

SMALL VESSEL OPERATOR PROFICIENCY (SVOP)

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A Transport Canada approved course and manual for SVOP (TP 14692 E) certification

Everything you need to know to pass the Transport Canada SVOP certification exam.

Fathom Marine Institute
fathommarineinstitute.ca

SMALL-VESSEL OPERATOR PROFICIENCY TRAINING COURSE

Small-Vessel Operator Proficiency Training Course

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Introduction

This manual is dedicated to members of British Columbia's Marine Search and Rescue units who provide countless hours of training every day, both on the water and in classrooms, preparing to render assistance to mariners in distress. SAR volunteers provide amazing amounts of skill, courage, and time, and have been doing so for decades. Marine Search and Rescue work is a serious obligation, and not always pleasant, but members volunteer their time and train others because it is important to make the waters of British Columbia safer for everyone.

Ambiguous threats at sea

In February 2003, the world watched as the Columbia space shuttle broke apart while re-entering the earth's atmosphere, resulting in the deaths of seven astronauts. The investigation determined that sections of panels had dislodged, damaging a wing and causing the fatal accident. Critics accused NASA's management of being incompetent and lacking safety protocols. However, subsequent research suggested that NASA was simply a victim of human nature's inability to recognized less obvious threats. This came to be known as the "ambiguous threat."

Unfortunate as it may seem, organizations tend to be better prepared for threats that are plainly obvious and that result in a clear dynamic response. Sometimes however, the most serious threats appear when a warning sign is ambiguous or unclear resulting in no response at all. For example, driving a vehicle with partially worn-out tires can result in a catastrophic accident under certain conditions like wet roads or excessive speed around a winding road. The vehicle owner may realize that the tires should be replaced but does not appreciate the serious risk that exists while they continue to use the vehicle.

The Columbia spacecraft accident and its relation to the ambiguous threat have everything to do with marine safety: Marine vessels also face a multitude of potential emergencies that can occur while at sea. Some arise from a combination of environmental conditions, human error, training issues, or equipment failures that may seem minor or insignificant but that result in a marine emergency.

It is critical that mariners ensure that the totality of safety, environment, and mechanical checks are conducted, and that any resulting issues are properly addressed. This course prepares mariners to identify and minimize any potential malfunction and trains them in avoiding or responding to circumstances that could jeopardize the operation of the vessel and the safety of its crew and passengers.

Course overview

This manual provides the essential core reference material for the student in identifying potential risks and developing situational awareness in the marine environment.

The course will provide the student with Transport Canada required seamanship skills and safety protocols to safely operate a small commercial vessel. Upon completion of the course, students will have:

- the knowledge and skills necessary to safely operate a small non-pleasure vessel in near coastal and sheltered waters under normal operating conditions, including darkness and restricted visibility.
- ability to engage on a near coastal, class 2, or a sheltered waters voyage and for fishing vessels up to 15 gross tonnage, or 12 metres overall length, engaged on a near coastal voyage, class 2.
- additional knowledge on aids to navigation and seamanship to supplement individual experience.

Delivery

Location: North Saanich on Vancouver Island, other areas of the BC Coast, and where applicable, online.

Classroom sessions include demonstrations, visual and hands-on instruction with safety equipment, videos, whiteboards, and work sheets. Students have opportunities to handle equipment and are expected to demonstrate identified competencies to the instructor.

A manual is provided to each student in advance of the course in an electronic format. (Hard copies can be provided if required.) Students are expected to read the manuals in advance of the course.

Duration: Minimum 26 hours, including two hours for evaluation

Reviews and exams

- All 23 chapters provide review quizzes in the form of short-answer questions.
- The written examination approved by Transport Canada Marine Safety contains 50 multiple-choice questions and the pass mark is 70%.
- Administering the examination orally and/or online may be considered on a case-by-case basis.

1. Legal aspects of non-pleasure, small-vessel operations

Goals of this chapter

This chapter outlines the legal aspects and requirements of non-pleasure small vessel operations, and provides the legal definitions of the various types of small vessels.

Learning outcomes

After completing this chapter, students will:

1. Understand the scope, purpose, and limitations of the Small Vessel Operators Proficiency (SVOP) Certificate and who requires the Certificate
2. Describe the *Shipping Act*, define non-pleasure vessels, passenger vessels and pleasure craft, and understand the legal requirements of non-pleasure vessels
3. Understand Transport Canada's Small Vessel Compliance Program
4. Describe the Master's responsibilities, including safety (life, environment, and property) and commercial aspects

1. Scope, purpose, and limitations of the SVOP Certificate and who requires the Certificate

The SVOP training certificate is issued by Transport Canada upon successful completion of a Transport Canada-approved SVOP training course. The SVOP training course is intended to address the particular need for minimum training of, and is required for operators of:

- **Non-pleasure small vessels**, other than tugs, up to 5 gross tonnage engaged on a near coastal voyage (within 25 miles from shore in waters contiguous to Canada, the United States (except Hawaii) or Saint Pierre and Miquelon, hereafter referred to as a "Near Coastal" voyage)
- **Fishing vessels** up to 15 gross tonnage or not more than 12 metres overall in length engaged on a Near Coastal voyage. (*Marine Personnel Regulations*)

The SVOP certificate is not the only certification required by a non-pleasure small vessel or fishing vessel operator. Pursuant to section 212 of *Marine Personnel Regulations***,** a person who holds a SVOP Certificate *and* a Small Non-Pleasure Domestic Vessel Basic Safety (SDV-BS) Certificate (previously, MED A3), may operate:

1. Passenger vessels or workboats not more than 5 gross tonnage, with not more than 12 passengers, on a Near Coastal voyage
2. Fishing vessels not more than 15 gross tonnage, with not more than 12 passengers, on a Near Coastal voyage. (Marine Safety Transport Publication)

Other competencies are also required of the operator who must possess, and carry on board, copies of a Restricted Operator's Certificate (Maritime) (ROC-M) and Marine Basic First Aid Certificate.

Also note that a person must be at least 18 years of age before using the SVOP certificate to carry out the duties of an operator of a commercial vessel. *(Small Vessel Operator Proficiency Training Course*)

2. The *Shipping Act* and regulations: non-pleasure vessels, passenger vessels, pleasure craft, and non-pleasure craft

The *Canada Shipping Act* (CSA) 2001 (the *Shipping Act*) is the principal legislation governing the safety of marine transportation and recreational boating, as well as the protection of the marine environment.

See www.tc.gc.ca/eng/marinesafety/debs-arctic-acts-regulations-csa-1782.htm and https://laws-lois.justice.gc.ca/eng/acts/c-10.15/

Regulations made under the *Shipping Act* referred to in this chapter, include:

Marine Personnel Regulations (SOR/2007-115) ("*Marine Personnel Regs*")

Small Vessel Regulations (SOR/2010-91) ("*Small Vessel Regs*")

Special-purpose Vessels Regulations (SOR/2008-121) ("*Special Purpose Regs*")

Fishing Vessel Safety Regulations (CRC, c. 1486) ("*Fishing Vessel Safety Regs"*)

Vessel Certificates Regulations (SOR/2007-31) ("*Vessel Certificates Regs*")

Vessel Pollution and Dangerous Chemicals Regulations (SOR/2012-69) ("*Pollution Regs*")

Vessel is defined under the *Shipping Act* as:

> *. . . a boat, ship or craft designed, used or capable of being used solely or partly for navigation in, on, through or immediately above water, without regard to method or lack of propulsion, and includes such a vessel that is under construction. It does not include a floating object of a prescribed class.*

The regulations that apply to a vessel are specific to the situation for which the vessel is being used. It must be determined if the vessel is being used commercially (non-pleasure) or for pleasure purposes. The factors that determine the regulations and requirements which govern use of a non-pleasure vessel include the size of the vessel, the number of passengers, the area of operations and environmental risks.

Vessels operating in protected waters require less and different regulation than vessels operating in open seas. Vessels operating in open seas require additional and approved safety equipment, enhanced vessel construction standards, and operators' certifications.

Small Vessel Regs provide safety requirements for five types of vessels:

- Pleasure craft
- Passenger carrying vessels
- Workboats (non-pleasure, non-passenger carrying)
- Tugs
- Human-powered non-pleasure vessels

The regulations do not apply to:

- Fishing vessels
- Rescue boats or lifeboats carried on board another vessel exclusively to meet a requirement for life-saving appliances set out in other regulations made under the *Shipping Act*
- Vessels for which the *Special-Purpose Regs* apply
- An air-cushion vehicle of more than 4,500 kg total weight

Consideration of a vessel's purpose

These include whether it is used for pleasure or commerce and, if used for commerce, its specific commercial use. For example, a commercial fishing vessel must comply with applicable *Fishing Vessel Safety Re*gs and a small passenger vessel must comply with the *Small Vessel Regs*. However, if a vessel is used for more than one purpose, such as commercial fishing *and* carrying passengers, it must meet both the applicable *Fishing Vessel Safety Regs* and the *Small Vessel Regs*.

Pleasure craft vs. non-pleasure vessels

Pleasure craft is a vessel used for pleasure, recreation, or daily living, including as a means of transportation, recreational or subsistence fishing, or for social or ceremonial purposes. A pleasure craft may carry non-paying guests without remuneration or any object of profit. Examples of pleasure craft include vessels provided with a rental cottage (but without a skipper) for the personal use of the renters.

Non-pleasure craft are vessels used for anything other than pleasure, recreation, or daily living and instead used for profit and/or service operations. Examples include vessels moving cargo or passengers for profit or as part of the operator's job.

Chartered vessels are commercial vessels if the master is the owner or if they are used other than for pleasure. If you rent or charter a vessel without crew and you either hire a master or operate it yourself, it is a pleasure craft so long as it is used only for your pleasure, recreation, or daily living, including as a means of transportation, or for recreational or subsistence hunting or fishing. If you are the owner and you rent or charter the vessel without crew to someone else who uses

it for pleasure, it is a pleasure craft. If you provide the Master or operate the vessel yourself, it is a commercial vessel.

It is the way a vessel is used that determines whether it is a pleasure or non-pleasure craft; accordingly, the same vessel may at times be a pleasure craft, and at other times a non-pleasure vessel.

While examples are helpful, they should be used as guidance only. In all cases, the *Shipping Act* and its regulations must prevail and shall at all times determine the safety requirements and the safe operation of the vessel. If in doubt about your vessel, contact your local Transport Canada Centre for further guidance.

See *TP 14070 E*, Chapter 1, at: https://www.tc.gc.ca/eng/marinesafety/tp-tp14070-3579.htm

See also Government of Canada*, Marine Transportation, Domestic Vessel Regulatory Oversight and Boating Safety, Small Vessels: Non-Pleasure Vessel or Pleasure Craft* at*:* https://www.tc.gc.ca/eng/marinesafety/oep-vesselreg-menu-4416.html

Guests vs. passengers

It is important for a vessel owner or operator to determine whether the vessel is carrying passenger(s) or guest(s). This is an element in determination of the vessel's purpose and the corresponding safety requirements.

Passengers: If the vessel owner or operator receives any form of remuneration for the use of the vessel, even if not directly from the persons carried on board, those persons are passengers. A fare does not have to be paid for a person on board to be considered a passenger. A passenger can be anyone (with a few, probably rare, exceptions detailed in the *Shipping Act*) except for the Master, a member of the crew or a person employed or engaged in any capacity on board the vessel in the business of that vessel. (*Shipping Act*)

Guests: A guest is a person on board a vessel that is being used exclusively for pleasure and who is carried without renumeration or any object of profit. For example, your fishing buddy who is sharing the cost of fuel on a fishing trip would be considered a guest as there is no profit sought.

Fishing vessels vs. special purpose vessels

Fishing vessels must comply with regulations specific to the vessel, including hull construction, rigging and gear.

See *Fishing Safety Regs* and the *Small Fishing Vessel Safety Manual TP 10038 E* (2003) at: https://www.tc.gc.ca/eng/marinesafety/tp-tp10038-menu-548.htm

As noted above, if your vessel is used for more than one purpose, it must meet all applicable safety requirements for both purposes.

Special purpose vessels such as commercial river rafts, sail training vessels, and amphibious and air cushion vessels, must consult Transport Canada for information and guidance.

3. Transport Canada Small Vessel Compliance Program (SVCP)

To own or operate a small commercial vessel, you must comply with applicable safety and environmental requirements set out in the *Shipping Act* and its related regulations and standards.

The voluntary SVCP gives owners and operators an easy-to-use tool that brings together all requirements for small non-pleasure vessels. It helps owners and operators to:

- Ensure that the vessel, its machinery and equipment comply with regulations.
- Develop procedures for safe operation and for emergencies.
- Ensure that crew and passengers receive safety training.

Participants receive a blue or orange decal (determined by the type of vessel) to display on their vessel, showing that the vessel is enrolled in the program, a letter of confirmation of participation in the program, and detailed compliance report forms for annual completion and submission. The program is for:

- Non-pleasure vessels up to 15 gross tonnage
- Passenger vessels up to 15 gross tonnage, carrying up to 12 passengers
- Fishing vessels up to 15 gross tonnage
- Recreational boating school vessels

The program does not apply to:

- Pleasure craft
- Tugs
- Human-powered crafts such as canoes and kayaks
- Small special-purpose vessels

How to enroll in the SVCP

Enrollment can be done online, or by printing the small vessel detailed compliance report and filling it in or by requesting a paper copy from your local Transport Canada Center (TCC). Return completed paper forms to the TCC Office for review.

