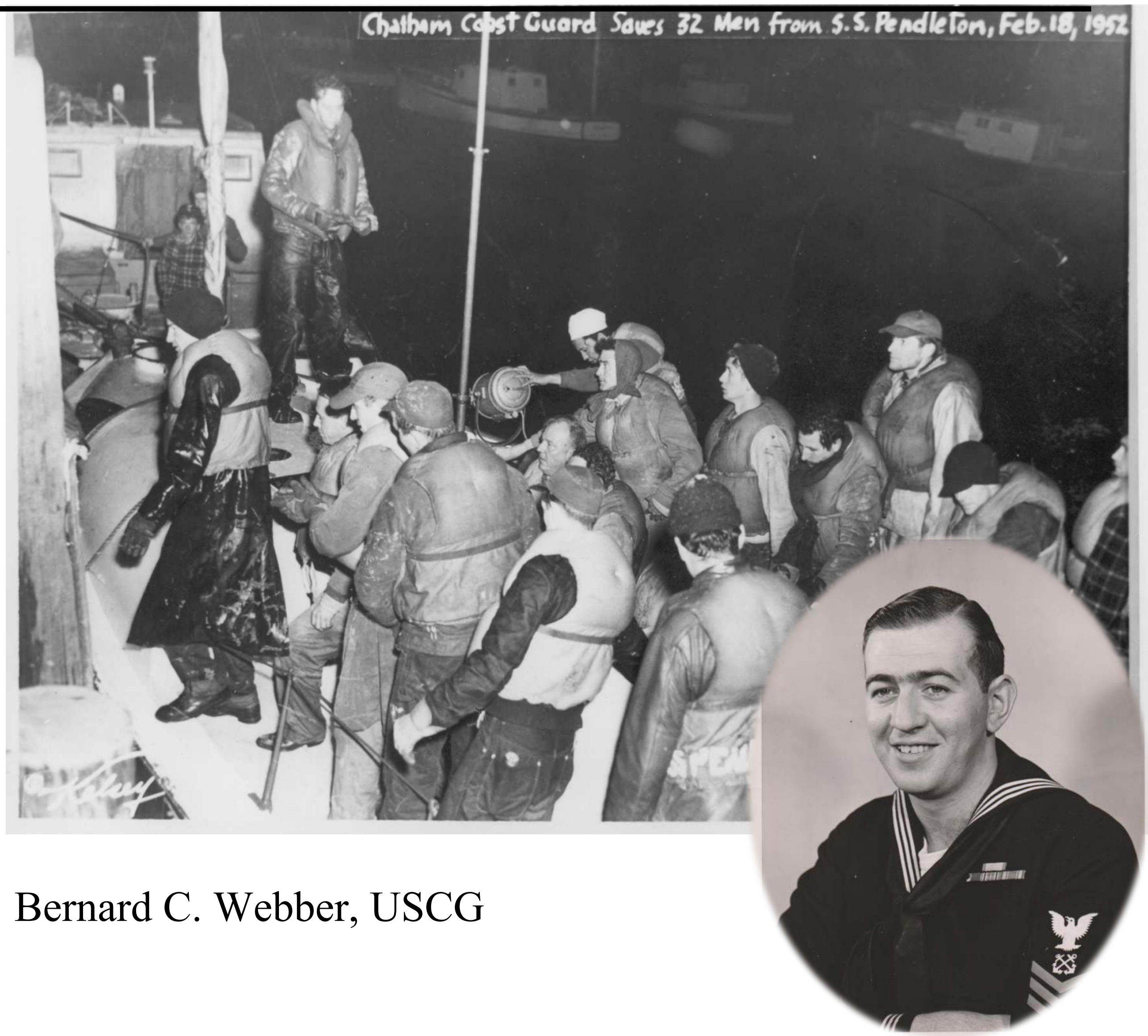
U.S. Department of
Homeland Security

United States
Coast Guard

BOAT CREW HANDBOOK –
Seamanship Fundamentals



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BCH 16114.4
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Synthetic Fiber Line

(01) Insert a pipe through the center and hang the reel off the deck,

(02) Draw the line from the lower reel surface.

Twisted fiber lines must not be "thrown" off the reel, as this will cause tangles and kinks. It is recommended that three-strand synthetic lines be faked down on deck and allowed to relax for twenty-four hours. Lengths less than 50 feet will relax in one hour when laid out straight. Fake down double-braided line in figure eight patterns (**Figure 2-4**).

Figure 2-4
Line Faked Down

Maintenance

B.15. Description

While there is nothing that can be done to restore bad line, precautions can be taken to extend the life of lines.

B.16. Keeping Lines Clean

Lines should be kept free from grit or dirt. Gritty material can work down into the fibers while a line is relaxed. Under tension, the movement of the grit will act as an abrasive and will cause serious damage to the fibers.

B.17. Using Chafing Gear

Chafing gear can be made of old hoses, leather, or heavy canvas. It is used to protect short pieces of line where they run over taff rails, chocks, or other surfaces (**Figure 2-5**).

