Chapter 10: Boat Handling

Overview

Introduction

This chapter covers handling vessels under power. Vessels under sail and personal watercraft are not addressed. Topics include:

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

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 best coxswains

Though good coxswains are familiar with the characteristics of their boat and how it operates, the best coxswains are knowledgeable in the operation of all types of small craft, including sailboats and personal watercraft. They know how varying weather and sea conditions affect the operation of not just their vessel, but are also keenly aware of the limitations that 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 coxswains understand how to mesh the capabilities of their vessel to weather and sea conditions to conduct the safest possible boat operations.

In this chapter

This chapter contains the following information:

Section A.   Forces

Overview

Introduction

Different forces act on a vessel's hull, causing it to move in a particular direction or to change direction. These forces include environmental forces, propulsion, and steering.

In this section

This section contains the following information:

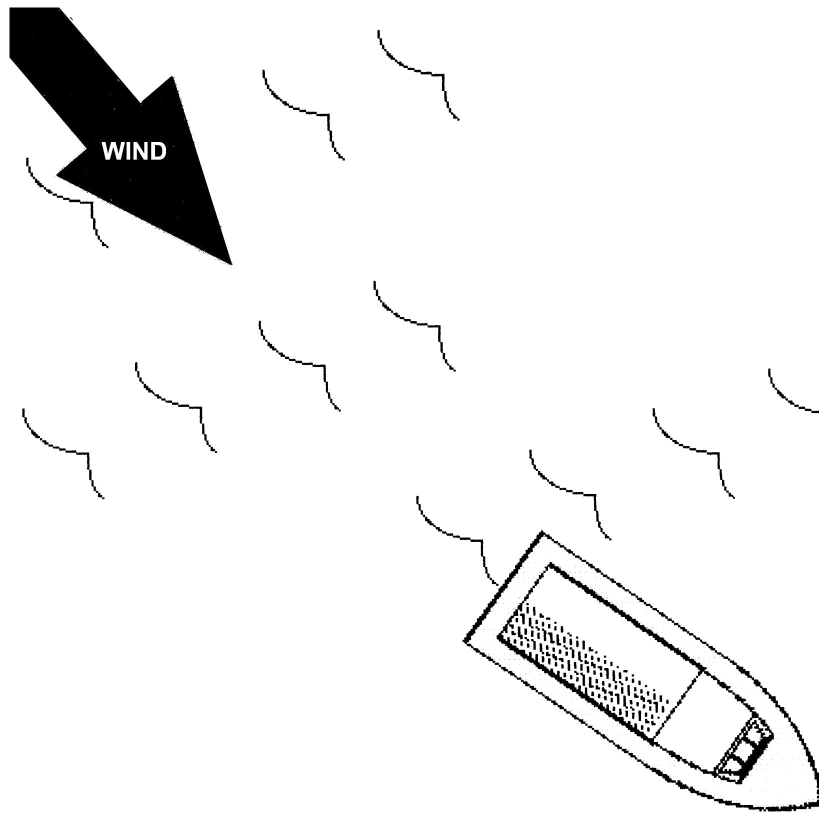
Environmental Forces

A.1. General

Environmental forces that affect the horizontal motion of a vessel are wind, seas and current. Remember that the coxswain 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. Coxswains 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.

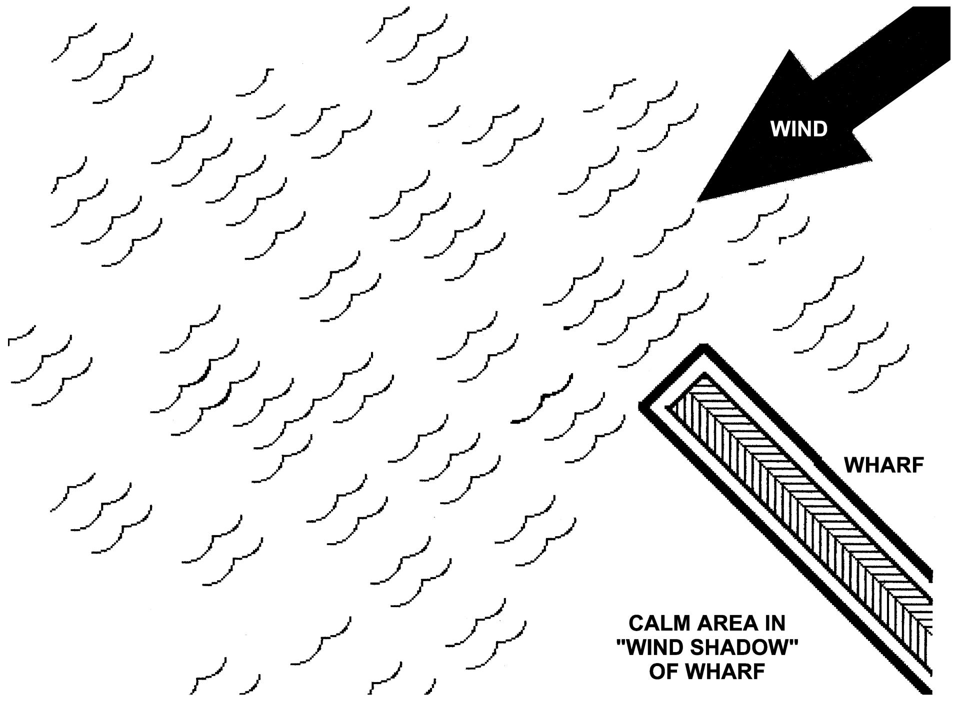
A.2. Winds

The wind acts on the hull topsides, superstructure, and on smaller boats, crew. 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 (Figure 10-1) 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.



High Cabin Near Bow, Low Freeboard Aft
Figure 10-1

A.2.a. 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 (Figure 10-2). Account for the change in wind by planning maneuvers with this wind shadow in mind.