Follow this link to download an enrolment form:

https://www.tc.gc.ca/en/services/marine/vessel-inspection-certification/voluntary-compliance-programs-commercial-recreational-vessels/enroll-small-vessel-compliance-program.html

4. The Master's and owner's responsibilities

Master/operator

The *Shipping Act*, section 2, defines a Master as ". . . the person in command and charge of a vessel." In this manual, the terms "Master" and "operator" are used interchangeably.

Pursuant to section 109(1) of the *Shipping Act*, the Master of a vessel ". . . shall take all reasonable steps to ensure the safety of the vessel and of persons who are on board or are loading or unloading it while using equipment on it."

In addition, the *Shipping Act* provides that the Master shall:

- Take reasonable steps to protect the vessel and persons on board from hazards.
- Ensure an excess number of persons is not carried on board.
- Ensure the applicable load lines on a vessel are not submerged.
- Comply with the direction given to the Master by a marine safety inspector.
- Give notice and share information with vessels in the vicinity respecting dangers to navigation. (*Shipping Act*)

The Master shall also ensure that pre-departure:

- Passengers receive pre-departure safety briefings. (*Shipping Act, Small Vessel Regs*)
- The number of persons on board has been reported to a person on shore who has been designated by the operator to be responsible for communicating with search and rescue authorities in case of an emergency. (*Small Vessel Regs*)

Part 4 of the *Shipping Act* requires Canadian vessels that are subject to periodic inspection to carry valid maritime documents on board. These documents must be appropriate for the vessel, its type of operation and its voyage, and the Master shall, before the vessel embarks on a voyage from a port in Canada, ensure that copies of all of the required maritime documents have been obtained.

An operator of a small non-pleasure vessel must have on board the vessel, copies of the following:

1. The required operator and crew certificates of competency/training, which will include:
    a. SVOP
    b. Domestic vessel safety, basic safety DVS-BS (formerly MED 3)
    c. Restricted Operator's Certificate (Maritime): the ROC-M is required by anyone using a marine VHF radio or other marine

radio (each person on the boat who use the radio needs their own card

d. Marine Basic First Aid Certificate, required by the person designated to provide first aid on board a vessel engaged on a Near Coastal voyage

2. Vessel registration (*Marine Personnel Regulations*, *Shipping Act*)

Authorized representative/owner

Every Canadian vessel must have a person designated as the "Authorized Representative," who is responsible under the *Shipping Act* for all matters relating to the vessel that are not otherwise assigned under the *Shipping Act* to another person. (*Shipping Act*)

In most cases the Authorized Representative will be an owner of the vessel and in this manual, the term "owner" is used to mean authorized representative.

Section 106 of the *Shipping Act,* requires that the owner ensure that the vessel and its machinery and equipment meet the requirements of all regulations made under Part 4 of the *Shipping Act*.

Further, the owner must:

- Develop procedures for safe operation of the vessel in normal and emergency conditions.
- Ensure that the crew is trained so that it can carry out its duties with skill.
- Maintain a record of training that has been carried out.

The owner must also ensure that the Master has the certifications necessary to operate the vessel on the type of voyage that will be undertaken and together, the owner and Master must ensure the crew meets all applicable certification and training requirements and receives onboard familiarization and safety training before they start to perform assigned functions. Mandatory training for all non-pleasure vessel crews will include the prescribed first aid and basic safety training and all crew members must be able to use safety, firefighting, and operation equipment effectively. (TP 14070 E, Chapter 4*, Small Vessel Regs*, *Marine Personnel Regs*)

Various Transport Canada policies and procedures support the operator's duty to make sure the crew is trained and well able to carry out their duties. To learn more about certification and training requirements, contact your local Transport Canada Centre.

All operators and crew must be aware that it is prohibited to, and shall prevent or mitigate overboard discharge of, fuel, oil, oily mixture, noxious liquids, sewage

and/or garbage. (*Small Vessel Regs*, *Shipping Act*, *Pollution Regs*, *Marine Personnel Regs*)

Inspection of small non-pleasure vessels

Sections 10 and 11 of the *Shipping Act*, authorize marine safety inspectors to perform inspections on small non-pleasure vessels, with little or no notice. Vessel inspection may include review of documentation, navigation equipment, vessel manning and crew qualifications, stability, safety and firefighting equipment, electrical systems, ventilation, fuel systems and machinery.

Transport Canada marine safety inspectors or Transport Canada enforcement partners may check that the crew's certification meets requirements and may test the crew's ability to respond efficiently in distress situations by asking questions related to safety, emergency, and survival procedures *or* by requiring a test voyage to demonstrate how well the operator and crew:

- Know navigation rules, local conditions and hazards.
- Operate the vessel.
- Use safety equipment.
- Follow specific operating and emergency procedures.
- Fill other safety-related roles and responsibilities. (TP 14070)

Deficiencies warranting a more detailed inspection include:

- Evidence that the vessel’s operations are not being conducted safely
- Inaccurate or expired certificates or documents
- Crewmembers who display unfamiliarity with their assigned emergency duties or operational procedures.

All crewmembers should be well versed in their areas of responsibility and prepared to demonstrate their requisite competencies in an inspection. *(Inspection of Small Non-Pleasure Vessels,* TP 13585E)

CHAPTER 1 REVIEW

1. What is the maximum gross tonnage a Master holding an SVOP certification can operate?

2. What copied documents must the Master keep on board the vessel at all times?

3. You make arrangements to get a free tour of the surrounding water on a vessel in return for the operator's use of your cottage. Is this vessel being used as a pleasure craft or for commercial purposes?

4. How many passengers can a vessel carry if the vessel is certified to hold 25 persons and the Master holds a SVOP certificate?

5. What is the minimum age requirement for operation of a commercial vessel under a SVOP certification?

6. Who is responsible for establishing safety procedures, protocols, and maintenance schedules for a commercial vessel?

7. What legislation governs oversight of commercial vessels?

8. What is the Small Vessel Compliance Program?

2. Basic small-vessel construction and nautical terminology

Goals of this chapter

This chapter defines basic nautical terminology used on marine vessels to describe parts, direction, and structural components, including basic structural terms.

Learning outcomes

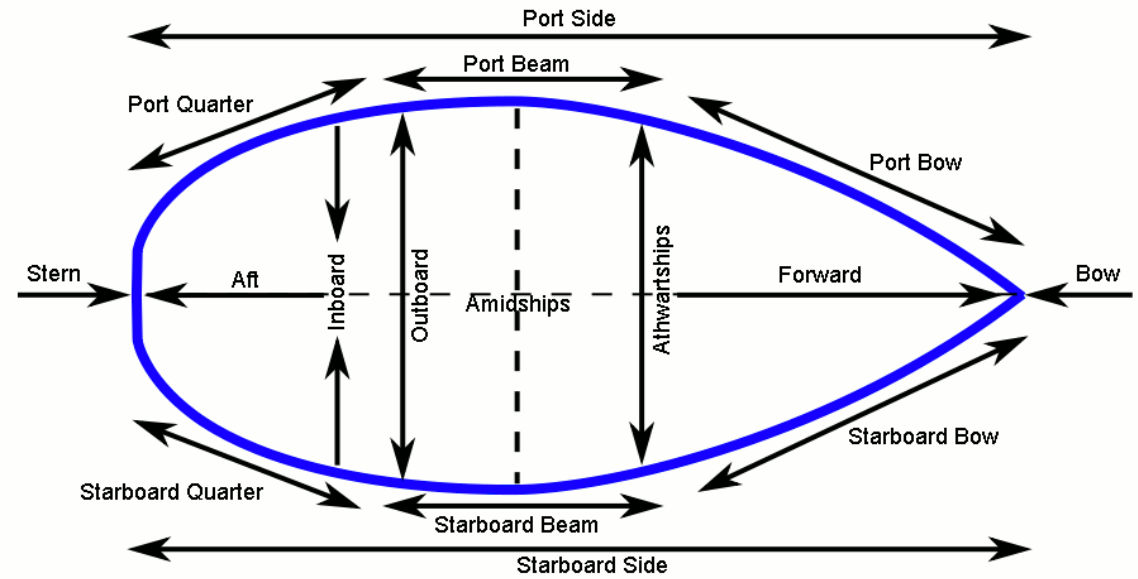
On completion of this session, students are expected to:

1. Understand the terms used to describe parts, direction, and structural components of a small vessel.
2. Apply basic terminology used in small-vessel construction.

1. Terms used to described direction, location, and structural components of a small vessel

Knowing basic nautical terminology is essential to safe and effective operations aboard a vessel. It is nearly impossible to communicate effectively with your crew if you are not speaking the same language. Knowing the proper terminology conveys a level of professionalism and competence to others on board. Proper communication is also critical during emergency situations.

Terms: position, location, and direction aboard a vessel



General Shipboard Directions

Abeam: At right angles to the **keel** of the vessel.

Aboard: On board or within the vessel.

Abaft: Toward the rear (stern) of the boat. Behind the stern.

Abreast: Side by side or alongside the **beam** of a vessel.

Aft: Toward the stern or the rear section of the vessel.

Ahead: In a forward direction or forward of the bow.

Amidships: The central or middle section of a vessel**;** in or toward the centre of the boat, laterally or longitudinally.

Astern: Behind or toward the rear of the vessel. If the vessel is moving in the direction of the stern, then the vessel is moving astern. If you are looking astern, you are looking toward the rear of the vessel.

Athwartships: In line with the centreline of the vessel between the port and starboard side. Going from the centreline of the vessel towards either port or starboard is **outboard** athwartships while from either side towards the centreline is **inboard** athwartships.

Beam: The widest part of the vessel, from the starboard side of the vessel to the port side of the vessel.

Bow: The front end of the boat, which faces forward when the boat is underway. Any onboard movement toward the bow of the vessel is described as moving **forward.** Your vessel is moving **ahead** if the bow is moving forward.

Fore-and-aft: In line with the length of the vessel and parallel to the longitudinal centerline of the vessel. Also used in reference to anything that exists at both at the bow/front and stern/back of the vessel, such as being anchored fore and aft.

Port: When looking forward, the left side of the bow of the vessel is the port bow. The entire left side of the vessel is the port side.

Port beam: The central, left side of the vessel**,** when looking ahead.

Port quarter: The rear portside part of the vessel.

Starboard: When looking forward, the right side of the bow of the vessel is the starboard bow. The entire right side of the vessel is the starboard side.

Starboard beam: The central right side of the vessel, when looking ahead.

Starboard quarter: The rear starboard part of the vessel.

Stern: The most rear part of the vessel**,** at the opposite end to the bow.

2. Basic terminology used in small vessel construction

Vessel construction terms

Breadth: The width of a vessel at a particular point. The most extreme width is the **beam**.

Bridge: The location from which a vessel is operated, which includes being steered and having its speed controlled.

Cockpit: An opening in the deck from which the vessel can be controlled.

Draft: The vertical distance between the waterline and the lowest point of the vessel underwater.

Helm: The wheel or tiller controlling the angle of the vessel rudder and thereby setting the direction of the vessel.

Freeboard: The vertical distance between the waterline and the top of the gunwales.

Gunwales (pronounced “gunnels”): The upper edges of the sides of the vessel.

Hull: The main body of a vessel requiring a framework of structural components and a “skin” or covering that can be made of many materials. The most common materials used today are wood, metal, and fiberglass. As boat building advances, innovative technologies result in new construction techniques, designs, and materials that are more resistant to abrasions and impact.

Displacement hull: A type of hull that moves through the water, with low propulsion, by pushing the water aside and displacing a weight of water equal to its own weight.

Planing hull: A type of hull shaped to rise upward and glide easily across the water with sufficient speed.

Keel: A flat bladelike structure, running longitudinally along the centre and bottom-most part of the hull. The keel serves to provide stability and resistance to the wind.

Length overall of a vessel (also referred to as the **LOA):** The maximum length of the hull, measured from the tip of the hull to the stern in a straight line that is parallel to the water.

Rudder: An underwater vertical plate or board at the rear of a vessel. Turning the rudder with a wheel or tiller sets the direction of the bow of the vessel.

Tiller: A bar or handle attached to, and used for turning, a boat’s rudder.

Waterline length: The length of the vessel, at the water line as it sits in the water.