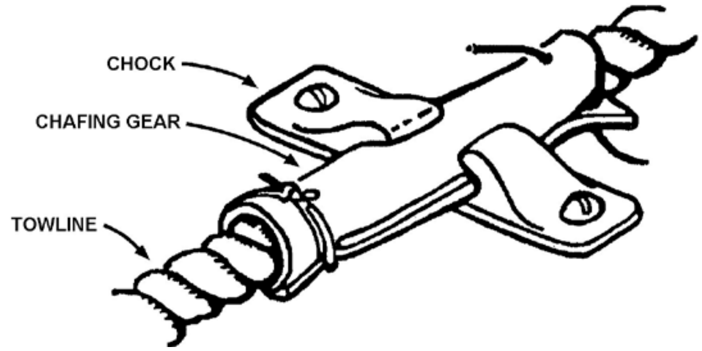


Figure 2-5
Chafing Gear

B.18. Keeping Deck Fittings Clean and Smooth

Bitts, cleats, and chock surfaces should be kept smooth to reduce line abrasion.

B.19. Watching for Frozen Water

Crewmembers should ensure that water does not freeze on lines and that any ice which accumulates is removed. Ice is abrasive and can cut fibers.

B.20. Avoiding Crushing or Pinching Lines

Crewmembers should avoid walking on, placing loads on, dragging loads over, or in other ways crushing or pinching a line.

B.21. Being Cautious of Sharp Bends

Bending under a load causes internal abrasion between the strands of the line. If a line has to go around something, a fair lead should be used. A fair lead is any hole, bullnose, lizard, suitably placed roller, sheave, etc., serving to guide or lead a rope in a desired direction. It is important to remember that if a fair lead is not used, the bigger the bend, the less the abrasive effect.

B.22. Care and Stowage of Natural Fiber Line

The practices that should be avoided or observed in the maintenance of natural fiber line are as follows:

DOs	DON'Ts
(01) Dry line before stowing it in a cool, dark, well-ventilated space, (02) Protect line from weather when possible, (03) Use chafing gear (canvas, short lengths of old fire hose, etc.) where line runs over sharp edges or rough surfaces, (04) Slack off taut lines when it rains. Wet lines shrink and if the line is taut, the resulting strain may be enough to break some of the fibers, (05) Reverse turns on winches periodically to keep out the kinks, (06) Lay right-laid lines clockwise on reels or capstans and left-laid lines counterclockwise until they are broken in, (07) Inspect lines for fiber damage and other wear conditions before each use, (08) Try to tie knots or hitches in new places as much as possible so as not to wear out the line, (09) Occasionally end-for-ending (swap one end for the other) to help reduce excessive wear at certain points.	(01) Stow wet or damp line in an unventilated compartment or cover it so that it cannot dry. Mildew will form and weaken the fibers, (02) Subject the line to intense heat or unnecessarily allow it to lie in the hot sun. The lubricant will dry out, thus shortening the useful life of the line, (03) Subject a line to loads exceeding its working load limit. Individual fibers will break, reducing the strength, (04) Allow line to bear on sharp edges or run over rough surfaces, (05) Scrub line. The lubricant will be washed away, and caustics in strong soap may harm the fibers, (06) Try to lubricate line. The lubricant added may do more harm than good, (07) Put a strain on a line with a kink in it, (08) Let wear become localized in one spot, (09) Unbalance line by continued use on winch in same direction.

B.23. Care of Synthetic Fiber Line

Most of the practices in the maintenance of natural fiber line are the same for synthetic fiber line. However, the differences are as follows:

(01) Nylon is not subject to mildew, and it may and should be scrubbed if it becomes slippery because of oil or grease. Spots may be removed by cleaning with a 10% solution of mild detergent/degreaser and water,

(02) Synthetic line stretches when put under a load.

Stowing Lines

B.24. Description

To prevent the deteriorating effects of sunlight, chemicals, paints, soaps, and linseed or cottonseed oils, lines should be stored to prevent contact with harmful items or conditions.

B.25. Synthetic Fiber Lines

Synthetic fiber lines are not as susceptible to the effects of moisture as natural fiber lines. They are, however, affected by all of the other conditions and materials that will hurt line. The boat's towline and other synthetic lines should be kept covered or stored in a dark area, when not in use.

Synthetic line should not be constantly coiled in the same direction, as doing this tends to tighten the twist. Three-strand synthetic line is often coiled clockwise to reduce a natural tendency to tighten up. It can be coiled in figure eights to avoid kinks when paying out (**Figure 2-6**).

Figure 2-6
Figure Eight Coils

B.26. Towline

See applicable boat operators handbook for location and procedures for towline stowage.

B.27. Coiling

The most common method of stowing the extra line on deck or on the dock after making fast to a cleat is to coil it.

B.28. Flemishing a Line

Flemishing a line consists of coiling a line against the deck ensures a neat and clean line without it being fouled. It is good for appearance as well for inspections providing a good seaman-like appearance. (**Figure 2-7**).

Figure 2-7
Flemishing a Line

Section C. Knots and Splices

Introduction

This section details the procedures regarding the art of knots and splices.