Wind Shadow
Figure 10-2

A.3. Seas

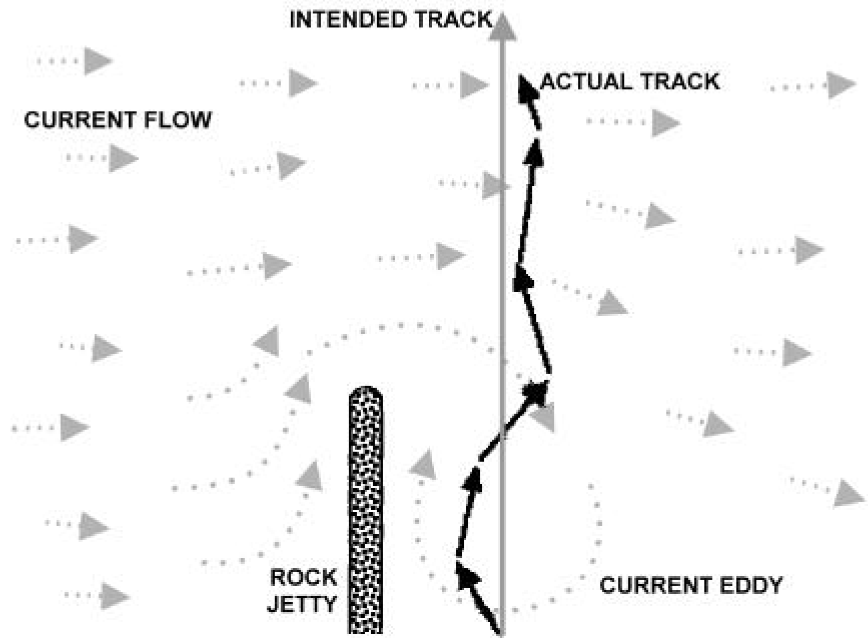
Seas are a product of the wind acting on the surface of the water. Seas affect boat handling in various ways, depending on their height and direction and the particular vessel's characteristics. Vessels that readily react to wave motion, particularly pitching, will often expose part of the underwater 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.

A.4. Current

Current will act on a vessel's underwater hull. Though wind will cause a vessel to make leeway through the water current will 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 10-3). 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 10-3

A.5. 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.

A.5.a. Know the vessel's response

NOTE ✍

> Stay constantly aware of conditions, how they may be changing, and how they affect your vessel.

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 coxswain.

On the other hand, making leeway while drifting downstream (down current) requires a change in approach to prevent overshooting your landing.

Forces Acting on a Vessel

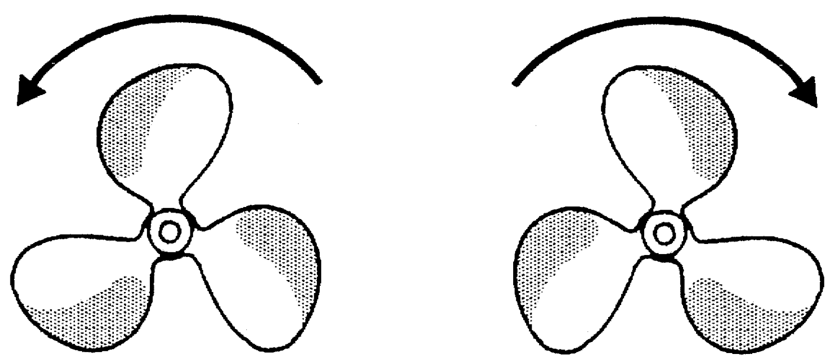
A.6. General

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

A.7. 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). See Figure 10-4.
- Be aware that some propeller drive units rotate in only one direction, and changing the propeller blade angle of attack controls ahead or astern thrust (controllable pitch propeller).

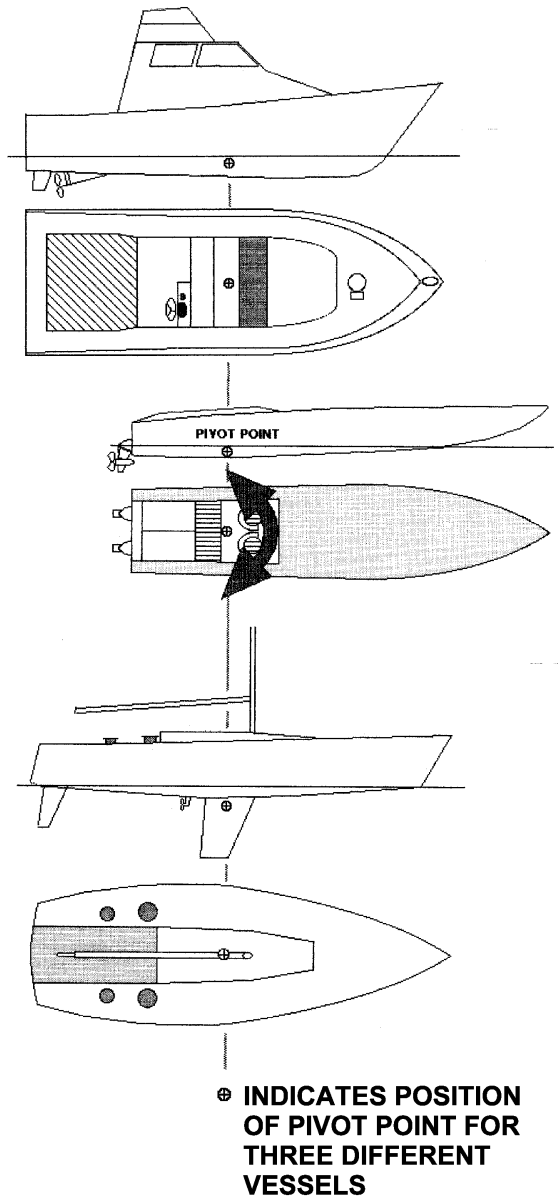


Viewed from astern, turning for propulsion to go ahead. Propeller on right (starboard shaft) turns clockwise and is called a right-handed propeller. When backing, rotation is opposite.