Ship’s framing structure



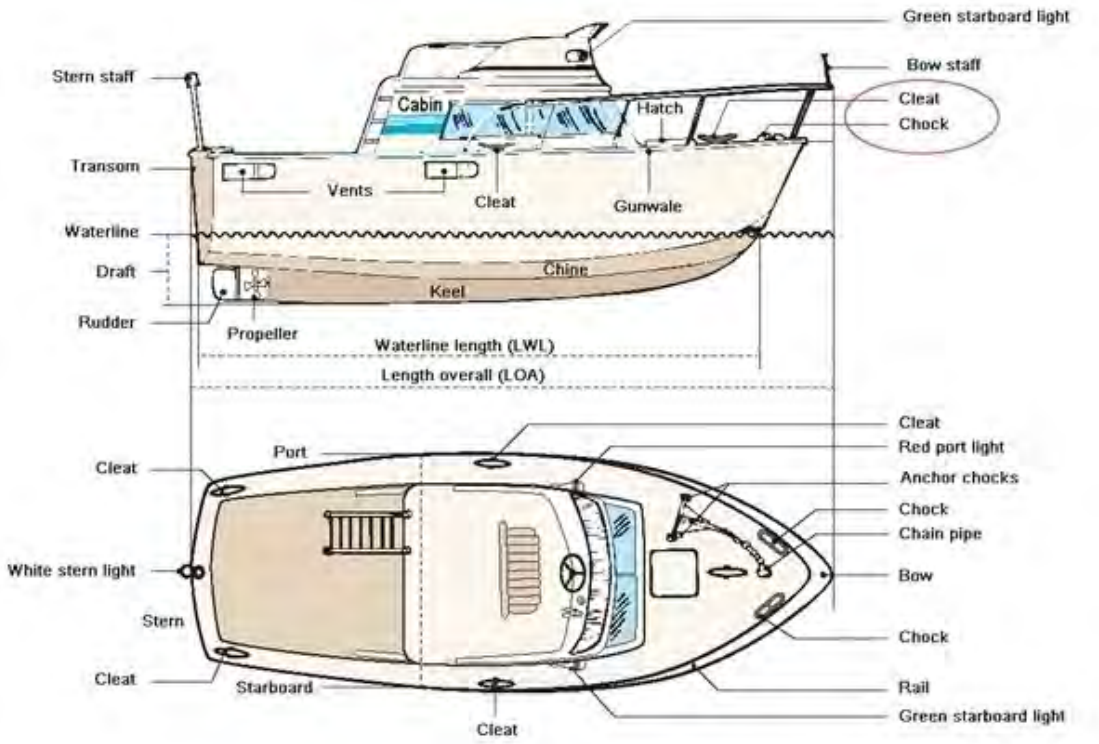
There are two types of frame structures**: transverse** and **longitudinal**.

Vessels are usually constructed using ribs and frames. Similar to the construction of a house or other building, the ribs and framing provide part of the strength and integrity of the hull to withstand the forces of the sea. Adding another overlapping and cross-sectional skin to the hull re-enforces the entire integrity of the structure and provides a surface for the skin to be attached to.

Transverse frames: The **ribs** are frames that extend across (athwartships) the hull and fitted at specific locations that determine in part, the hull’s design and lines while providing structure and strength to the sides of the hull.

L**ongitudinal frames:** These frames cross the ribs at roughly 90 degrees of angle and parallel the keel fore-and-aft of the vessel from bow to stern. This framing is secured to the ribs and providing exception strength to the hull’s bottom and sides. The longitudinal framing is often seen on wooden boats that follow the vessel curvature.

Vessel structures



Bilge: The lowest interior part of the hull below the floorboards where fluid may collect. A bilge pump clears water from the bilges.

Cabin: A compartment for passengers or crew.

Camber: A deck will curve by several degrees downwards from its centerline amidships to the outward sides of the vessel. A rounded athwartship curving of the deck allows water to drain outwards to either the starboard or port side of the vessel.

Cuddy: A small shelter cabin in a boat.

Deck: The horizontal part of a boat, providing the floors, sometimes on different levels, that can be walked on. The deck is attached to the longitudinal beams and in addition to serving as a permanent cover to the hull and its compartments, provides additional strength. The top deck of a vessel is known as the **weather deck** because it is exposed to the outside and is not covered. **Above deck** means on the deck and **below** means beneath the deck. As a deck on a boat is not usually flat, it will have various levels of curvature which are called **sheer** and **camber**.

Galley: The kitchen area of a boat.

Gangway: The area where people board and disembark.

Grab rails: Hand-hold fittings mounted on cabin tops and sides for personal safety when moving around the boat.

Hatches: The openings between decks. Weather deck hatches become watertight when installed in a raised framework known as a **coaming.**

Head: A marine toilet.

Scuppers: Holes or drain fittings in the side or deck of the vessel, allowing water to drain off the ship.

Seacock: A through-hull valve, allowing fluid to enter or exit the boat. Seacocks can be left open or closed, as required.

Sheer: The degree to which the deck longitudinally curves up at the fore and the aft of the boat. Sheer lines differ on each vessel and generally present different grades of decking to allow sea water and rain to move fore-and-aft often to the midships area of the vessel.

Stem: The most forward part of the bow and an extension of the keel, rising from the keel upwards to the gunwales; it forms an anchor point for the sides and covering of the hull.

Transom: A solid flat part that forms the stern of the vessel, running from starboard to port sides of the stern. On smaller vessels an outboard engine may be attached to the transom.

CHAPTER 2 REVIEW

1. As the helmsman of a vessel how would you define a position of something in the water just forward and to the right of the bow?

2. What is the gunwale and where is it located on a boat?

3. What is the transom on a vessel and what might it be used for?

4. What would you call the position of something in the water on the rear starboard side of your vessel?

5. What would you call a door on a ship?

6. What does athwartships mean?

7. What types of traditional materials are used to build a boat?

8. When looking directly to the right side of the vessel and seeing an object in the water, how would you describe the object's position to the Master?

9. Define the draft of a vessel.

3. Vessel hull types and configurations

Goals of this chapter

This chapter describes various hull types and configurations used in construction of small- and medium-size vessels, and outlines their advantages and disadvantages of operation.

Learning outcomes

On completion of this chapter, students are expected to have a basic understanding of:

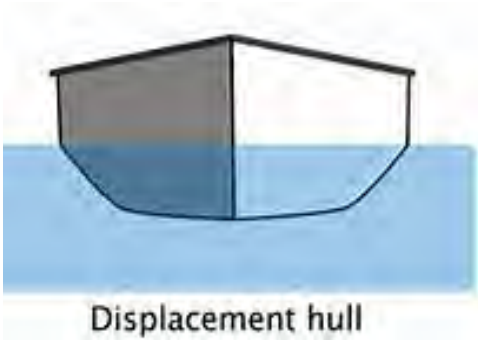
1. Displacement hulls and planing hulls
2. Open-hull vessels and enclosed-hull vessels
3. Inflatable rescue craft and multi-hull vessels
4. Other hull types

1. Displacement hulls and planing hulls

Different hulls behave differently and are designed for different purposes. From light rapid zodiacs skimming across the water to slow-moving trawlers, one hull design cannot meet all the requirements for the variety of operating demands of vessels at sea.

Hulls have been evolving in technology and design for the last 2000 years. Some of the limiting factors that control the hull speed, size of the engine, carry capacity and other factors will be discussed in this chapter.

Displacement hulls





"Displacement" refers to a vessel of any type and the weight of water it displaces while sitting in the water. A displacement hull is typically big and with a rounder hull design with a long waterline length that slows the speed of the vessel and prevents its ability to plane out of the water. Additional horsepower would not make a difference, as the hull design provides no ability to create lift.

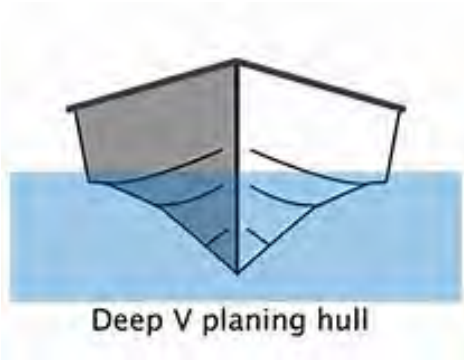
The difference between a displacement hull and a planing hull starts at the time they begin to make way (move through the water). When a vessel begins to move through the water, a displacement vessel moves or displaces the water away and to the side of the vessel, similar to a snowplow. As the vessel proceeds, the water closes in behind it. A displacement vessel moves forward through the water continually displacing the water and thus remains fixed with the weight of the vessel equal to the weight of the water it displaces.

Regardless of the speed, the equilibrium is maintained and the vessel never climbs out of the water and in fact, digs deeper into the water as the vessel speed increases. Displacement vessels have large bow and stern waves generated by pressure imbalances between the water and hull; the design of the displacement vessel's bow never lets it rise above the water.

Since pressure is created at the bow and stern, the larger the displacement vessel, the larger the wake.

Displacement hulls are more stable in the water than planing hulls, and generally can carry more cargo and are better suited for larger seas. Many examples of displacement hulls include commercial trawlers, freighters, sailboats, larger yachts, and tugboats.

Planing hulls





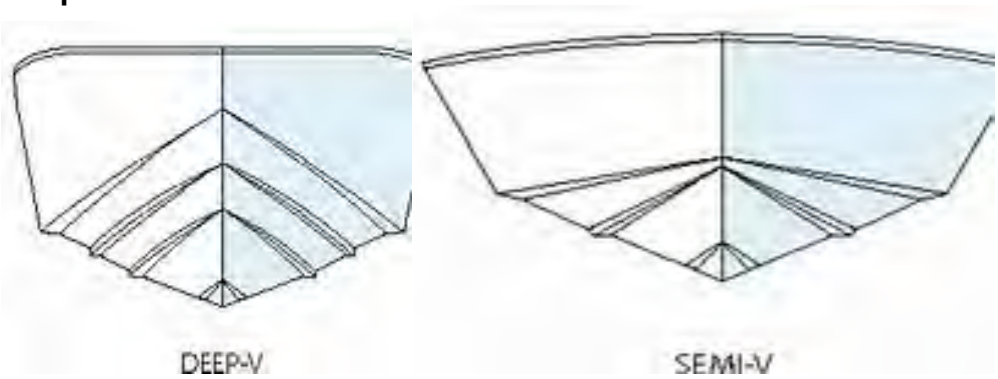
"**Planing**" from a nautical perspective, is the sliding or skimming across the water. At rest, or at slow speeds a planning hull acts similar to a displacement hull. The surrounding water pushes inwards and upwards with equal force to the weight and displacement of the vessel. As speed increases, the hull's design uses hydrodynamic lift to push the water underneath the bow. This occurs as the vessel increases in speed and reaches planing speed based on the hull's specific design and circumstances (weight and distribution referred to as being "on step").

Underway, planing vessels, convert some of the energy of their forward motion into vertical lift by deflecting water downwards. Similar to a stone skimming across the water, the forward energy of the stone enables it to obtain lift in the same way. A tremendous amount of forward thrust is required for a vessel to reach a planing speed. Unlike a light-weight stone skipping across the water when thrown with a tremendous amount of energy, a planing hull never obtains enough dynamic lift from the water to lower its displacement all the way to nothing. However, the reduction in displacement of the hull, through increased speed, allows a planing vessel to achieve reduced friction that significantly increases its speed over the water.

Planing hulls come in different forms with the more common being a V shape usually with a chime in it. The flat edge of the chime pushes the water downwards, which in turn aids lift. Examples of planning vessels are small pleasure craft, hydroplanes, and some smaller pleasure yachts.

V-bottom hulls

Deep-V and semi-V hulls



V-bottom hulls are extremely popular and for good reason. They are highly resistant to purposing (a tendency to pitch and slam) also have an enhanced capability of operating effectively in rough water, higher speeds and banking into turns, similar to a motorcycle. (Displacement hulls characteristically bank away from the turn, similar to vehicles).

V bottom boats bank harder and more reliably than flat bottom boats. As the v bottom boat begins it turn the vessel banks, changing the center of gravity inwards. The outer side is lifted from the vacuum of the water allowing the inner side to cut into the water, assisting in tracking and stability. Though requiring more power to obtain stability when planning, in almost all cases the tradeoff is worth it. Good planning boats are more stable at speeds than at rest

The importance of trim

The vast majority of small crafts, runabouts, and small fishing vessels have a flat or V bottom design that when acceleration occurs from a standstill the bow will raise at about the same time the effects of planning occur. The water eventually breaks away from the bow and transom and progressively levels off. This is a characteristic of all planing hulls. Consideration must however be given to weight distribution, in order to reach the desired effects of proper trim. Modern V-bottom haul design accounts for load capacity, though extreme loads should be carried as close to amidships as possible.

Semi-displacement hulls





Semi-displacement hulls are generally considered a cross between planing hulls and displacement hulls. They generate some amount of lift but not as much as a planing hull. Semi-displacement hulls require a tremendous amount of power to create lift, resulting in a larger bow and stern wave. These hulls typically have a similar hull shape to a displacement hull, except with a harder chime and they flatten off toward the stern.

Flat-bottom boats



Flat-bottom boats are a type of planing hull with some limitations and advantages. They are sometimes called "**prams**" or "**bay boats.**" These hulls require less effort to get on plane because they have a larger flat surface area that sits on top of the water surface essentially requiring less power to achieve plane. Flat-bottom hulls are not suitable for larger seas in chopper conditions as they cannot absorb the waves that make for an uncomfortable ride. These boats provide a stable platform at slow speeds and a large working deck, and are best suited for calmer waters such as small lakes and slow-moving rivers.

These vessels are often seen in marinas functioning as workboats, jet boats on rivers, or for fishing in protected waters.

2. Open-hull and enclosed-hull vessels

Most vessels are built with a single hull, known as a mono- or single-hull vessel. The hull of any vessel is the foundation for many of its characteristics including stability, handling the seas, and support of the above deck infrastructure that will house the crew and working machinery for the vessel's operations.

From the standpoint of smaller vessels, there are essentially two types of configurations that form the superstructure above the waterline of any vessel: an open-hull vessel or a closed-hull vessel. Regardless of a vessel's configuration, a vessel that can take on water and get rid of it quickly can operate in more unfavourable conditions.