In this Section

This section contains the following information:

Estimating the Length of a Line

C.1. Procedure

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

Step	Procedure
1	Hold the end of a length of line in one hand.
2	Reach across with the other hand and pull the line through the first hand, fully extending both arms from the shoulder.

The length of line from one hand to the other, across the chest, will be roughly six feet (one fathom). Actually, this distance will be closer to the person's height, but this measure is close enough for a rough and quick estimate of line needed.

If more line is needed, the process should be repeated keeping the first hand in place on the line as a marker until the length of line required has been measured off. For example, if 36 feet of line is needed, the procedure should be repeated six times.

D.2.c. Securing a Line to Paired Bitt

The following procedures describe how to secure a line to paired bitts (**Figure 2-34**):

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

Figure 2-34
Securing a Line to Paired Bitt

D.2.d. Securing a Line to a Single Bitt

A single bitt is a post on the forward or aft deck of a boat. It is used as a cleat or tow bitt. The following procedures describe how to secure a line to a Single Bitt (see **Figure 2-35**):

Step	Procedure
1	Make a complete turn around the base of the bitt.
2	Form several figure eights around the horns of the bitt. (Standard is 3 turns.)

Figure 2-35
Securing a Line to a Single Bitt

D.2.e. Securing a Line to a Cleat

The following procedures describe how to secure a line to a cleat when mooring (**Figure 2-36**):

Step	Procedure
1	Make a complete turn around the cleat.
2	Lead the line over the top of the cleat and around the horn to form a figure eight.
3	Make two or more additional figure eights to secure the line.

Figure 2-36
Securing a Line to a Cleat

D.2.f. Securing a Dock Line to a Cleat

The following procedures describe how to temporarily secure a dock line to a cleat (see **Figure 2-37**):

Step	Procedure
1	Use a line with an eye already spliced or tie a bowline large enough to loop back over the horns of the cleat.
2	Feed eye of the line through opening.
3	Loop the line back over both horns and pull line taut.

Figure 2-37
Securing a Dock Line to a Cleat

D.2.g. Dipping the Eye

When two lines with eye splices are placed on a bollard, it may not be possible to remove the bottom line until the top line is removed. By dipping the eye, both lines can be placed for easy removal. The following procedures describe how to dip the eye (see **Figure 2-38**):

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

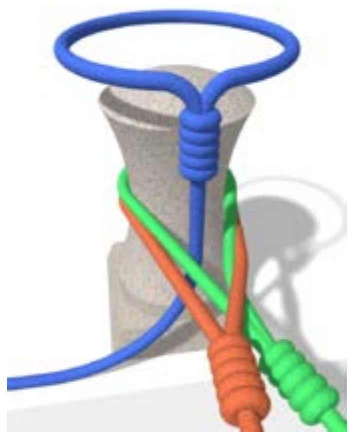


Figure 2-38
Dipping the Eye

D.2.h. Securing a Towline

The towline is the hardest worked line on a boat. When in use, it can carry a tremendous strain and is a possible danger to anyone working near it. Boats have different styles of tow bitts. Towlines should aways be secured (made up) using one complete round turn and three figure eights regardless of the style of bitt. Towlines are secured in this method so they can be easly and safely adjusted or cast off in an emergency. Additional information on the use of towlines is provided in Reference (b).

Factor	Description
Beam and breadth	Beam and breadth are measures of a boat's width. Beam is the measurement of the widest part of the hull. Breadth is the measurement of a frame from its port inside edge to its starboard inside edge. Molded beam is the distance between outside surfaces of the shell plating of the hull at its widest point. Extreme breadth is the distance between outside edges of the frames at the widest point of the hull.
Draft	Draft is the depth of the boat from the actual waterline to the bottom of its keel.
Draft appendage	Draft appendage is the depth of the boat from the actual waterline to the bottom of its keel or other permanent projection (e.g., propeller, rudder, skeg, etc.), if such a projection is deeper than the keel. The draft is also the depth of water necessary to float the boat. The draft varies according to how the boat lies in the water.
Trim	Trim is a relative term that refers to the way the boat sets in the water and describes generally its stability and buoyancy. A change in trim may be defined as the change in the difference between drafts forward and aft. A boat is trimmed by the bow when the draft forward increases and the draft is greater than the stern draft. A boat is trimmed by the stern if it is down by the stern.

Figure 3-2
Tumble Home Hull Design

Displacement

B.3. Measurement

Displacement is the weight of a boat and is measured in long tons (2,240 lbs) or pounds.

B.4. Gross Tons

A gross ton is the entire cubic capacity of a boat expressed in tons of 100 cubic feet.

B.5. Net Tons

A net ton is the carrying capacity of a boat expressed in tons of 100 cubic feet. It is calculated by measuring the cubic content of the cargo and passenger spaces.

B.6. Deadweight

Deadweight is the difference between the light displacement and the maximum loaded displacement of a boat and is expressed in long tons or pounds.