Propellers
Figure 10-4

A.8. 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 10-5

NOTE

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 10-5). 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.

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, or
- By an engine-driven pump mechanism with directional control, called a waterjet.

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.

Shaft, Propeller, and Rudder

A.9. 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.

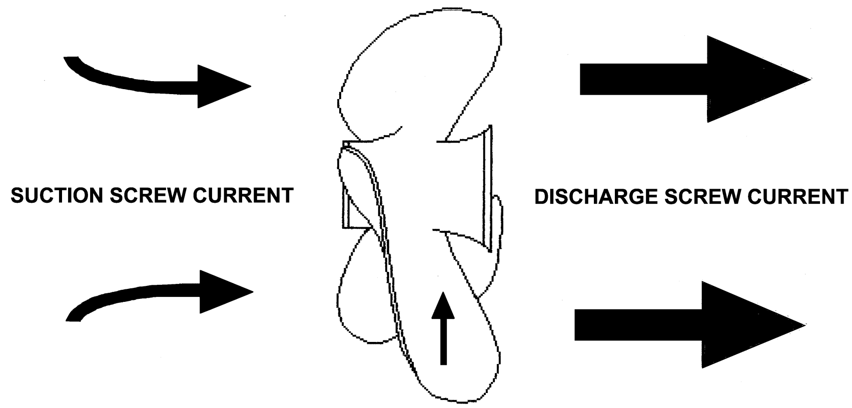
For twin-screw vessels, we will only consider the case where both shafts are parallel to the vessel's centerline (or nearly so), rudders are mounted astern of the propellers, and the rudders turn on vertical rudder posts.

A.10. 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.

A.10.a. Screw current

Regardless of whether the propeller is turning to go ahead or astern, the water flow pattern into the propeller's arc of rotation is **called suction screw current**, and the thrust flow pattern out of the propeller is called **discharge screw current** (Figure 10-6). The discharge screw current will always be stronger and more concentrated than the suction screw current.



PROPELLER IS VIEWED FROM PORT SIDE WITH NEAREST BLADE ROTATING UPWARD (RIGHT-HANDED)

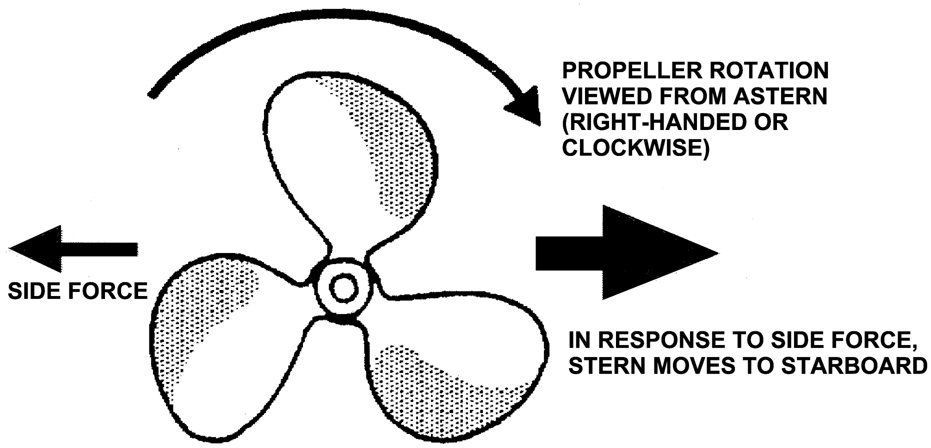
Screw Current
Figure 10-6

A.10.b. Side force

In addition to the thrust along the shaft axis, another effect of propeller rotation is **side force**. Explanations for side force include:

- How the propeller reacts to interference from the vessel hull as the hull drags a layer of water along with it (the propeller encounters boundary layer “frictional wake”),
- How the discharge screw current acts on the rudder,
- The propeller blade at the top of the arc transfers some energy to the water surface (prop wash) or to the hull (noise) and that the blade at the top of the arc either entrains air or encounters aerated water, and

Due to the angle of the propeller shaft, the effective pitch angle is different for ascending and descending propeller blades, resulting in an unequal blade thrust. (The descending blade has a higher effective pitch angle and causes more thrust.) This net effect is sometimes referred to as sideways blade pressure.



Side Force
Figure 10-7

NOTE ☞

The important facts to know: for a right-handed screw turning ahead, the stern will tend to move to starboard (Figure 10-7), 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.

A.10.c. Cavitation

Cavitation usually occurs when the propeller rotates at very high speed and a partial vacuum forms air bubbles at the tips of the propeller blades. Cavitation can also occur when trying to get a stopped propeller to spin at maximum speed, rapidly going from ahead to astern (or vice-versa), or by operating in aerated water where bubbles are dragged into the propeller flow.

Cavitation occurs more readily when trying to back, as the suction screw current draws water from behind the transom, and air at the waterline mixes with the water and is drawn into the propeller. Cavitation frequently occurs when backing with outboard motors. In this case, through-hub exhaust gas bubbles are also drawn forward into the propeller blade arc.

NOTE ✍

> A small degree of cavitation is normal. For our purposes, we will use the term to cover the situation where effective thrust is lost and the propeller just spins and makes bubbles. Cavitation can diminish propeller efficiency to this point. Once cavitation occurs, the easiest way to regain thrust is to reduce propeller revolutions per minute (RPMs) and as the bubbles subside, gradually increase RPMs. Propeller cavitation can occur on vessels of all sizes.