Open-hull vessels

On smaller vessels an open area provides a larger surface deck space to work in. Smaller vessels may have a small open bridge or console to control the vessel and usually "built in" watertight compartments to store product and cargo. These vessels tend to be built lower to the water (lower freeboard), which in part, offer some stability at slower speeds but also subject the vessel to larger waves and the potential for swamping. (large amount of water entering the vessels). Smaller open vessels are therefore not well suited for rough and open seas. All small open vessels must have the ability to remove any water from their decks and bilges. Dinghies, flat-bottom vessels, smaller recreational fishing vessels, and harbour workboats tend to fall into the category of open-hull vessels.

Enclosed-hull vessels

The enclosed-hull vessel provides more watertight infrastructure, and protects the crew and equipment from the marine environment. Depending on the amount of enclosure fitted on the vessel, it can provide sleeping and eating accommodations, protect equipment, and enable the vessel to stay at sea for longer periods of time. Enclosed vessels are heavier and therefore can accommodate larger seas than a smaller open vessel. Depending on its design and above-deck weight and surface area, the enclosed vessel can be more difficult to maneuver but has less of a tendency to be swamped. Due to the infrastructure above the deck, the vessel has less deck space for work outside. As in any vessel, there are compromises that need to be made. All enclosed vessels are designed with a purpose in mind, and therefore the size and layout of the vessel is built according to the relevant specifications. Most enclosed-hull vessels are designed with a displacement or planing hull.

Mid-size and larger recreational yachts, sport fishing and commercial fishing vessels, and other "specific use" work boats can be found in this category.

3. Multi-hull vessels and inflatable rescue boats

Catamarans and trimarans



Catamaran



Trimaran

Some vessels are equipped with multi hulls. The most common are **catamarans** (two hulls). There are also **trimarans** (three hulls) Multi hull vessels are designed with less displacement in the water therefore less friction and draft resulting in faster speeds. As the center of gravity in a single hull is lower in the water, mono hulls tend to be better vessels to maneuver in large open seas, but somewhat slower.

Inflatables and rescue boats



Inflatable boats are essentially water-borne balloons with an extremely tough membranes that resist abrasions. Inflatable boats usually have multiple self-contained air cells within the pontoon (called sponsons) that protect the integrity of the vessel in case of a puncture, making the boat extremely durable. Smaller inflatables are often used as yachts tenders as they are light, and don't tend to scratch surfaces.



Rigid-hull inflatable

When adding an aluminum or fiberglass bottom to the surrounding pontoons you create a very effective workboat that delivers a wide range of functionality. A V-bottom hull can provide a softer and faster ride supported by giant sponsons as floatation with the additional benefit of acting as a fender without damaging another vessel or dock. These vessels are commonly equipped with single or twin outboard engines that deliver needed power for speed, travel through surf, towing operations, and close-quarter maneuverability.

Commonly referred to as **rigid-hull inflatables** these vessels have become fast response crafts used by emergency services, government agencies and private industry. Examples include the Canadian Coast Guard, federal and municipal police vessels, marine search-and-rescue vessels, whale watching boats, harbour workboats, and life raft vessels used on larger ferries and ships.

4. Other hull types

Boats and vessels come in many shapes and sizes and for different purposes, determined largely on their desired function and environmental exposure. Vessel configuration can be broken down into subcategories that include:

- Houseboats
- Pontoon and deck style boats
- Personal watercraft
- Runabouts
- Sport-fishing craft
- Cruisers, trawlers, and liveaboards
- Sailboats
- Small craft: kayaks, canoes, rowboats, and paddleboards

Houseboats



Designed around the concept of an RV or camper style structure on the water, houseboats are generally attached to a set of aluminum cylinders know as pontoons. Other hull styles include some V hulls or flat bottom barges on which the structure is built upon. These vessels are best suited for lakes and slow-moving rivers as the design and construction would not be suitable for open seas. Houseboats are slow moving and often powered by outboard engines as the hull's draft is shallow and therefore does not require more power to move them forward.

Pontoon and deck style boats



These vessels are also designed to be used on calm waters and are supported by aluminum cylinders, filled with foam for floatation. They are generally used for recreational purposes and include a variety of designs including can include small kitchens, barbeques, chairs and couches. Some deck boats can also include V bottom hulls to make them more seaworthy and to attain higher speeds. A pontoon style vessel will generally have less horsepower to propeller the vessel. With a V bottom hull design, more horsepower is required.

Personal watercraft



Personal watercraft are designed for thrills and speed and can be considered as the equivalent of a motorcycle on the water. These vessels are propelled by a water jet system instead of a conventional propeller that adds a measure of safety for the user. These crafts are extremely fast and mobile and can turn on a dime. Similar to riding a motorcycle, the user sits on a saddle and steers the vessel with handlebars.

The majority of boats you will encounter during the warmer seasonal months will be recreational boats. Apart from large yachts and sailboats, sport-fishing vessels and family-oriented runabouts will be most common. These vessels have a lot of flexibility and can be either moored or trailered.

Runabouts



This style of boat is the typical family boat that is designed for short cruises, waterskiing, and as a swimming platform. They generally have a closed bow with a windshield. Seating can be arranged in different configurations. These boats are built similarly to a car and offer versatility and comfort; they are not a workboat. Some of these vessels have an open bow that offers more seating capacity. Runabouts are powered by either an inboard or an outboard engine and are generally fitted with a planing hull.

Sport-fishing vessels

These vessels fall into three categories:

- Cuddy cabins
- Walk arounds
- Pilothouse boats



Cuddy-cabin: This vessel has a forward cabin under a raised bow that is designed to house a small gallery, head, and berth for short overnight trips or to get out of the weather. They are almost exclusively fitted with a planing hull and used as sport fishing vessels or as a pleasure craft. Cuddy cabin vessels can also be called walk around vessels, as it is an included characteristic design of these vessels.



Walk-arounds: Also known as "**center console**" vessels, these are designed with a centre console to control the vessel. The operator and passengers are able to walk around the entire vessel to allow easier access for fishing and anchoring. On larger vessels, there is some room under the console for a head and other storage.



Pilothouse boats: These vessels are designed with a larger cabin and thereby deliver more comfort and watertight space. They may or may not provide “walk around” capabilities but can offer more comfort and the ability to stay at sea for multiple nights. They are also a very popular boat, as they can be trailered as with other smaller pleasure craft.



Trawlers, cruisers, and liveaboards

Trawlers are usually slow moving (less than 10 knots) full-displacement hulls with round bottoms. These vessels are extremely seaworthy and can travel hundreds of miles without needing to fuel due to the low consumption rate. They are the preference for long-distance voyagers. Trawlers are powered by diesel engines.



Cruisers tend to have planing or semi-displacement hulls that offer high speeds but with significant increase in fuel consumption. Cruisers can be powered by twin engines, either diesel or gasoline, and reach speeds of over 15 knots. Cruisers tend to be luxury boats with elegant living quarters.

Liveaboards are essentially either a trawler or cruiser with the capabilities of living on the vessel for extended periods of time. They can have a full-displacement, semi-displacement, or planing hull.

Sailboats



Though different than power-driven vessels, sailboats have many similarities in terms of construction, fittings, and terminology. Sailboats do have significant performance characteristics that require specialized equipment and knowledge to operate. All sailboats utilize displacement hulls (except for catamarans and trimarans which skim upon the surface of the water) but are designed to move through the water much more effectively than most power-driven vessels. Sailboats also require more draft, as they require a deep weighted keel or centreboard to counterbalance leeway created by the force of the wind in the sails.

There are many types of sailboats, each having specific characteristics that serve the needs of the sailor. Some sailboats have one or two masts with multiple sails mounted in different sizes and configurations.

Small watercraft: kayaks, canoes, rowboats, and paddleboards

As the public's desire for marine recreational activities increases, so will the frequency of encounters between commercial and these small watercrafts. Many of these encounters occur close to ports and marinas, but not exclusively.

These vessels follow variations in hull designs similar to those mentioned in this chapter; however, they are generally not powered by machinery and therefore

operate at slow speeds, have little freeboard, and are much less stable than traditional water craft.

For these reasons, it is imperative that commercial vessel operators and crew be aware of these smaller vessels and their limited capabilities. Operators must:

- Stay away from these vessels.
- Always maintain a proper lookout and be responsible for your wake and the impact it will have.
- When in doubt… slow down.
- Apply good practices of seamanship at all times.

CHAPTER 3 REVIEW

1. Define a displacement hull.

2. What is the difference between a displacement hull and a planing hull when not making way through the water?

3. What is the difference between an inflatable hull and a rigid-hull inflatable boat?

4. How does a planing hull generate its speed over water?

5. What is a deep-V hull?

6. What are some of the characteristics of a displacement hull?

7. Describe catamarans and trimarans.

8. What are some of the differences between an open-hull vessel and an enclosed-hull vessel?

9. What are scuppers?

4. Propulsion systems

Goals of this chapter

This chapter provides the student with a basic understanding of the propulsion systems available to the operator of a small vessel, describes how to address proper and safe startup and shutdown procedures, and outlines emergency procedures in the event of a failed system or alarm activation.

Learning outcomes

After completing this chapter, students are expected to:

1. Describe the various propulsion systems available for small vessels, including outboard engines, stern drives, inboard engines, and jet drives
2. Explain basic engine starting and shut down procedures
3. Describe engine propulsion systems, surveillance and monitoring required, and action to be taken in the case of an emergency, fault, or alarm

1. Types of propulsion systems

Waterborne transportation has taken many forms since man began to float on the water as a way of transportation.

Propulsion is the act of moving an object forward, and early forms of marine propulsion included poles, paddles, and primitive sails. The industrial revolution brought the successful use of steam power, which has now largely been replaced by internal combustion engines. More recently, electricity has been introduced as a power source.

Marine engines

Basic marine engines consist of four parts:

- The power source (engine) that turns the drive mechanism
- The transmission, used to control the rotation of the shaft
- A shaft that provides rotation to the propeller
- A propeller that creates the thrust

While large diesel engines, gasoline inboards, and small outboard engines look different from each other, the essential characteristics and principles of operation for each of them are often the same. All internal combustion engines require three things to function:

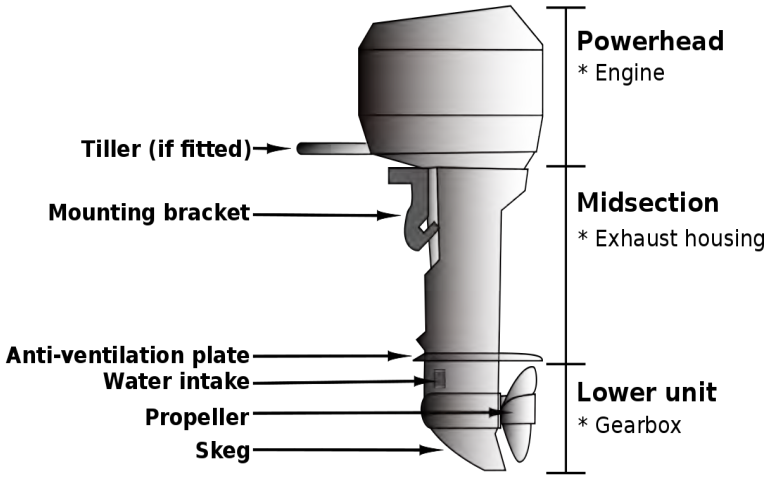
- Fuel
- Air (oxygen)
- A source of ignition to start the combustion process

The different types of propulsion systems that the operator of a small commercial vessel will likely use include:

- Outboard engines
- Stern drives
- Inboard engines
- Jet drives

Outboard, stern drive, and inboard engines all use propellers. Jet drive engines do not have propellers and generate propulsion through pressurized water jets.

Outboard engines



The outboard engine is a common propulsion system used for both small commercial vessels and pleasure craft. Outboard engines are positioned on the rear exterior, often the transom of the vessel and steer and power the vessel. The entire outboard engine is moved (by the steering wheel or a hand-held tiller) when it is used to steer a vessel.

Outboard marine engines can be either "**two-stroke"** or "**four-stroke"** engines, depending on whether the power cycle of the engine occurs in two or four cycles, or strokes, respectively. In North America, two-stroke engines have generally been phased out as the emissions and resulting pollution levels created by these engines no longer meet environment standards, although they are still used in some countries.



Outboard engines mounted on a vessel's transom

Accessibility

Outboard marine engines contain all their operating components in a compact unit (power head, intermediate unit and lower unit), making them much easier to remove, repair and replace quickly.

Outboard engines are installed on the transom of a vessel or on a weighted pod (platform that extends beyond the transom), which also eliminates the need for any "through hull" openings, which breach the integrity of the hull.

Flexibility

Outboard engines can power a vessel with a single engine or can be combined with one or two other outboard engines of the same or differing power to deliver multiple levels of horsepower

Outboard engine fuel

Generally, outboard engines use gasoline to power the engine. Diesel outboards and electric motors have been developed but are not yet widely available in the mainstream market.

Operating outboard engines

Outboard engines offer ease of replacement, are lighter than inboard engines and can be tilted so that the lower part of the engine, including the propeller can remain out of the water when moored and when operating in shallow water.