B.6.a. Light Displacement

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

B.6.b. Loaded Displacement

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

B.7. Displacement Hull

A displacement hull boat pushes away (displaces) water allowing the hull to settle down into the water. Underway, the hull pushes out this water, creating waves (see **Figure 3-3**). The water separates at the bow and closes at the stern. Tremendous forces work against a displacement hull as the power pushing it and the boat's speed both increase. At maximum displacement speed, there is a distinct bow and stern wave. The length of these waves depends upon the boat's length and speed. (The longer the boat, the longer the wave length.) The bow and the stern ride lower in the water while increasing speed, and the water level alongside, amidships becomes lower than that of the surrounding water.

This lower water level is caused by the increase in the velocity of the water flowing under the boat and its interaction with the bow and stern wave. As the boat travels along, it rides in a depression created by its own passage. The displacement hull vessel's maximum speed is determined by the vessel's waterline length. Heavy displacement hulls cannot exceed a speed of 1.34 times the square root of their waterline length without requiring excessive power. This speed is known as critical speed. For details on towing displacement hulls, see Reference (b).

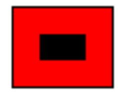
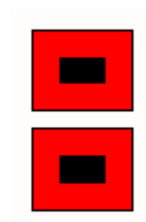
A.4. Weather Warning Signals

The National Weather Service provides radio weather broadcasts. Beginning June 1, 2007, the U.S. Coast Guard formally re-established a Coastal Warning Display program at selected boat stations which will hoist display flags to warn of small craft advisories, gale warnings, storm warnings and hurricane warnings. These weather warnings and their flags and lights signals are summarized in **Table 5-2**.

Table 5-2
Marine Advisories and Warnings Included in Coastal and Offshore Forecasts

Marine Advisories and Warnings	Winds	Day Signal Onshore	Night Signal Onshore
Special Marine Warning	A severe local storm warning affecting coastal water areas, or a warning of potentially hazardous weather conditions usually of short duration (2 hours or less) and producing wind speeds of 34 KT or more, that is not adequately covered by existing marine warnings.		
Small Craft Advisory (conditions dangerous to small craft operations)	An advisory in coastal waters for winds from approximately 18 to 33 KT inclusive (lower limit may vary by region) or for sea conditions, either predicted or occurring, that are considered potentially hazardous to boats. There is no legal definition for "small craft."	Red pennant 	Red-over-white light 
Gale Warning	A warning of sustained winds in the range 34 to 47 KT (39 to 54 MPH) inclusive either predicted or occurring, not associated with tropical cyclones.	Two red pennants 	White-over-red lights 
Storm Warning	A warning of sustained winds of 48 to 63 KT (55 to 73 MPH), not associated with a tropical cyclone.	Square red flag with black center	Two red lights

Table 5-2 (continued)
Marine Advisories and Warnings Included in Coastal and Offshore Forecasts

Marine Advisories and Warnings	Winds	Day Signal Onshore	Night Signal Onshore
Hurricane Force Wind Warning	A warning for sustained winds of 64 KT (74 MPH) or greater either predicted or occurring, not associated with a tropical cyclone.		
Tropical Storm Warning	A warning of sustained winds from 39 to 73 MPH inclusive either predicted or occurring, associated with tropical cyclones.		
Hurricane Warning	A warning for sustained winds of 74 MPH or greater either predicted or occurring, associated with a tropical cyclone.	Two square red flags with black centers 	Three vertical lights - red, white, red 

Thunderstorms and Lightning

A.5. Thunderstorms

Thunderstorm**,** a violent, short-lived weather disturbance that is almost always associated with lightning, thunder, dense clouds, heavy rain or hail, and strong, gusty winds. Thunderstorms arise when layers of warm, moist air rise in a large, swift updraft to cooler regions of the atmosphere. Thunderstorms are dangerous not only because of lightning, but also because of the strong winds and the rough, confused seas that accompany them.

B.5.a. Height of Eye or Freeboard

With the boat in the trough and on a level and even keel, any wave that obscures the horizon is greater than the height of a person's eye. One can compare a wave to the deck edge or a structure such as the handrail. The wave face is observed while bowing into it, with the boat on an even keel in the trough.

B.5.b. Comparison with Floating Structures or Vessels

This technique is most useful when observing from land, but may be applied while underway. If the freeboard of a buoy is known to be 13 feet, that information can be used to determine the height of the waves passing it. A buoy can also be used to determine the wave period. One can observe a vessel underway and by estimating the freeboard of the vessel and observing its motions on the water, he or she can gain a fair estimate of the seas in which it is operating.

B.5.c. Comparison with Fixed Structure

Observation of waves as they pass a fixed structure, such as a break-wall, jetty, or pier, can be very accurate and can also provide wave period.

B.5.d. Depth Sounder

Using a digital depth sounder with a fast update speed can be very accurate for determining wave height. By comparing the depth in the trough on even keel with the depth at the crest on even keel, an accurate measurement can be obtained.

All of these methods can be useful and reasonably accurate, but they require practice and experience. By comparing a local Weather Service buoy report with the crew's observations, they can fine tune their sense of wave height. With enough practice, they should be able to judge wave heights simply by looking at the waves themselves.