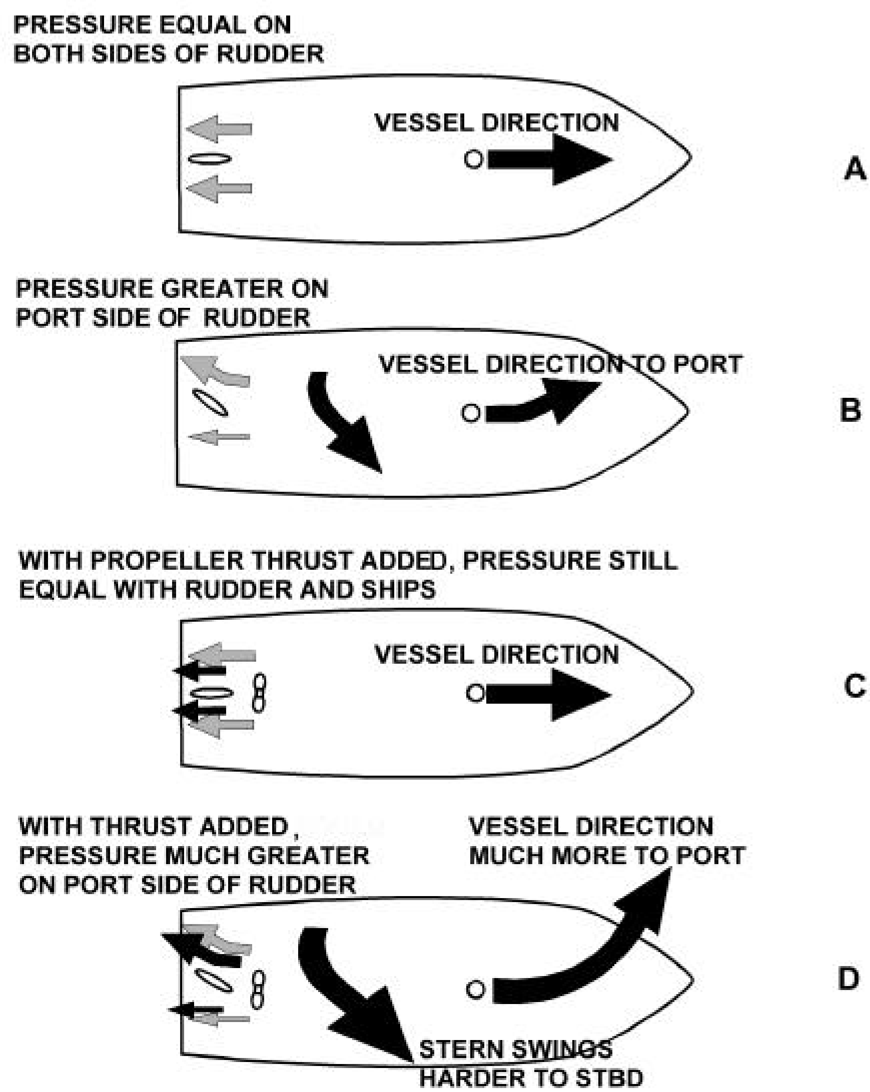
A.11. Rudder action

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 10-8 (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 10-8 (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 10-8

Outboard Motors and Stern Drives

A.12. 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 difference between these drive arrangements and the shaft/propeller/rudder arrangement is that the screw currents and thrust from an outboard or stern drive can be developed at an angle to the vessel centerline. 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 coxswain some amount of trim control. Trim control adjusts the propeller axis angle with the horizontal or surface of the water.

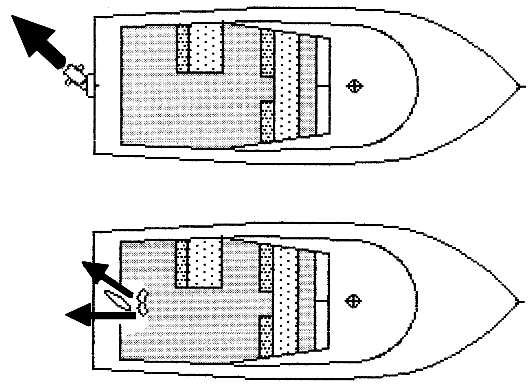
The major difference in operation between the I/O and outboard is that the outboard motor, operating with a vertical crankshaft and driveshaft, develops a certain degree of rotational torque that could cause some degree of “pull” in the steering, usually when accelerating or in a sharp turn to starboard.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

A.13. Thrust and directional control

Outboards and stern drives have a small steering vane or skeg below the propeller. The housing above the gearcase (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 10-9). 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.

NOTE

> The propeller forces discussed above in section A.8. (screw current and side force) also apply to the propellers on outboards or outdrives. 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 force.

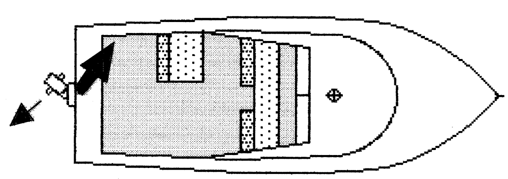


The outboard or outdrive (top) directs all the thrust in the direction the helm is turned where the inboard with separate propeller and rudder (bottom) directs only 60-70% of the thrust to the side.

Lower Unit/Outdrive Directed Thrust
Figure 10-9

A.14. 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 10-10), 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.