Outboard engines are very well suited for search and rescue (SAR) rigid hull inflatable boats due to these characteristics. Under proper conditions and handling, a SAR vessel can be driven onto the beach without damaging the engine due to the ability to raise the lower part of the engine out of the water.

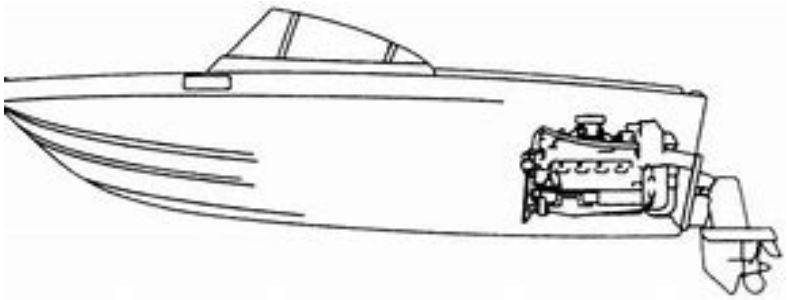
When mounted as twin engines, outboard engines increase the mobility and handling features of SAR and other small crafts. As a result of these features, outboard engines are popular on small pleasure craft and small commercial vessels.

Steering and control

Since the outboard motor is a self-contained unit, the entire motor will turn, re-directing the angle of the propeller to the appropriate direction of angle that then changes the direction of the vessel. A hydraulic system and steering cables are mounted to the outboards which are controlled by the helm (steering wheel) forward of the vessel.

On some smaller workboats with less horsepower, a tiller arm is mounted to the outboard engine that includes the throttle controls and safety features that enables the operator to control steerage, speed, and trim.

Stern-drive engines

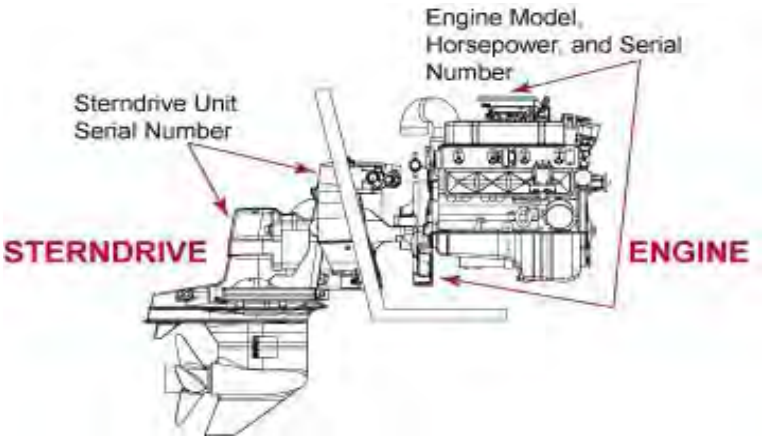


Stern-drive engines are generally referred to as **Inboard/outboard or I/O** engines and all are four-stroke gasoline or diesel engines. Manufacturers of the inboard engines can retain the advantages of the outboard lower unit by incorporating many of the features in the inboard/outboard stern drive's lower unit.

The stern drive engine is positioned forward of the transom with a shaft that goes through the transom to connect to the drive unit (or lower drive), similar to the lower part of an outboard engine and which, as it does in an outboard engine, steers the boat by directing the angle of thrust of the propeller. There is still a requirement for controlling the rotation of the propeller angle of thrust and trim in the stern drive.

There are two methods of providing reverse and forward control:

- A separate system involving a gear box immediately after the engine and
- An integral system similar to an outboard lower unit drive but that allows the lower unit to act independently of the engine and turn the propeller to steer the boat.

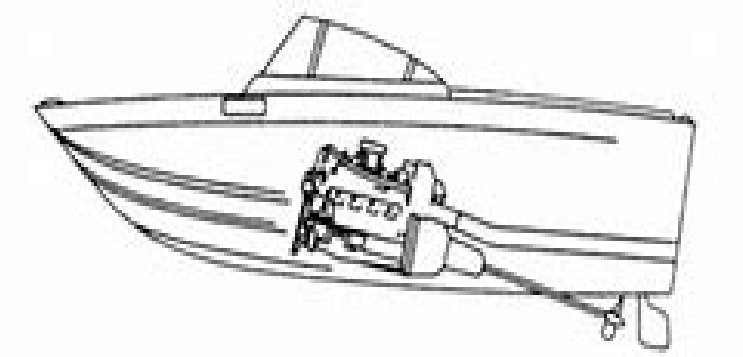


Stern drives vs. outboards

- Stern-drive engines tend to be heavier than outboards but offer a better power-to-weight ratio.
- The placement of the stern engine is more forward than that of the outboard engine, offering better weight placement and greater stability.
- On larger vessels stern drives are better suited to support larger power drives where they are located forward and beneath the decking of the vessel.
- To increase the power on a vessel equipped with outboard engines, you may require multiple engines. This requires consideration of the extra weight and stability issues which the additional outboard engines, installed at the stern, will create.
- Both outboard engines and stern drive engines can be operated in twin series (twin engines), to provide greater power and maneuverability.
- Stern drive engines can be fitted with either diesel or gas engines whereas outboard engines are primarily fueled by gasoline.
- Outboards are more accessible to maintain, repair, or replace. Stern-drive engines are located in confined spaces, making them less accessible to maintain and repair.
- Stern-drive engines use conventional car motors that are adapted for marine use, making parts more readily available.

- Stern-drive engines require more maintenance and winterizing than outboard engines.
- An outboard engine can raise its lower unit out of the water higher than a stern drive.
- The installation of a stern-drive engine must penetrate the transom of the vessel; an outboard does not.
- Stern drives tend to be used on larger vessels, whereas outboards are more common on smaller vessels.

Inboard engines



An inboard engine is a marine propulsion system that is enclosed within the hull of the boat. These engines are either four-stroke gasoline engines or diesel engines. The inboard engine is usually connected to a propeller by a straight drive or propeller shaft. The driveshaft goes from the transmission to a propeller and penetrates the hull of the boat through a “stuffing box,” which provides a watertight seal.

The boat is steered with a rudder that is placed aft of the propeller and which is mechanically connected to the vessel helm (steering wheel). The propeller pushes the water over the rudder. While there is much to know about steering a vessel, it is helpful to know that as the rudder turns, the stern follows, and the bow goes in the opposite direction.

The inboard engine is similar to a stern-drive engine but without the outdrive part found on both a stern drive engine and an outboard engine. Instead, the inboard engine is enclosed and mounted inside the vessel and tends to be located further forward than a stern-drive engine. An inboard engine has no ability to change the angle of the propeller. Most inboard engines are not as fast as stern drives but also require less power and fuel.

Ski boats are an exception and can use inboard engines (or jet drives) and still generate a lot of power and speed. The propeller of an inboard is located under

the boat, making it much safer than a stern drive (with its propeller at the stern) for people in the water.

Inboards are usually fitted to larger boats, including those with displacement hulls, and they offer a stable and comfortable ride.

Jet-drive engines



Jet-drive engines use water instead of a propeller to propel and steer the vessel. Water enters through an intake port pump located on the bottom of the hull of an inboard or at the end of the lower unit of an outboard. The water is then pressurized and accelerated through the jet drive, exiting at high speed and causing the thrust.

Jet-drive engine components include water intake hoses, intake pump, compressor, nozzle and, in some designs, deflectors for steering.

Jet-drive engines can generate a lot of speed and by design are best configured with flat-bottom or planing hulls that require little water depth where jet drive engines are often utilized, such as on shallow rivers. Main disadvantages to jet-drive vessels are that they are difficult to steer at slow speeds, and they consume more fuel than a typical outboard engine.

Jet-drive engines are used on jet skis.

A jet drive can be mounted on the lower unit of an outboard engine, thereby converting the outboard into a jet-drive, or configured with a stern drive in a similar fashion.

2. Basic engine startup and shutdown procedures

It is mandatory for commercial vessels, and is recommended that all vessels, have startup and shut down procedures that best ensure the safety of all crew and passengers prior to leaving the dock. As mentioned in Chapter One, the owner and Master of a small commercial vessel is responsible for ensuring that startup and shutdown policies are in place and adhered to.

General pre-departure checks

- Before considering starting up your vessel, check the weather forecast and tides for your place of departure, the route, and at your destination. Adjust your planned route as required to meet weather conditions.
- Turn on and test the navigation lights.
- Conduct a walk around the vessel and ensure lifejackets, fire extinguishers and other safety equipment are in place (there should be enough life jackets for passengers and crew expected).
- Ensure bilge pumps are free of debris and are working.
- Check that rain plug is securely in place.
- Ensure the radio, GPS, and radar systems are functioning (more on this later). Conduct a test.
- First aid kit and spare tools are where they should be.
- There is no sign of water or oil in the bilge.

Engine startup procedures

Basic steps that should be taken before starting the engine and/or prior to departure:

Checking fuel and fluids

1. Ensure the vessel has sufficient fuel to complete the voyage and extra fuel for any unforeseeable situation. The general one-third rule applies: one third to get to your destination, one third to return, and one third for other unforeseen circumstances.
2. Check all fluid levels, including coolant and oil.
3. Look for fuel, oil, coolant, and water in the bilge.
4. Remove any oily rags and ensure there are no loose parts in the engine room. Investigate anything that does not seem right, such as damaged

fuel or other lines, and loose or damaged belts or battery terminal connections.

5. Activate ventilation. Fuel can sometimes leak into the bilge from tanks or hoses and can then ignite when the engine is turned on. This is a greater risk with gasoline engines. To address fuel fumes that may have leaked out in the bilge, run the vessel blower for four minutes prior to starting the engine is the standard procedure.

Starting the engine

1. Ensure the vessel is secured to the dock and the throttle is in the neutral position before starting the engine.
2. Follow the “turn on” procedure specifically recommended for the vessel engine.
3. Allow the vessel to warm up for two-three minutes while listening for any unusual sounds.
4. Check engine gauges to ensure oil pressure, vacuum and temperature are normal.
5. Address any issues before leaving the dock and turn on all alarms and if required, the bilge pump.
6. Check that the water is being discharged from the engine as required for your particular engine.

Before leaving the dock

1. Ensure that before the vessel is underway, all equipment and lines are secured and put away. Nothing should be left to dislodge and create potential injury or damage to equipment or persons. A safety briefing to those not familiar with the vessel is mandatory.
2. While underway, maintain a vigilant check of all systems and promptly investigate any low battery voltage readings, excess fluid in the bilge(s), any changes in engine sounds or exhaust, gauge readings and engine performance, smoke or the smell of burning.

Engine shutdown procedures

Once the vessel has reached its destination there are several things to do to secure the vessel and ensure that it is prepared for its next safe voyage:

1. Ensure the vessel is properly secured to the dock before turning off the engine.
2. Follow the turn off procedure specifically recommended for the vessel engine.

3. Undertake such steps required to maintain the engine as are specific to the type of engine and voyage, such as freshwater flushing an outboard engine after a saltwater voyage.
4. Connect the battery shore power unit.
5. Ensure that all systems have been turned off.
6. Conduct a cursory walk around of the vessel, ensuring that equipment is still secure and has not shifted.
7. Examine the bilge for water, oil or any other contaminants.
8. Check for appropriate fuel levels for the next trip.
9. Remove garbage and clean the vessel as required.

3. Propellers and alarms

Propeller basics

The blade of a propeller rotates in the water to create the thrust that moves a vessel in a linear direction. A vessel's performance is only as good as the condition and selection of the right propeller and a damaged propeller can significantly reduce performance and fuel efficiency and even cause engine damage. Propellers are specifically designed for types of vessels and performance requirements.



Today, we are accustomed to boats being driven through the water by the use of a propeller. A boat propeller works by pushing the water beyond and to the rear of its propeller. It does this by transferring the rotational energy generated by the power source into **thrust** created by a turning propeller. The circular motion of the propeller blade creates an imbalance of water pressure between the front and the back of the blade thus causing increase water pressure to the rear and reduce water pressure in front of the propeller, moving the vessel with it.

It is important to periodically check the condition of your propeller. Modern propellers have three distinct parts:

Blades

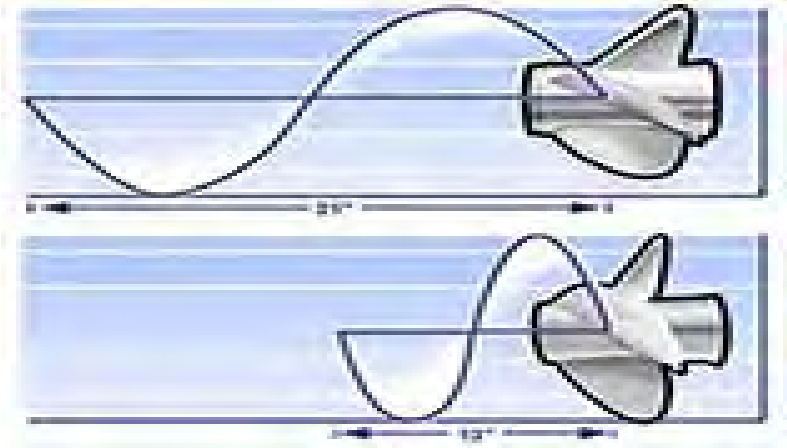
The number of blades on a propeller is easily distinguishable with the three blades configuration being the most common. Four and five blade propellers are used when high power and weight are needed. As a general rule, the number and size of a propeller is increased as the power requirements and overall weight is increased.