B.6. Breakers

A wave or swell of the sea breaking on the shore, shoal, reef, bar, or inlet. Breakers are a result of wave interaction with the bottom contour of the sea, shoal, reef, bar, or inlet. With each of these waves/swells the bottom of the wave slows on the ocean floor, shoal, reef, bar, or inlets while the top of the wave moves ahead of it causing it to break.

B.7. Types of Breakers

There are three basic types of breaking waves:

(01) Plunging (**Figure 5-6**),

(02) Spilling (**Figure 5-7**),

(03) Surging (**Figure 5-8**).

Each type of breaking waves brings its own hazards, such as suction currents, dropping huge quantities of water, and exerting a great deal of force. It is important to remember that when operating in heavy weather, these hazards are magnified beyond those found during calm water operations.

NOTE A 20 foot breaker will drop 1,500 tons of water on a boat.

B.7.a. Plunging Breaker

Plunging breakers are created when a wave encounters a sudden decrease in depth, such as a reef or a steep rise of the ocean floor. The momentum caused by the breaking top of the wave will cause the water to curl.

Figure 5-6
Plunging Breaker

B.7.b. Spilling Breaker

Spilling breakers are created when wave energy encounters a gentle sloping ocean floor. The spilling breakers normally have a crest of white water spreading down the wave face.

Figure 5-7
Spilling Breaker

B.7.c. Surging Breaker

Surging breakers are created on very steep beaches. The wave builds very quickly and expends its energy on the beach.

NOTE It is unlikely you will encounter surging breakers while aboard a boat unless you are beaching it on a very steep beach.

Figure 5-8
Surging Breaker

B.8. Wave Series

Wave series are irregular because of constant shifting of wind direction and speed. Storms at sea create masses of waves that build up in groups higher than other waves. Breakers vary in size and there is no regular pattern or sequence to their height. But while the space or interval between series of breakers may vary, it is fairly regular. Despite the interval, breakers tend to stay the same for hours at a time.

The height and period of a wave depends on:

(01) The speed of the wind,

(02) The amount of time the wind has been blowing,

(03) The distance over water which the wind travels unobstructed, known as fetch. Nearness to land will limit fetch, if the wind is blowing offshore.

The lifecycle of a wave consists of its:

(04) Generation by wind,

(05) Gradual growth to maximum size,

(06) Distance traveled across the sea,

(07) Dissipation as wind decreases or when the wave impacts against the shore or an object.

NOTE Tidal currents going against the waves will make the waves steeper.

B.9. Surf

Irregular waves of deepwater become organized by the effects of the contact with the bottom. They move in the same direction at similar speeds. As the depth of water decreases to very shallow, the waves break and the crests tumble forward. They fall into the trough ahead usually as a mass of foaming white water. This forward momentum carries the broken water forward until the wave's last remaining energy becomes a wash rushing up the beach. The zone where the wave gives up this energy and the systematic water motions is the surf (see **Figure 5-9**).

Figure 5-9
Surf

Sometimes there are two breaks of surf between the beach and the outer surf line. These breaks result from an outer sand bar or reef working against the wave causing the seas to pile up. The movement of water over such outer bars forms the inner surf belt as the water rolls toward the shore. The surf that forms around an inlet depends on the size of approaching swells and the bottom contours. The waves' speed and shape change as they approach shallow coastal waters. They become closer together (as their speed slows) and steeper as they contact the bottom. This change typically happens at a point where the water is approximately one half as deep as the wave's length.

As a wave steepens, its momentum will cause it to fall forward or curl. It is this momentum that gives a curl of breakers its tremendous force.

WARNING

Stay out of the wave's curl. Boats not authorized to operate in breaking surf or bar conditions should remain well clear of these hazards.

B.10. Surf Definitions	Following are descriptions and definitions relating to breakers encountered during surf conditions.
B.10.a. Surf	Several waves or swells of the sea breaking on the shore, shoal, reef, bar, or inlet.
B.10.b. Comber	A wave on the point of breaking. A comber has a thin line of white water upon its crest, called feathering.
B.10.c. Crest	The top of a wave, breaker, or swell.
B.10.d. Surf Line	The outermost line of waves that break near shore, over a reef, or shoal. Generally refers to the outermost line of consistent surf.
B.10.e. Surf Zone	The area where surf exists, between the outermost and innermost breaking waves.

B.11. Surf Zone Characteristics

In normal operations and especially in heavy weather, there are a number of conditions created in the surf zone and in individual waves of which the coxswain must be aware. These include:

(01) Windows,
(02) High/low side of a wave,
(03) Wave saddles,
(04) Closeouts,
(05) Wave shoulder,
(06) Rip currents.

B.11.a. Windows

A window is an area where the waves have momentarily stopped breaking, opening up a safer area of operation for your boat. Windows often form in the area of aerated water where a large set of waves has just finished breaking. The window may remain for a long time or may begin breaking again almost immediately. It is preferable to operate the boat in the windows whenever possible.