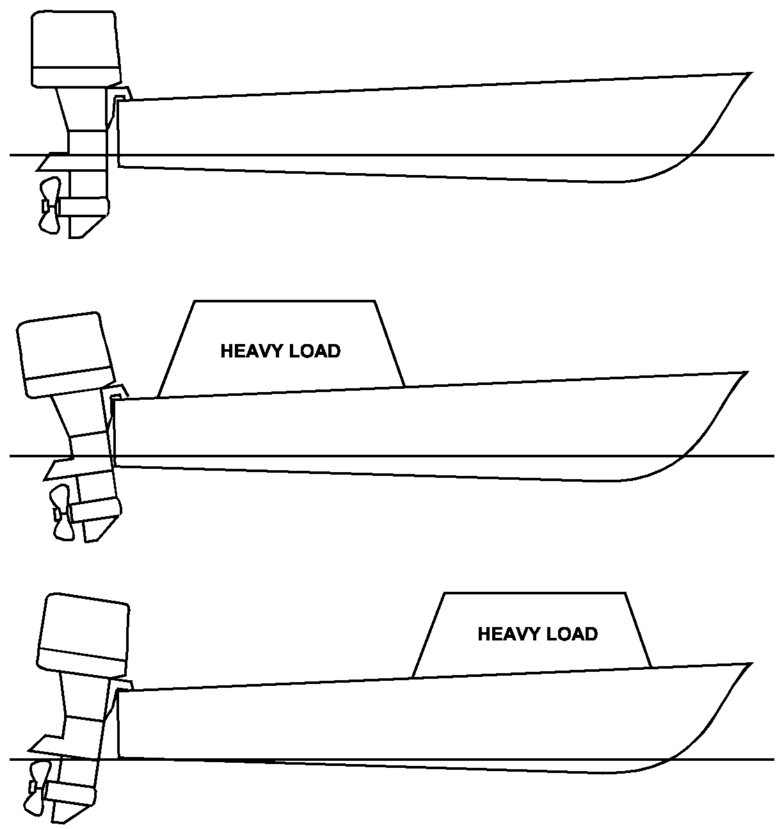


With helm over, the propeller side force (small arrow) has a fore and aft component. This example shows the effect of side force when backing with an outdrive. With helm to port, the boat's transom will move both to port and forward (large arrow)

Lower Unit/Outdrive Side Force
Figure 10-10

A.15. 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 10-11). 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 10-11

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.

WARNING ☝

> 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 coxswain. If installed, the helmsman should always attach engine kill switch lanyard to themselves.

A.16. 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

A.17. General

A waterjet 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 waterjet is forward of the nozzle, usually mounted at the deepest draft near the after 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 waterjet normally has no appendages, nor does it extend below the bottom of the vessel hull, allowing for operation in very shallow water.

A.18. 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 waterjet 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 waterjet with a small steering vane, but in most cases the only vessel control is by the nozzle-directed thrust. If a waterjet 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 waterjet alone has no directional control when there is no power.

A.19. No side force

Since the waterjet 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.

A.20. Cavitation

Waterjet 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 waterjet 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 waterjet 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.

Section B. Basic Maneuvering

Overview

Introduction

To learn basic handling and maneuvering characteristics of a vessel, a trainee must first observe a skilled coxswain. 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.

In this section

This section contains the following information:

Learning the Controls

B.1. 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.

B.2. 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.

NOTE

Check control operation while moored with engines secured. Some larger vessels require engine operation to operate controls such as engine assisted hydraulic steering. If so, check throttle controls with engines secured.

B.3. 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.

B.4. 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	Does the kill-switch lanyard allow adequate but not excessive range of motion?
8	Does an engine shut down handle work properly?
9	Is idle speed adjusted properly?

WARNING ✋

Smooth, positive operation of helm and engine controls is absolutely necessary for safe boat operation. Don’t accept improper control configuration, mismatched equipment, or improper maintenance as a reason for poorly operating controls. Poor control operation causes unsafe boat operations.

B.5. 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.

CAUTION !

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

NOTE

Perform these steps as part of every getting-underway check.

When training, an experienced individual should get the vessel underway and into open water before turning control over to anyone not familiar with the particular boat’s operation. Once in open water, turn control over to the new coxswain and have them recheck helm and engine control operation at clutch speed.

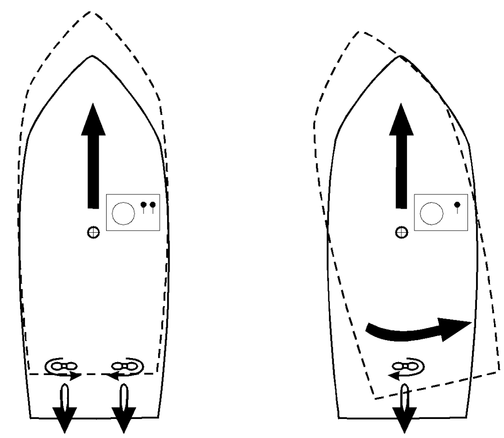
Moving Forward in a Straight Line

B.6. General

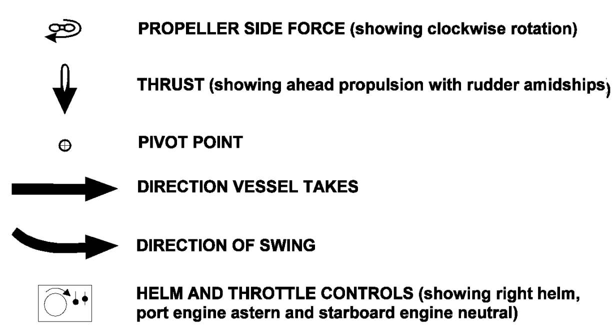
When moving forward in a straight line, advance throttle gradually and firmly. If the vessel is single-screw, outboard, or outdrive, propeller side force will tend to move the stern slightly to starboard (Figure 10-12). Offset the side force with slight starboard helm. If twin-engine, advance throttles 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. Some vessels have a separate indicator to show if engine RPMs match, but also compare tachometer readings.

NOTE

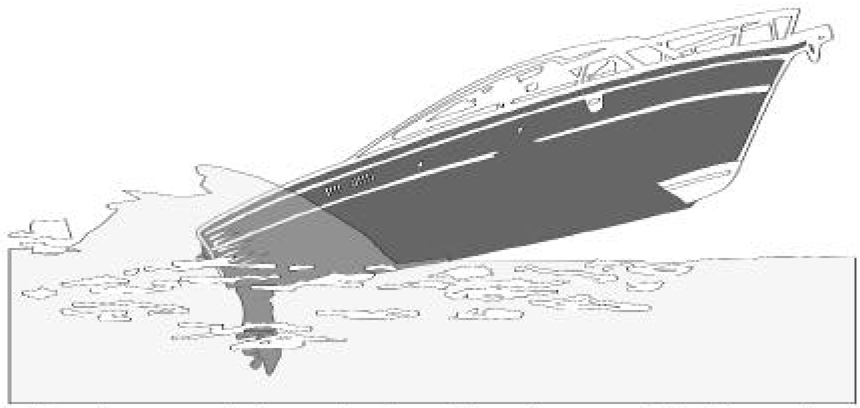
> Don't ram throttles forward when starting up. As the engines try to transfer the excessive power, the stern will squat, raising the bow and decreasing visibility (Figure 10-13), and propellers or impellers may cavitate.