Diameter

The diameter of the propeller is the diameter of the circle through which the propeller turns. The larger the diameter of the propeller, the more torque is needed to turn it at a given speed

Pitch

Defined as the distance the propeller would advance a boat during one complete rotation of the propeller, pitch is often compared to a screw as it is driven into an object. To get maximum efficiency from your engine, the pitch of the propeller should be matched to the engine power, gross weight, and intended use of the boat.



Cavitation

Even slightly chipped propeller blades can cause the surrounding water to be disrupted and “cavitate.” Gas bubbles then collapse elsewhere on the blade, releasing energy that causes metal erosion or cavitation burn. Cavitation on the propeller can develop at high speeds reducing the efficiency of the propeller.

Ventilation

When air from the surface water or exhausts gases from the engine outlet are drawn into the propeller blades, ventilation is caused. As this occurs, the air, in part displaces the normal water load, causing the propeller to over-rev and lose a lot of trust. Ventilation usually occurs with high transom mounted outboards, where the lower unit is not deep enough in the water or trimmed up too high allowing surface air to enter the propeller’s path. Ventilation can also occur on tight turns of a vessel.

Alarm systems

All modern engines and ancillary systems are equipped with sensors and alarms. These systems identify problems or irregularities and failures within marine operating and propulsion systems. These alarms should be tested and respected. Gauges and alarms must be monitored at all times when at sea.

As the vessel operator, you are expected to be familiar with the vessel's operating systems and procedure manual in the event of any emergency situation or alarm activation. Which alarm is activated will determine the necessary action.

Never leave the dock when an alarm or gauge indicates a system irregularity.

When an alarm is sounded, slow or stop the vessel and investigate. Once the cause is determined, make the necessary repairs or corrections. If there is continued danger present and you cannot fix the problem, advise your supervisor or call Coast Guard for assistance. Do not wait until the problem is unmanageable.

CHAPTER 4 REVIEW

1. What is the difference between a stern drive and an outboard engine?

2. What is ventilation?

3. What is the general principle behind the amount of fuel that should be carried on board a vessel?

4. What is propeller pitch?

5. Name four things that should occur on a pre-departure check.

6. How does a jet drive work and what is the best application for its use?

7. How does an inboard engine differ in steering than outboard and stern-drive powered boats?

8. All internal combustion engines require three things to function? What are they?

5. Mooring, knots and lines, and related seamanship skills

Goals of this chapter

This chapter will provide the student with a basic understanding of the skills required to control and moor a vessel safely and outlines the basic seamanship skills necessary to function on all aspects of the vessel at sea.

Learning outcomes

After completing this chapter, students will:

1. Understand the role of ropes, lines, knots, and spices in the marine industry
2. Demonstrate basic knots, bends, and hitches
3. Explain the difference construction methods and properties and limitation of synthetic and natural ropes
4. List the names of the common mooring lines and how to properly secure a vessel to the dock (floating and non-floating wharves)
5. Understand the roles and when to house fenders

1. Ropes, lines, knots, and splices

Ropes and lines

Some believe the terms “rope” and “line” are interchangeable but technically they are not. A **rope** is essentially unused cordage or simply rope that is not being used. Conversely, when a rope is assigned a function, it is no longer a rope; it is now a **line** that is labeled by the specific task it is assigned to: anchor line, dock line, or fender line. Sometimes, to identify the use of a line more specifically, it is given another name that identifies its function. For example, a line that is used for anchoring is part of the **anchor rode** and a line attached to a sail is referred to as a **sheet**.

Knots

Knots have been used around the world at sea and on land for centuries. A sailor is often defined by his or her ability to tie various knots. Mariners use knots on a regular basis and understand that a knot has a specific function and cannot be used in all applications. Three factors define a good knot: it is easy to tie, easy to undo, and safe.

When using a knot, the mariner should take into consideration that when fastening a line to an object, the knot will reduce the strength of the line by as much as 50 percent. The knot used in a line or rope will depend on the type of material used. On some rope material, the knot used needs to be “doubled up” due to the slippage of the specific material of the rope.

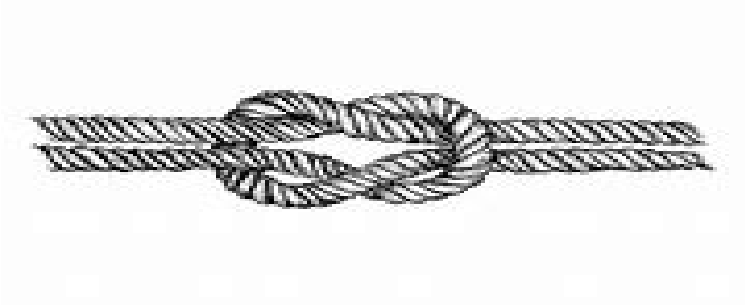
Splices

Splices are commonly used in marine applications. The purpose of a splice is to join two pieces of rope together or two parts of the same piece of rope. The splice is typically completed by untwisting an existing strand of rope and then interweaving the strand back into the adjoining piece.

Splices can be used to finish off the end of a rope and keep it from fraying or to create an **eye splice** used for mooring lines and anchoring. Most types of splices are done on three-strand rope, although some are done on braided rope.

2. Basic knots, bends, and hitches

Square knot

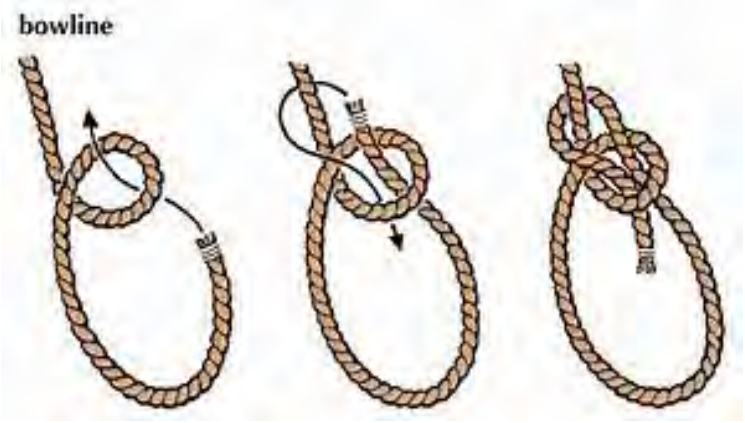


Also referred to as a **reef knot**, this knot is used to fasten two lines of equal size together. The knot requires equal tightness on both ends of the line and therefore comes apart easily.

Note that this knot is **not** designed to take a great amount of stress and should not be used for towing or when retrieving a person from the water.

Bowline knot

This is one of the most versatile and usable knots that a mariner will use. It is designed to form a loop that will not slip and that can be easily be untied. Even under extreme stress, such as a towing operation, the bowline can be used to tie two lines together and be untied easily. It has numerous practical applications both on land and sea and can be used with any material of rope.

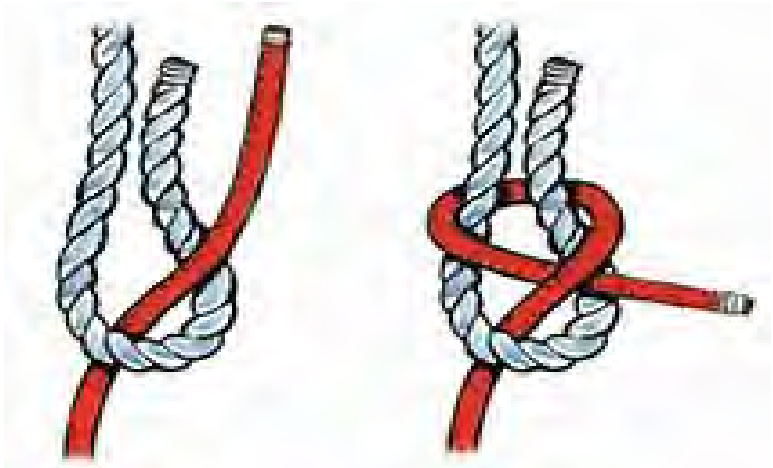


How to tie a bowline

- Lay the rope across your left hand with the free end hanging down.
- Bring the free end up to and pass through the eye from the underside (“the rabbit comes out of the hole”).

- Wrap the line around the standing line and back down through the loop (“around the tree and back down the hole”).

Sheep-bend knot



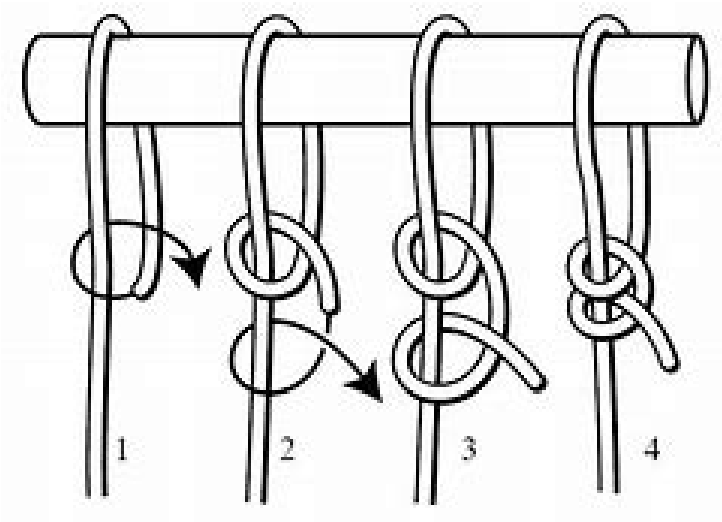
A sheep-bend knot is used to join two lines of different diameters. The sheep bend also allows for doubling up of the knot which is preferable and provides a more secure knot for its applications. This knot should be used for lines that have different thicknesses. It should not be used in towing operations or when extreme stress is applied to the knot.

Clove-hitch knots



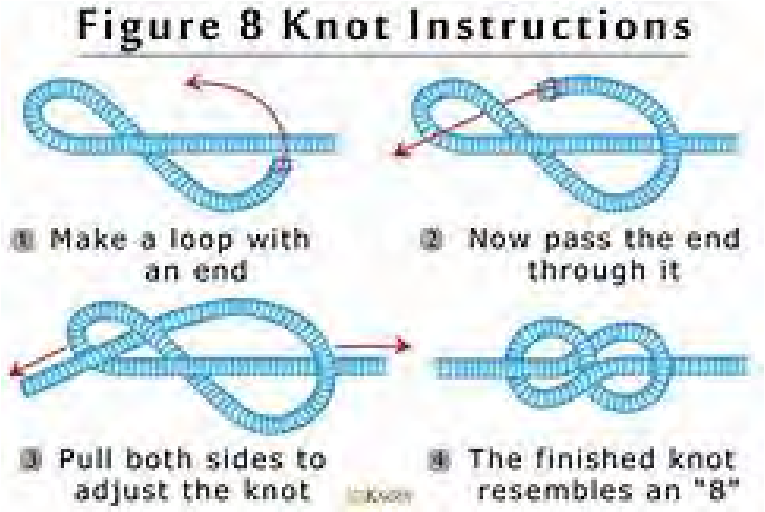
This knot is best used for temporarily securing a line to a railing, spar, or other object. The knot will not slip as the second hitch of the knot rides over the first hitch. It is a temporary knot not to be used for securing a line for long periods of time or under much stress. It is often used to tie and adjust the length of line needed to secure fenders to a boat. Under a lot of stress, this knot can jam tightly. It is best to incorporate a clove hitch with a couple of half hitches as added security

Half-hitch and double-hitch



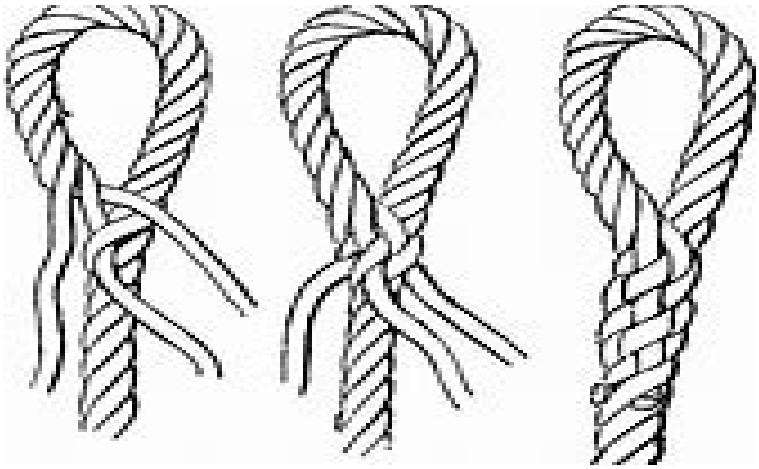
A half-hitch knot can be useful to add security to a pre-existing knot or can be used on its own. The half hitch is completed by taking a turn of line around the object then placing the **bitter end** back through the **bight** on the line. The half hitch is the basis for the creation of many knots used today.

Figure-eight or stopper knot



A figure-eight knot is not meant to attach or secure a line to another object. It is simply designed as a stopper knot that can be used for various purposes.