Figure 5-10
Window

B.11.b. High/Low Side of a Wave

The "high side" is defined as the section of a wave which carries the most potential energy. The "low side" is where the least potential energy exists and represents the safest direction to turn when facing the wave/swell (**Figure 5-11**).These high and low sides often change rapidly, and the ability to quickly navigate the high and low sides is a critical skill for surf operations.

Figure 5-11
High/Low Side of a Wave

B.11.c. Wave Saddles

The “saddle” is the lowest part of a wave, bordered on both sides by higher ones. Often it is a small, unbroken section of a wave that is breaking. It is preferable to drive a boat in the saddles if possible, thus avoiding the white water. While saddles are very useful, they must be watched carefully, because they easily turn into “close-outs.”

Figure 5-12
Saddle

B.11.d. Closeouts

“Closeouts” occur when a wave breaks from the ends toward the middle, or two waves break towards each other. The middle may look like a good saddle, but can quickly turn into whitewater. Closeouts should be avoided because they can create more energy than a single break.

Figure 5-13
Closeout

B.11.e. Wave Shoulder

The "shoulder" is the edge of a wave. It may be the very edge of the whitewater on a breaker, or the edge of a high peaking wave that is about to break. The shoulder is usually lower in height than the middle of the wave. Driving on the shoulders can be particularly useful in a narrow surf zone because it allows driving very close to a break in relative safety.

Figure 5-14
Shoulder

B.11.f. Rip Currents

Rips are created along a long beach or reef surf zone. The water from waves hitting the beach travels out to the sides and parallel to the shoreline, creating a "long-shore current" that eventually returns to sea. This seaward flow creates deep channels in the sand offshore that can shift from day to day. In the case of a reef, the channels are permanent parts of the reef, but otherwise behave the same. In these channels, the waves or surf are usually smaller because of refraction over the deeper water. Because of this, a rip channel often represents a safer route into or out of a surf zone. A rip current may also carry a person-in-the-water or a disabled vessel clear of the surf zone (**Figure 5-15**). If using a rip current, great care should be taken to stay in the channel by watching the depth sounder. Boat crews should always be alert for debris, which tends to concentrate in these areas.

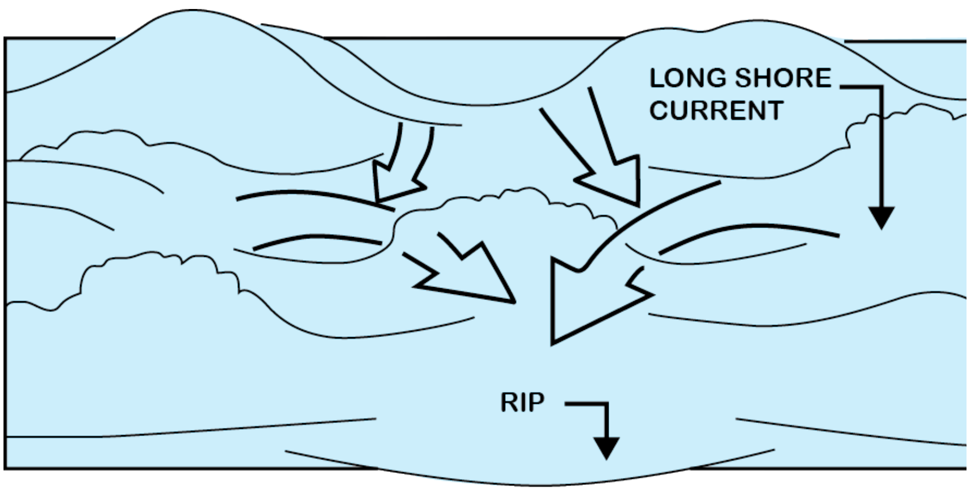


Figure 5-15
Rip Currents

Currents

B.12. Description

Tide is the vertical rise and fall of the ocean water level caused by the gravitational attraction of the sun and moon. A tidal current is the horizontal motion of water resulting from the change in the tide. It is different from ocean currents, river currents, or those created by the wind. Tidal currents are of particular concern in boat operations.

NOTE

Current direction is the compass heading toward which the water moves.

B.13. Flood, Ebb, and Slack Currents

Flood current is the horizontal motion of water toward the land, caused by a rising tide. Ebb current is the horizontal motion away from the land, caused by a falling tide. Slack water is the period that occurs while the current is changing direction and has no horizontal motion.

An outgoing or ebb current running across a bar builds up a more intense sea than the incoming or flood current. The intense sea results because the rush of water out against the incoming ground swell slows the wave speed and steepens the wave prematurely.

B.14. Longshore Currents

Longshore currents run parallel to the shore and inside the breakers. They are the result of the water transported to the beach by the waves.

CAUTION !

Pay close attention to longshore currents. They can cause a boat to broach or the object of a search to move further than expected.

B.15. Eddy Currents

Eddy currents (eddies) occur at channel bends, near points of land, and at places where the bottom is uneven.

CAUTION !

Watch for and avoid eddies. They can abruptly change speed and steering control of boats.