Twin-screw vessel accelerates in a straight line, single-screw vessel is affected by side force, stern "walks" to starboard. Offset for side force with slight right rudder.



Accelerated Ahead
Figure 10-12



Excessive power applied causes stern to squat. Large stern wave and raised bow result.
Coxswain loses forward visibility until craft attains planing mode.

Pronounced Squat on Acceleration
Figure 10-13

B.7. 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. Don't oversteer, leaving a snake-like path. At low speeds, helm correction will be more frequent than at higher speeds.

B.8. Get on plane

For planing or semi-displacement hulls, the boat will gradually gain speed until planing. 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."

B.9. Determine appropriate speed

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

B.9.a. 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.

B.9.b. 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.

NOTE

Find the most comfortable, secure location for the entire crew. For many vessels, this means in the immediate vicinity of the helm.

- *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.

WARNING

Being "on plane" will not let you to cross a shoal that would ground your vessel in the displacement mode. At high planing speed, the stern will squat as it gets in shallow water, possibly grounding at a very damaging speed.

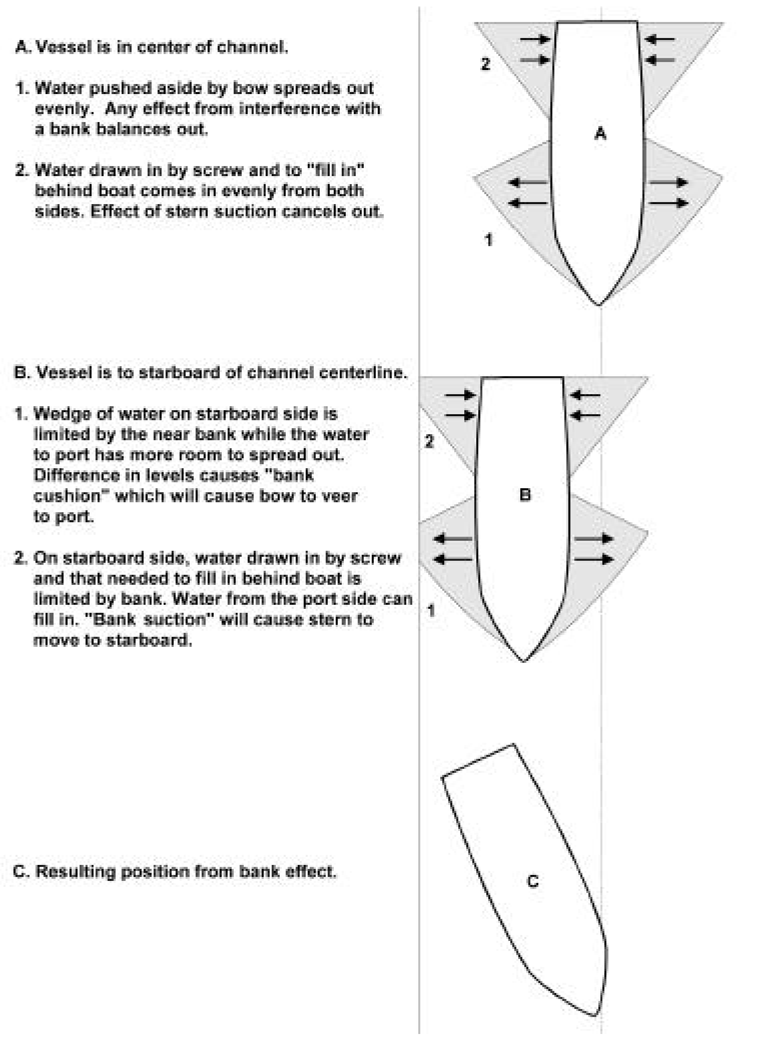
- *Traffic density*. **Don't use high speed in high traffic density areas**. A safe speed allows you to respond to developing situations and minimize risk of collision, not only with the nearest approaching vessel, but with others around it.
- *Visibility*. **If you can't see where you're going, slow down**. Fog, rain, and snow are obvious limits to visibility, but there are others. Geographic features and obstructions (river bends, piers, bridges and causeways), 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 (particularly salt spray or freezing spray) 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.

B.10. Bank cushion and bank suction

In extremely narrow channels, a vessel moving through the water will cause the “wedge” of water between the bow and the nearer bank to build up higher than on the other side. This bow cushion or bank cushion tends to push the bow away from the edge of the channel.

As the stern moves along, screw suction and water needed to “fill-in” where the boat was creating stern or bank suction. This causes the stern to move towards the bank. The combined effect of momentary bank cushion and bank suction may cause a sudden shear toward the opposite bank. Bank cushion and bank suction are strongest when the bank of a channel is steep. They are weakest when the edge of the channel shoals gradually and extends in a large shallow area. When possible, stay exactly in the center of an extremely narrow channel to avoid these forces (Figure 10-14). Slower speed also reduces the amount of cushion and suction. Offset for continuous cushion and suction effects by some rudder offset towards the closer bank.

If a strong, sudden shear occurs, counteract it with full rudder towards the bank and increasing speed. Remember, on a single-screw vessel, propeller side force will cause the stern to move to starboard.



Bow Cushion and Stern Suction
Figure 10-14

CAUTION !

