather and sea conditions.
5. Take care not to overrun the person overboard or to have so much headway on that the sailboat drifts beyond the person overboard.
6. If the PIW does drift aft of the sailboat, do not back down to make the recovery. The propeller could injure the person. The best course of action, should the boat overshoot the PIW, is to swing around and make another approach. It is best to make one correct approach slowly than several attempts quickly.

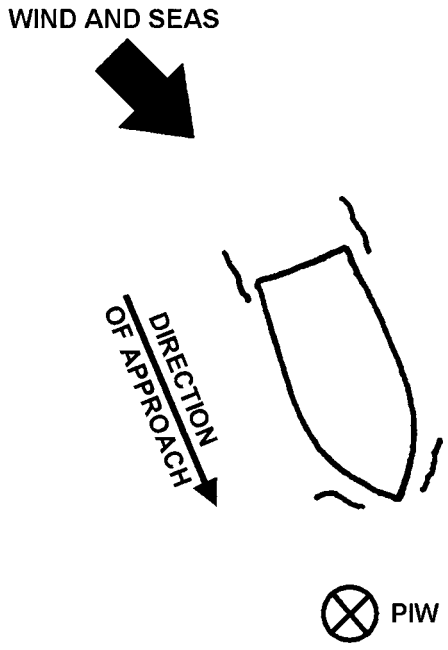


Leeward Approach

• Windward Approach

The windward approach is performed with the wind coming from behind the sailboat, when the person overboard is in a confined space, and a leeward approach is impossible. The following procedures should be used for a windward approach:

1. The operator must maneuver into a position upwind and upcurrent from the person overboard.
2. Place the engine in neutral.
3. Drift down to the person.
4. Ensure that the sailboat drifts so it places the person overboard along the "recovery" side, but do not allow the boat to drift over the person.



Windward Approach

Stopping Immediately

There may be instances when stopping the sailboat and allowing the person overboard to swim back to the sailboat, or at least to reach the tethered floating object, is the most appropriate action. This is effective especially if the sailboat can be stopped quickly after the person falls overboard. The helmsman should always ensure that propellers are not engaged anytime someone is in the water near the stern of the vessel.

Stop, Pivot, Return

Another option, particularly in a restricted waterway, is to stop, pivot/back and fill, then return to the PIW. The turning and backing characteristics of the sailboat and the prevailing wind and sea conditions will dictate how the approach is made. The helmsman will maneuver the boat to the weather side of the PIW so that the sailboat is set by the wind or seas toward the person rather than away from.

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