B.16. Wind Effects on Current

Wind affects the speed of currents. Sustained wind in the same direction as the current increases the speed of the current by a small amount. Wind in the opposite direction slows it down and may create a chop. A very strong wind, blowing directly into the mouth of an inlet or bay, can produce an unusually high tide by piling up the water. Similarly, a very strong wind blowing out of a bay can cause an unusually low tide and change the time of the high or low tide.

B.17. Effects on Boat Speed

When going with the current, a boat's speed over ground is faster than the speed/RPM indication. When going against the current, a boat's speed over ground is slower than the speed/RPM indication.

A.21. Roll Axis

As a result of uneven weight distribution (e.g. passenger or excess gear), propeller torque or wind, a vessel can run with a list. Running with a list is uncomfortable, as well as unsafe. The port and starboard trim tabs act independently, making them an excellent instrument to provide effective list correction. To do this, adjust the trim tab downward on the listing side using short bursts. The water pressing against the tab as you move will lift that side of the vessel around the **roll axis (Figure 6-12)** and eliminate your list.

NOTE Trim tabs will have less effect at slower speed than at high speed.

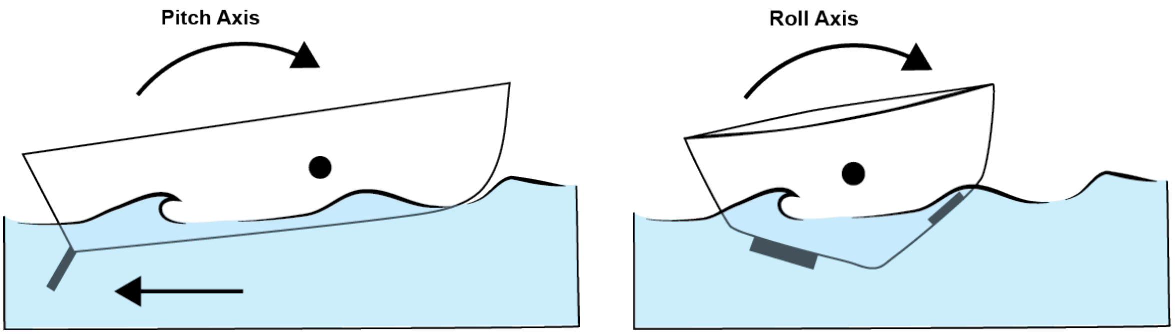


Figure 6-12
Pitch and Roll Axis

A.22. Using Your Engine Power Trim and Trim Tabs Together

Power trim can be used to adjust the boat's pitch axis, but it is highly inefficient. This is because a propeller is designed to force the boat forward. When utilizing your engines power trim, the propeller must not only push the boat forward but raise the stern as well. In this situation, propeller slippage is greatly increased thereby wasting RPMs. Power trim also cannot correct listing, and is ineffective at slower speeds. For increased speed and power, use your trim tabs in conjunction with your engine trim. The trim tabs adjust how your vessel plane, while the power trim adjusts the propeller. The result is optimum performance and efficiency not attainable by the use of the engine power trim alone. To achieve maximum performance:

(01) Adjust the trim tabs to achieve a planing efficiency,

(02) Then use the engine trim to position the propeller path parallel to the water flow,

(03) If necessary, re-adjust the trim tabs to "fine tune".

Utilizing Trim Tabs

A.23. Head Seas

For the most comfortable ride, when running into a head sea you want to trim the bow down so the sharp forward sections of the boat do their work splitting the waves. This will bring the "V" of the hull in contact with the waves rather than having the wave's pound the hull.

A.24. Following Seas

For best maneuverability and maximum steering control, trim tabs should be fully raised in a following sea. Keep the trim tabs up so the tide or current won't push the stern from side to side.

A.25. Astern Propulsion

When operating in astern propulsion, both trim tabs should be fully raised. The trim tabs produce drag if they are left down. This puts strain on the tabs as well as affects the boat's handling. Additionally, if one tab is lowered more than the other while operating astern the boat tends to pivot around the lowered tab.

A.26. Correcting Porposing

As speed increases, the bow repeatedly rises out of the water until gravity overcomes lift and the bow bounces down. Trimming down in half second bursts will allow the trim tabs to deflect, thus resulting in the porpoising to subside and your speed should remain the same or increase. Only a slight amount of trim tab adjustment should be necessary.

Jacking Plates

A.27. Description

Jacking plates are used on smaller boats, usually less than 30ft in length, to aid in operating in shallow water. Instead of being mounted directly to the transom, the outboard motors are mounted to the jack plate which can be raised or lowered as needed (**Figure 6-13**).

Figure 6-13
Jacking Plate

A.28. Basic Operating Principle

Jacking plates, when equipped, can raise the outboard motors allowing you to control the engine draft.

By raising the jacking plates and applying throttle, you can get on a plane in shallower water than you could if you were operating without the jacking plates. Once on plane, you can adjust or lower the jack plates as appropriate.

Jacking plates can be powered via manual or hydraulic means. When powered by hydraulic means there is usually a control panel on the dash which can be used to raise or lower the outboards and also indicates the jacking plate height.