Don’t overcompensate for bank cushion and bank suction. Too much helm in the direction of the bank could cause the bow to veer into the bank. Then, a subsequent large helm movement to turn the bow away from the bank may cause the stern to swing into the bank.

B.11. Bow cushion and stern suction

When meeting another vessel close aboard, bow cushion and stern suction occur between the vessels much the same as bank cushion and suction. Use helm corrections to compensate. As both vessels move through the water, the combined effect is greater than what a single vessel encounters from bank interaction. Use caution so the bow does not veer too far from the intended track and the stern swings into the path of the other vessel.

Assume a port-to-port meeting situation. Before vessels are bow-to-bow, use a small amount of right rudder to ensure the bows clear. The bow cushion will increase separation. As the vessels near bow-to-beam, use left rudder to keep away from the right-hand bank and to stay parallel to the channel. When the vessels are bow-to-quarter, the bow cushion will be offset by the stern suction, and bank cushion may need to be offset by some right rudder. Finally, as the vessels are quarter-to-quarter, stern suction will predominate, and will require left rudder to keep the sterns apart.

NOTE ✍

The following bow cushion and stern suction considerations apply when meeting another vessel in a narrow channel and when operating near a bank.

- The deeper the vessel's draft, the greater the cushion and suction effect, particularly if draft approaches water depth.
- The closer to a bank or another vessel, the greater the cushion and suction.
- In very narrow waterways, slow down to decrease cushion and suction effects, but not to the point that you lose adequate steerage.

When you meet another vessel in a narrow channel, balance the bow cushion and stern suction effects caused by the other vessel with the bank cushion and suction effects due to the channel.

B.12. Watch your wake

CAUTION !

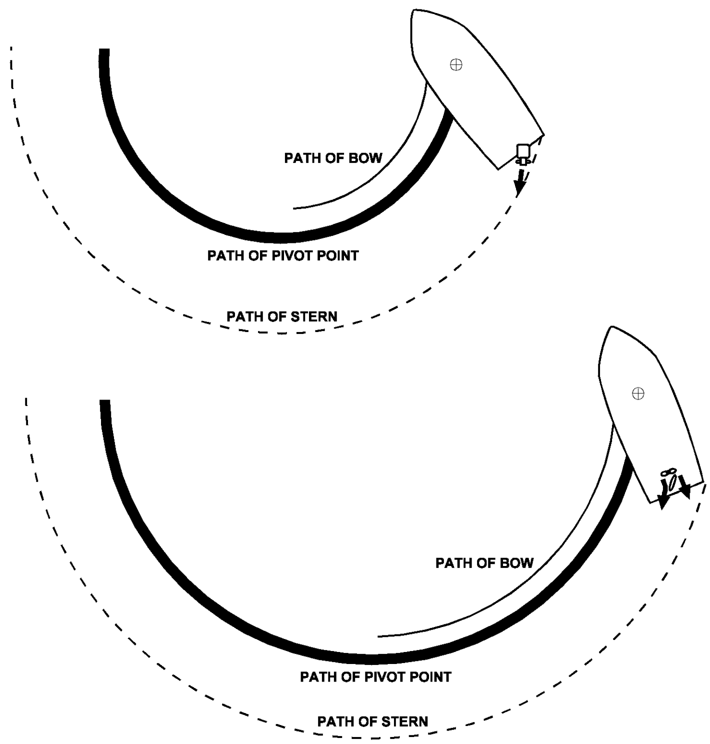
Whenever you maneuver, keep the crew informed, especially if rapidly accelerating, turning or slowing. A quick warning shout could prevent

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 planing 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.

All vessels are responsible for their wake and any injury or damage it might cause. Only an unaware coxswain trails a large wake through a mooring area or shallows, tossing vessels and straining moorings. “Get-home-itis” and a false sense of urgency are two reasons coxswains 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

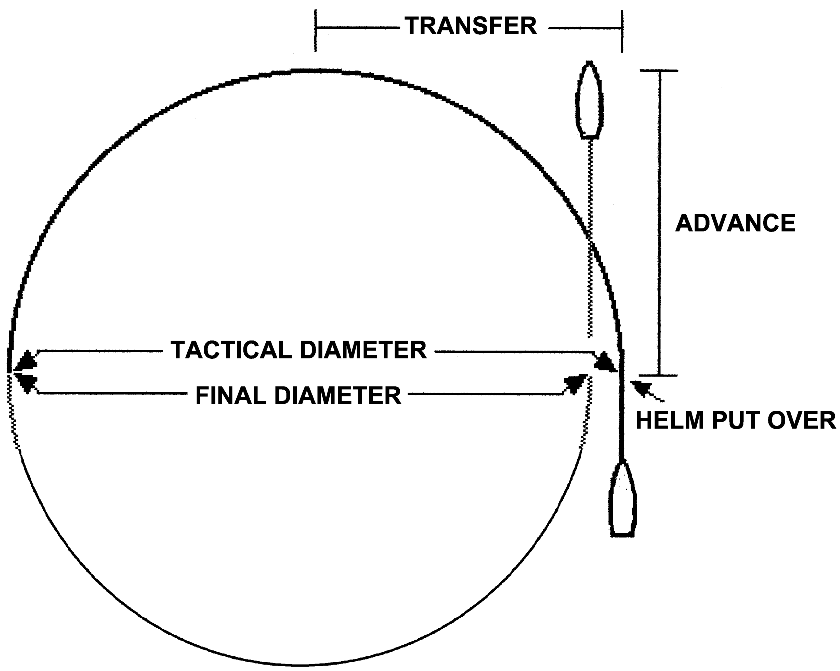
B.13. General	To move in a straight line, small, frequent, momentary helm inputs adjust the position of the stern and bow to head in the desired direction. To intentionally change the vessel heading, use larger, more sustained helm movement.
B.14. Be aware of the pivot point	As noted earlier, you change 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.
B.15. Note how propulsion type affects turning	Because outboards, stern drives and waterjets 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 (Figure 10-15).