Splices



A splice is a useful way of joining the end of a rope to itself by interweaving the strands. It particularly works well with three-strand rope and can form a loop (**eye splice**) at the end of the line that is strong, secure, and streamlined. Connecting an anchor line to chain or mooring lines is a common use for an eye splice. Splices can also be used to keep the end of a stranded rope from fraying (**back splice**). Another application is called a **short splice**, which can be used in certain types of rope to join identical pieces together.

3. Types of synthetic and natural ropes

There are two broad categories of rope: **twisted and braided.**



Twisted rope

is formed by coiling three strands of rope together in a twisted direction opposite to each strand. All ends of a twisted rope need to be fused together, as they tend to fray or unravel. Fusing the rope can be best done by burning, taping, or splicing the ends. The reason that twisted rope is relatively easy to work with is due to the alternate twisting of the rope that prevents the rope from becoming **”unlayed.”** The **“lay”** of the rope is used to describe the natural twist in the rope when completed. The lay of the rope can be referred to as “right hand” or “left hand.” Most ropes are a right-hand lay. Twisted rope can be easily spliced.

Common uses: Much of the rope used today is three stranded rope that consists of fibers including nylon, polyester, polypropylene, and polyethylene. This rope is commonly used for anchoring rode and mooring lines. Three-strand rope is strong, resists chaffing, and is relatively inexpensive to purchase.

Braided rope

There is essentially three types of braided rope: Diamond braid with a core, diamond braid without a core (hollow braid), and solid braid.



Diamond braid is manufactured by weaving the yarn over and under the core material. It is easy to use but cannot be spliced. The same process occurs with a hollow braid except the rope can be spliced.



Solid braid consists of bundles of yarn wound into strands before braiding. Solid braid ropes are strong and firm and do not tend to unravel easily. They are very resistant to chaffing but cannot be spliced.

Common uses: Braided line is easy to handle. It tends to be more expensive than three-strand rope but is durable and long lasting. Braided line is often used for mooring lines, anchoring rope, and in small diameters, for fishing lines and downriggers. Since braided line is not twisted, it coils much more easily than twisted rope.

Rope materials

Natural fibres

Natural fibres are still in use today in some areas of the world and include manila, sisal, hemp, and cotton. These fibres shrink and tend to rot when they are exposed to water. Manila is the most commonly used natural fibre, and is used on large ships as mooring and anchor lines. Manila has little stretch and is very strong, but has only half the strength of synthetic fibres.

Natural fibres should be washed with fresh water to remove salt, then air dried and properly coiled to avoid kinks. Natural fibres should always be kept in a clean and dry state. They are more resistant to heat than traditional synthetic fibres and are therefore more resistant in certain applications.

Synthetic fibres

Synthetic ropes are stronger than natural fibres, are far more resistant to rot and mildew, and they have good resistance to chemicals. Synthetic rope is constructed with long running strands of fibre for the entire length of the rope rather than the overlapping strands on natural rope. Although natural fibres are still used worldwide, synthetic rope has replaced much of their use. Synthetic rope is much more available, easier to manufacture, and therefore cheaper than natural fibre rope.

Nylon: Nylon is a very strong synthetic fibre and has more stretch than any of the natural fibres such as manila. Nylon is the most widely used and the best-known synthetic fibre used in ropes today. It has a high breaking strength, wet or dry, and good resistance to sunlight and weather

Where some level of stretch and shock absorption is needed such as for anchor, mooring, or fender lines, nylon rope is the common and practical choice. Nylon is relatively light (half the diameter of manila), with a smooth surface and is easy to handle when coiling. Nylon does not float and can be stiff to handle in colder temperatures. It should be stowed out of direct sunlight and away from any chemicals.

The significant benefit of nylon rope is its elasticity and strength. Nylon can stretch between 10 and 40 percent when under load. Under extreme stress though, nylon will stretch but give no audible warning before it reaches its breaking point, as with an elastic band. Serious injuries can occur with someone in the direct path of the breaking point of nylon rope.

Polyesters: Dacron and Terylene are brand name products for polyester rope. Polyester is considered more resistant to chemicals than nylon but is not as strong or as stretchable. Its abrasion and temperature resistance are similar to nylon. Polyester rope's strength remains consistent whether the line is wet or dry. Its lack of stretch and good strength make polyester ideal for rigging on sailboats.

Like nylon, polyester will not float and has some degree of stretch (25 to 35 percent) and is used as towlines for marine SAR operations.

Polypropylene: Polypropylene is light, flexible and floats on water. It is available in bright colors, usually yellow or blue. It is not as strong as nylon but does not loose strength when exposed to water. It softens up in heat and therefore functionally unsuitable in certain applications. When under stress, polypropylene will begin to steam which will indicate it is reaching its breaking point.

Polypropylene is susceptible to sunlight damage but will not rot and is highly resistant to most chemicals. Polypropylene does not absorb water, and therefore is lighter to handle. It used extensively in the marine industry for running rigging, mooring ropes, and towlines.

Care of ropes and lines

Mariners, whether professional or recreational, require an understanding of care and maintenance of their vessels' ropes and lines and should adopt a routine maintenance schedule for all lines aboard their vessels:

- Examine lines for chafing, rips, or deterioration.
- As much as possible, keep lines and rope from exposure to direct sunlight and chemicals.
- Store lines coiled up and off the decking.
- Clean lines with soap and water periodically and avoid any kind of commercial detergent.
- Remove all knots that have no purpose.

Coiling and stowing

A cursory observation of a vessel's maintenance protocols and the professionalism of the Master and crew can determine how well-organized the equipment on the vessel is kept and in turn how safely the vessel will operate. Care of rigging, and stowage of the vessel's ropes and lines are good indicators of this. A pile of line laying on the deck that appears like cooked spaghetti is not advised or appropriate. Rope must be coiled and ready for immediate use.



To avoid kinks in the rope, twisted rope should be coiled in the direction of the twist (usually in a clockwise direction). The reverse should occur to uncoil the rope. This particularly applies to three-strand rope, which can have a right- or left-hand twist (usually right-hand twist). Braided line has no inherent twist, and therefore will not kink.

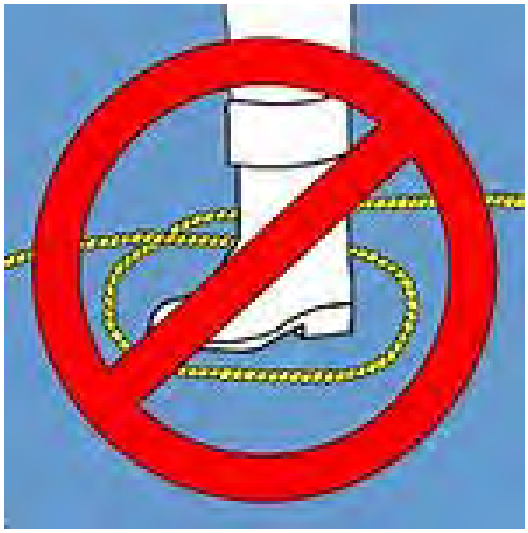


Coiling a twisted rope

The best way to coil stranded rope is to lay it on the deck or around a vertical cleat. Lay the rope down in its natural direction without forcing the line. Avoid hand coiling the line as there is a tendency to put turns in the rope that will cause kinks. To finally secure the line for stowage, run a couple of turns around the line and then pass the bitter end through the loop as illustrated above.

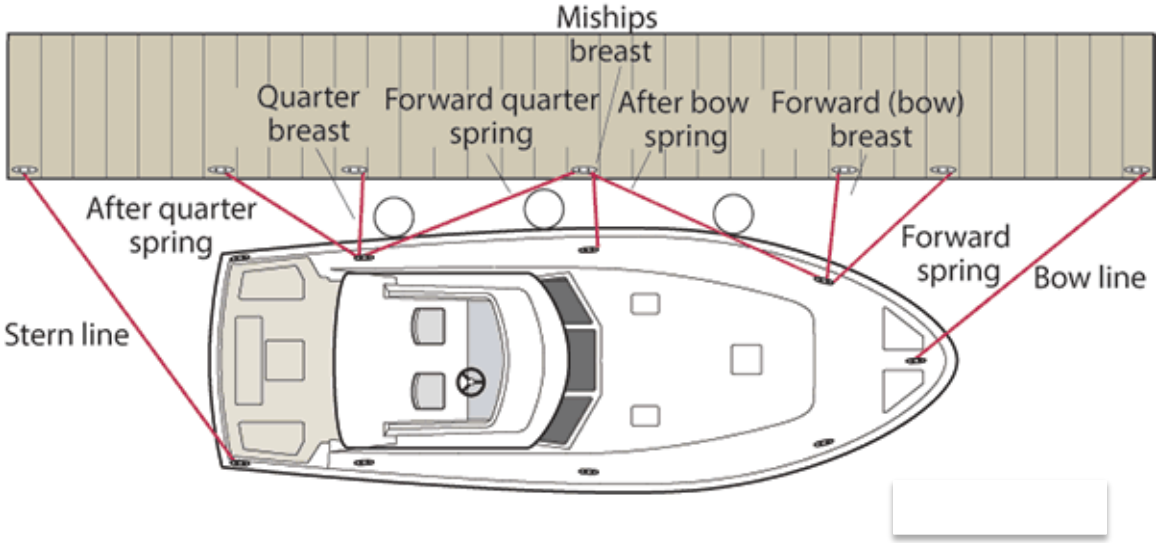
Caution: Be aware of the overloading line or rope. Groaning, creaking, and popping sounds are indication of over-straining the line.

NEVER stand in the bight of a line!



4. Common mooring lines and securing a vessel to the dock (floating and non-floating wharves)

A small vessel usually functions with 2 to 4 mooring lines on each side of the vessel. The use of these lines will depend on the size of the vessel, the weather conditions, the exposure of the moorage, and the length of the stay.



Securing the vessel

Environmental conditions such as wind, current, and position of the vessel in relation to other moored vessels will often dictate the order in which the lines are secured.

Bow lines and stern lines: Generally, the bow line is the first line to be attached to the wharf followed by the stern line. The bow line is used to keep the bow of the vessel close to the dock. The stern line serves the same purpose for the stern of the vessel.

Spring lines: Using the **after-spring** line with the forward motion of the vessel will force the stern into the dock. Alternatively, in the vessel's forward direction, using the **forward spring** will force the bow out. Spring lines can also be used as the first lines attached to the dock when wind and current are not favourable.

Once secured, the spring lines are used to stop the vessel from moving forward or aft, preventing the vessel from sliding into other vessels along the dock.

Breast lines: Breast lines can be employed to attach a vessel to a wharf for additional security. The breast line is a lateral line extending from the vessel close to the midships area at ninety degrees. It is different from the spring lines,

which run at an angle both forward and aft of the vessel. The breast lines keep the vessel tight to the dock.

There are many ways to secure a vessel to a dock or wharf or alongside another vessel. Sometimes a slip line is appropriate. This allows a vessel to use its own securing post to secure both ends of the mooring lines to itself while looping the line around a post or cleat on the other vessel.

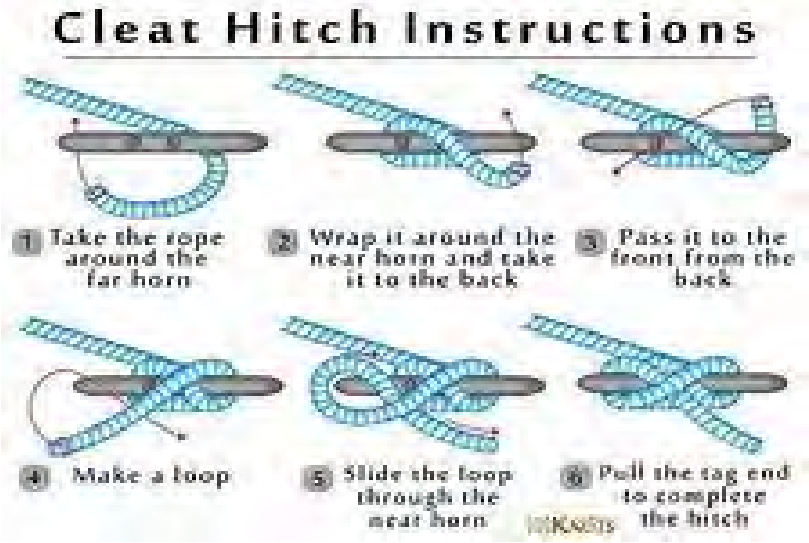
Common fittings on a small vessel

Cleat



A cleat is by far the most common fitting on small vessels. It is used to secure a line. It is a fast, simple, avoids jamming, and is very secure.

Simply take one turn around the base of the cleat and lead the line around each end of the horn forming a figure eight. With sufficient turns, there is no need to lock the line down but that can be done if there is not enough line available for sufficient turns.



Sampson post



Single



Double

A Sampson post is not as common as a cleat for smaller vessels but use on larger vessels/ships as it can be stronger and able to handle larger diameter line. It is also known as a bollard. It is a strong pillar style post that is fixed to a vessel's deck that acts as a support for tackle, mooring, anchoring or other equipment. On smaller vessels used for towing, the Sampson post is used to secure the towing line. It is usually found at the bow or stern of the vessel on larger vessels where lines are moored on. Begin by taking a turn around the base of the post. Then make several figure eight loops around the horn or ears of the Sampson post. Complete securing the line by making a half hitch.