CAUTION !

Until you are familiar with jacking plates and their use. Utilize the crawl, walk, run method when operating your boat. High speed turns with the jacking plates in the full raised position may result in a loss of control, ejection, or capsizing event.

A.29. Advantages of Jack Plates

There are 2 main advantages to using jacking plates:

(01) Operate in shallower water than normal,

(02) Increased Efficiency.

Trimming up your outboard(s) causes the bow to go up and the stern down, increasing your draft. However, jacking the outboards up to the point just before cavitation allows for thrust to be directed directly astern and reduces the increase in draft. This is because once water clears the transom; it flows upward into the propeller and provides sufficient water for the propeller(s) to work.

Because the thrust is more efficient, not thrusting up or down by using the engine tilt, it helps to save more fuel.

A.30. Warnings of Using Jacking Plates

High speed maneuvers can be more difficult when the jacking plates are fully raised. Additionally, a false sense of bravado may occur when determining operational draft realities. Always use sound risk management principles when operating in shallow water.

Usually when getting a plane, boats squat in the stern causing the bow to rise and reducing visibility. When trim tabs are used, they increase visibility by reducing the squatting at the stern and in turn lessening the “bow rise” associated with coming up on a plane. Additionally, the engines do not have to work as hard to get on plane and therefore increased fuel efficiency.

The tabs are more effective than engine tilt at controlling the pitch axis when already on a plane where the tabs can be manipulated to keep the bow from digging into waves or prevent launching the boat over waves.

A.31. 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, the coxswain should always take care to limit cavitation, particularly when backing or maneuvering using large amounts of throttle.

Waterjets

A.32. Operation A waterjet (**Figure 6-14**) is an engine-driven impeller mounted in a housing. The impeller draws water in and forces it out through a nozzle. The suction (intake) 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.

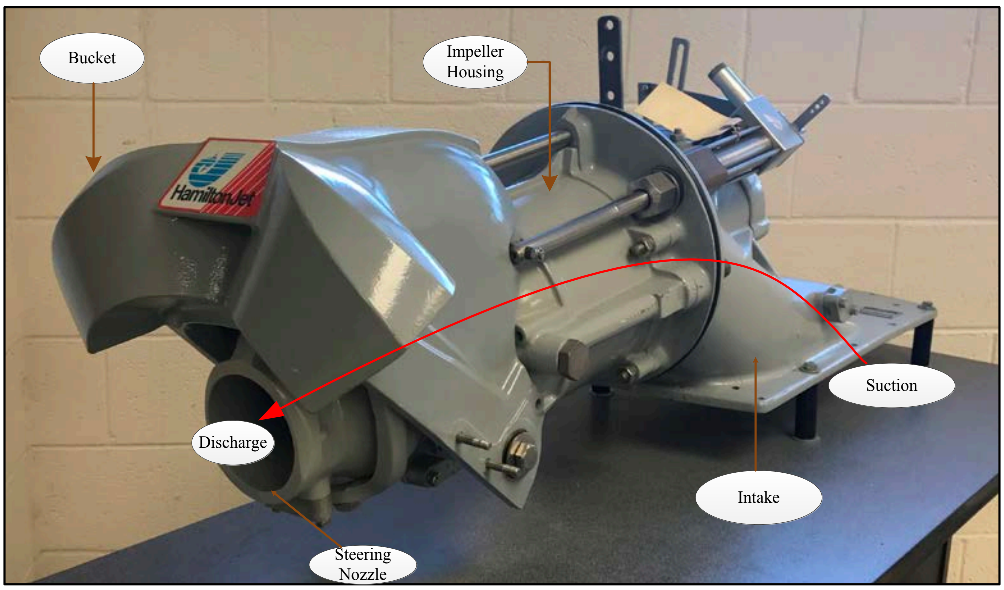


Figure 6-14
Waterjet

A.33. Thrust and Directional Control

Vessel control is through the nozzle-directed thrust (**Figure 6-15**). 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.

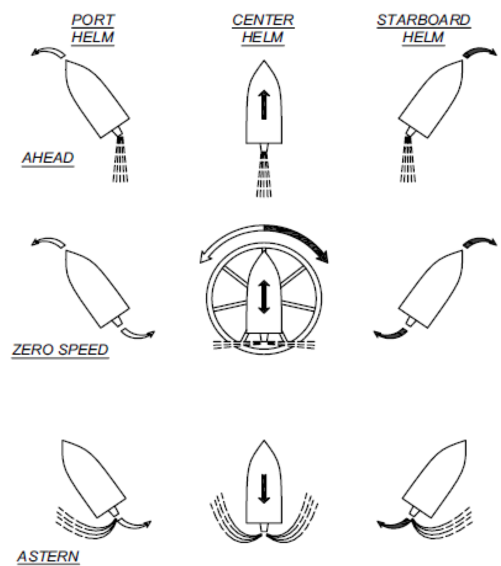


Figure 6-15
Thrust and Directional Control

A.34. 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.