Pivot Point, Skid, Kick, Inboard vs. Outboard
Figure 10-15

B.16. 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 10-16).



Turning Characteristics
Figure 10-16

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 oversteer a course change.

B.17. Note loss of speed through the water

Some planing 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.

WARNING ☝

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 unsuspecting crewmembers. 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.

B.18. Make course changes and turns in channels

Bank suction, bank cushion (see B.10. above) and currents will all affect a boat navigating a sharp bend in a narrow channel. Where natural waterways have bends or turns, the water is always deepest and the current is always strongest on the outside of the bend. This is true for 15-degree jogs in a tidal estuary and for the "s" shaped meanders on the Mississippi River. This happens because the water flow has a great degree of momentum and resists having its direction changed. As it strikes the outside of the bank, it erodes the earth and carries the particles with it. The particles fall out farther downstream in areas of less current (the inside of a turn or bend) and cause shoaling. In some turns or bends, there may be circular currents or eddies in either the deep outside or the bend or the shallow inside. Back currents also sometime occur near the eddies on the inside of the bend. When eddies or back currents occur, those near the shallows are much weaker than eddies or the main current flow at the outside of the bend back-currents.

Because bank cushion and suction are strongest when the bank of a channel is steep and weakest when the edge of the channel shoals gradually, bank effect is stronger on the outside of bends or turns. Be aware of the mix of current and bank effect and use these forces to your advantage.

B.18.a. Counter a head current through a bend

Minimize the effect of a head current by steering along the inside quarter of the channel. Make sure you avoid shoaling. If the bow gets into the area of greater current, it may begin to sheer towards the outside of the bend. Counter it through helm towards the inside of the bend and by getting the stern directly down-current from the bow. Gradually work back to the inside quarter of the channel.

- If you start from the outside of the bend, you will encounter the full force of the current. Bank cushion should keep the bow from the outside edge, but the stern is limited in its movement by bank suction. Initial helm towards the inside of the turn may allow the current to cause the bow to rapidly sheer away from the outside, but immediately offset this with power and helm to keep the bow pointed upstream. Use gradual helm with constant power to get out of the main force of the current and work across to the inside quarter of the channel.

B.18.b. Navigate with a following current

Approach the turn on a course just to the outside of the middle of the channel. This will avoid the strongest currents at the outside edge while still getting a reasonable push. As you turn, the strongest current will accentuate the swing of the stern quarter to the outside of the channel. Because of this, and because the following current tends to carry the boat toward the outside, begin the turn early in the bend.

- If you stay too far to the outside of the bend, timing the turn is difficult. Too early, and stern suction on one quarter with the strongest current on the other quarter may cause an extreme veer to the inside of the turn Any bow cushion will accentuate the sheer. Too late, stern suction and the quartering current could cause grounding.
- If you try to hug the inside of the turn, both current and bank effect will be lessened. Use a small amount of rudder toward the inside bank to enter the turn. As the channel begins to bend, use less rudder while the boat starts to move from the inside bank. Use caution as the current under the quarter affects the stern, giving in an increase in sheer towards the inside bank. Slack water or an eddy down current on the inside will increase this sheer while bow cushion may not be enough to prevent grounding.

Stopping the Boat

B.19. General

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 planing 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.

B.20. Use astern proplulsion to stop the vessel

WARNING

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.

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 clutch 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 waterjet, reverse thrust is immediate. No marine gear or drive unit changes shaft and propeller rotation. The clamshell or bucket shaped deflector 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.

B.21. Use full helm to stop forward way

As noted above, with light-displacement, high-powered craft, maximum helm at high speed will quickly stop a boat's progress in the original direction of movement. To fully stop, throttle down to neutral after entering the skid. If done properly, no astern propulsion is required.

NOTE

With a jet drive, no directional control will be available without thrust. The boat must be in a the skid before reducing power. If thrust is reduced before trying to turn, the boat will slow on the original heading.

WARNING

As with the crash stop, a full-helm, high-speed stop is an emergency maneuver. The violent motion could eject crewmembers. Don't use this maneuver in choppy waters as a chine could "trip" and cause the vessel to snap-roll and flip or capsize.

Backing the Vessel

B.22. 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.

CAUTION !

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.

CAUTION !

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.

B.23. 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.

B.23.a. 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.

B.23.b. 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.

B.24. 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.

B.24.a. Single-outboard/ outdrive

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

B.24.b. 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.

B.25. 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 waterjet intake flow ahead of the transom.

Using Asymmetric or Opposed Propulsion (Twin Screw Theory)

B.26. General

NOTE

> As with all boat handling techniques, learn these first in calm weather, in open water and at low speeds.

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.

B.27. 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)

B.28. General

These techniques cause a faster change in heading by increasing both skid and kick, reducing advance and transfer, and if the heading change is held long enough, the overall tactical diameter.

B.29. 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 (where equipped) can use screw discharge current from the ahead engine to help pivot the stern. Because boats operate more efficiently ahead, some headway may develop.

B.29.a. 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).

B.29.b. 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).

Step	Procedure
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.

B.29.c. 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.

CAUTION !

All crew members must pay close attention to throttle changes and vessel movements. Firmly hold on to the vessel during these maneuvers.

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.

NOTE ☞

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.

B.30. Reduce tactical diameter at speed

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

B.30.a. 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."

NOTE

> Don't put throttle to neutral position. In neutral, the propeller will "free-wheel" and rotate without any resistance. By staying at clutch 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.

B.30.b. 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.

WARNING

> 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.

NOTE

> 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, planing-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)

B.31. 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 coxswain 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 coxswain must account for the propeller rotation and side force for the particular drive used (normally starboard: right-hand turning, port: left-hand turning), and the offset of the drive from centerline.

B.32. 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. For initial training, turn through at least 360 degrees.

From dead-in-the-water:

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).

Step	Procedure
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.

NOTE

- 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.