Mooring to floating and non-floating wharves

There can be a significant difference in construction and procedure on mooring to a wharf that remains static in the water or to one that rises and falls with the tide.

In fresh water, wharves are not subjected to tides and therefore, in most cases, vessels remain static in the water.

In waters or rivers that are subject to changes of water heights, floating wharves that rise and fall with tides or changes in water levels are prevalent. When a vessel is attached to a floating dock there is no need to constantly adjust the lines as the dock and vessel remain constant to each other.

In the case of a **fixed dock** or piling in tidal waters, certain procedures must be in place to avoid significant damage to the vessel and dock:

- In a non-floating wharf, as the name suggests, the wharf remains in a fixed position with the surrounding water rising and falling.
- When securing a vessel to this type of wharf, a constant watch must be maintained to adjust the mooring lines to address the rise and fall of the water.
- Tides changes should be known and anticipated.
- The mooring lines must be significantly longer than lines for a floating wharf. The bow and stern lines must be longer than the length of the boat.
- The bowline should be attached aft on a secure cleat of the wharf with the stern line lined forward on the cleat to allow some degree of rise and fall of the tide.

5. Fenders and when to use them

Fenders are an essential piece of equipment to protect a vessel's hull from contact or damage when coming alongside other vessels, pilings, or docks. They are designed to absorb the kinetic energy of a boat coming into contact with a fixed object.

The type, size, and number of fenders used will depend on the size of your vessel, the object your vessel is making contact with, and the environmental conditions. Boats are expensive. Fenders can significantly reduce damage to your and other vessels when used properly.

Types of fenders



There are a variety of fenders that can suit the specific situation at hand. Some fenders are cylindrical, or sausage shaped, having a double-eye opening at each end for attachment either vertically or horizontally.

Round fenders tend to be thicker, thus keeping the vessel further away and providing more protection. Fenders can also be deployed at the bow or stern of the vessel (transom fenders) or other applications that may arise.

Using fenders



Fenders need to be deployed properly to be effective. Consideration should be given to the number of fenders used on a vessel, taking into account the length of stay, environmental conditions, and the amount and density of other vessel traffic at the moorage.

A general rule is one fender for every 10 feet of vessel. For small vessels, a minimum of two fenders should be used. One should be placed at the widest part of the hull where contact will be made, with the second closer to the stern. However, there is no harm in using more fenders, particularly in rougher weather.

Ensure that your fender is placed at the right height and not laying in the water. Fenders help protect the sides of a vessel, so it is important to adjust the height to correlate with the side of the boat and dock, wharf, or object it is tied up to.

To secure the fender to the boat, the knot must be adjustable. The most appropriate knot for this application is the clove hitch. This knot is best secured to the stanchion. If a cleat is available, then apply the figure-eight procedure laid out in Section 4.

CHAPTER 5 REVIEW

1. What is the difference between a cleat and a Sampson post?

2. What is a reef, or square knot, used for?

3. Name six mooring lines and their positions found on any one side of a vessel at dock.

4. What type of rope is best used for splicing?

5. What is the most versatile knot used by a mariner?

6. How many fenders should be used on a 30-foot vessel?

7. Name three types of synthetic rope material.

8. What is the “bight” of a line and how can it be dangerous to a member of the crew aboard a vessel?

9. What is a clove hitch used for?

6. Maneuvering and anchoring

Goals of this chapter

This chapter explains various types of propulsion systems and their effects on maneuvering a vessel while docking and leaving port, and describes anchoring procedures.

Learning outcomes

After completing this chapter, students will understand:

1. Effects of wind and currents
2. Effects of propellers, rudders, jets, and outboard engines when moving ahead and astern
3. Berthing and departure from a dock
4. The turning circle
5. Anchoring and types of small-vessel anchors

Maneuvering safety: an overview

Proper boat handling involves the ability to anticipate and control a vessel's movements, taking into consideration the effects of marine environmental forces and other situational factors. A competent vessel operator can develop these skills only through acquired knowledge, practical experience, and skill.

A good way to determine the experience level of the operator of a vessel is to watch how the vessel is controlled while docking or in tight quarters. The Master should ensure no panic, shouting, or overuse of the engines.

Vessel safety and control are achieved by:

- Situation awareness and understanding the characteristics of the vessel
- Knowing how to control the vessel and having a good plan that is shared with the crew
- Knowing how to integrate the capabilities of the vessel with environmental conditions.

1. Effects of wind and currents

The Master or operator of a vessel must at all times be aware of the local wind, tide, currents, and seas. This mental exercise is continuous, starts before leaving the harbour, and includes the local environmental conditions of the entire planned route. These environmental conditions must be understood collectively, and experienced operators know how to use these conditions to their advantage.

Wind and waves

As wind increases, the influence it has on the maneuverability of a vessel also increases, thus making it more critical to control the vessel. The more structure a vessel has above the waterline, the more effect the wind will have. When arriving or departing a dock, the vessel will drift in the direction of the wind's force either towards or away from the berth, requiring an adjustment to approach or departure.

Depending on the configuration of the vessel, the wind will also cause it to drift and spin. For example, a vessel with a high structure at the bow will cause the stern to spin in the direction of the wind. This knowledge becomes critical when in close quarters of a marina and in the presence of other vessels.

As the wind develops over distance, waves are created. Waves can have a variety of effects on a vessel. The pitching of a vessel due to the action of the waves can cause a vessel's hull to lift out of the water and make contact with the wind and making it difficult to control.

As waves increase, troughs and large crests begin to appear. This situation can create wind "dead zones" or wave "shadows" in the trough where a small vessel may find itself. Corrective action needs to be taken for small vessels moving through the trough and approaching the crest of the next wave. Vessels must orient their positions to large waves to avoid swamping (usually from a wave breaking over the stern) and capsizing (usually taking a breaking wave on the beam of the vessel). Vessels should always face the weather bow first, or slightly quartering to, where a vessel's stability characteristics are best.

Currents

As wind acts on a vessel's topside, the effects of currents on a vessel are applied to the underwater portion of the vessel's hull. Current is a powerful force, causing the vessel to move in the direction of the current's flow (leeway). The effects of currents are more significant than the effects of wind. For example, one knot of current is equivalent to approximately 30 knots of wind.

It is important to read and determine the intensity and direction of the current before leaving or arriving at a dock. Knowing the current and tide predictions should be done well in advance of departure by reviewing tide and current publications. However, there is no substitute for assessing the current at the water's edge.

Currents are also affected by any obstruction in the water, which can create back eddies and alter the direction of a current. Once underway, it is important to be cautious about how the current will affect vessels in close quarters such as marinas and when close to other vessels, breakwaters, and aids to navigation. Being able to control the vessel is critical.

Multiple environmental conditions

The operator of the vessel must account for the totality of all environmental forces that affect the movement of their vessel, from calm days to severe weather systems with high winds and an opposing current. The operator must determine which conditions will have the most impact on the vessel, and adjust accordingly.

When wind patterns are against the direction of the current, the waves are steeper and choppier. When wind and current are moving in the same direction, larger, longer waves can occur. Both situations can create challenges, including large tide rips, breaking waves, and surf conditions, all of which can be a challenge to any vessel operator.

Practicing and knowing how to read these environment conditions and developing the necessary boat handling skills will make you a better operator, including knowing the limits of your and your vessel's capabilities.

A good captain knows when NOT to leave port!

2. Effects of propellers, rudders, jets, and outboard engines when moving ahead and astern

Propulsion and steering overview

A propeller is the most common form of propulsion used by small vessels. An engine provides the power source that delivers the energy to the propeller through a shaft. As stated in Chapter 4, the propeller creates thrust that moves the vessel forward or astern. However, the thrust created by the propeller is useless unless there is an ability to control the direction of that thrust. Both steering and propulsion must therefore be considered together.

There are three ways in which to control the propulsion of a vessel, using:

- A rudder positioned astern of a propeller affixed to a rotating shaft
- A propeller with partial rotation that makes its direction controllable
- A jet drive that pumps water on a rotational nozzle propelling the vessel forward

Rudders and propellers (inboards)

Most displacement hulls and many semi-displacement hulls use a rudder in conjunction with a propeller (inboard). The drive shaft penetrates the bottom of the hull at an angle to the propeller deep enough for the propeller to clear the bottom of the hull. The propeller is usually centred and forward of the stern. The rudder is placed at the stern of the vessel and is rotated to direct water flow generated by the propeller.



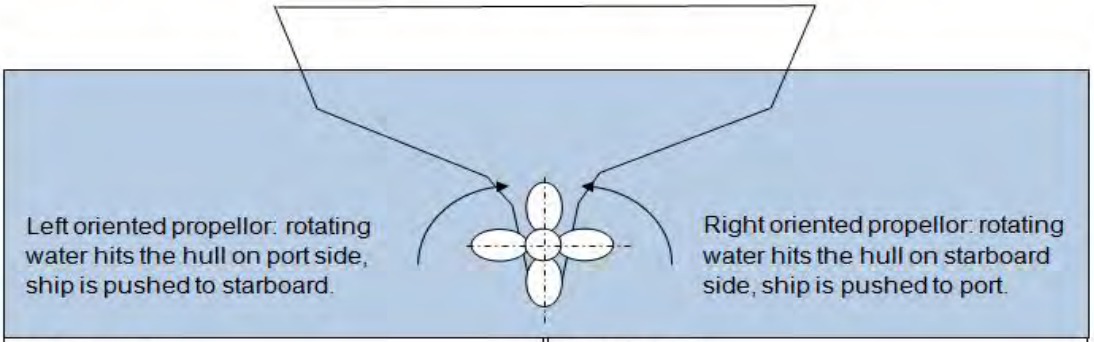
As the propeller drives the vessel forward, the position of the rudder determines the direction of the vessel. If the rudder is centred in a straight line, the vessel moves forward in a straight line, as the water pressure on each side of the rudder is equal. As the rudder is turned to port or starboard, the pressure decreases on one side of the rudder and increases on the other side. The force of this pressure imbalance causes the stern of the vessel to slide in a different direction resulting in the vessel turning.

Propeller current and side force

A propeller is effective when rotating forward (thrust) or in reverse rotation (suction) but the forward motion provides more thrust and therefore more control and power.

Another effect of propeller rotation is “side force.” Propellers on a single centreline shaft axis rotate clockwise (or right-hand rotation). For right-hand propellers operating in a forward motion, the stern of the vessel has a tendency to swing to starboard. When operating astern the stern tends to swing to port. Imagine looking at your vessel’s stern: as the boat moves forward through the water, the propeller rotates to the right, resulting in the slight swing of the stern to starboard. This is also known as **“prop walk.”**

Propellor Walk for a single propellor (engine in reverse)



Left oriented:	Right oriented:
Preferred side to moore is starboard. When reversing propellor walk helps to move the stern to the quay.	Preferred side to moore is port. When reversing propellor walk helps to move the stern to the quay.
Preferred side to turn in narrow waters is to port. When reversing halfway the turn, propellor walk helps to turn the ship to port.	Preferred side to turn in narrow waters is to starboard. When reversing halfway the turn, propellor walk helps to turn the ship to starboard.

Twin propellers and rudders

Most vessels equipped with twin propellers will have counter-rotating propellers fitted. The big advantage to this is that the effects of prop walk are eliminated and cancelled out when equal RPMs are applied to each engine. The operator will

find it much easier to control the vessel as each individual propeller thrust can be used to maneuver the position of the vessel, particularly in tight conditions.

Following are some general characteristics of vessels with twin propellers and rudders:

- **Port prop** in neutral (rudder amidships): The vessel will turn to port as the starboard engine will force the turn. The radius of the turn will increase with more rudder applied. Opposite occurs going astern.
- **Starboard prop** in neutral (rudder amidships): The vessel will turn to starboard due to port engine thrust. More rudder provides tighter turns. Opposite occurs going astern.
- **Pivoting** the vessel: The vessel will pivot to starboard with port engine forward and starboard engine astern. The vessel will pivot on its own axis without and application of rudder. To turn to port, apply starboard engine forward and port engine astern. **NOTE:** This maneuver should be conducted only at very slow speeds.

General characteristics of inboards

- These vessels have more difficulty than twin engines to maneuver and are less reactive without the combination of both trust from the fixed propeller and rudder direction applied.
- Vessels with rudders have little to no control when not moving in the water but tend to hold their headway longer that a planing hull when forward power is removed.
- When going astern, recognize that prop walk will alter the swing of your vessel. Typically, a right-handed prop rotation is fixed to a single propeller vessel; therefore, going astern will swing the stern to port. When going astern and when possible, ensure the rudder is amidships to bring the vessel straight back. Always know the position of your rudder.
- The principle of steerage with a rudder requires water flowing past the rudder in order to work. When operating astern, the propeller provides little flow of water past the rudder and thus reduces its effectiveness at steering the vessel.

Stern drives and outboards

Stern drives and outboards (I/O), though different, have similar characteristics in their propulsion systems that enable the operator to control the direction of the vessel by rotating the angle of thrust of the propellers in the water. Handling outboard and stern drive engines tends to be much easier than inboard engines.

Forward motion: The propeller and rudder act as one unit thus creating immediate and directional thrust forward as the propellers are turned in the desired direction. Control of the boat is almost instantaneous.

Astern direction: With the propeller turning in reverse, the suction of water through the propeller is not as strong as the forward thrust, but still significant enough to provide much more control than an inboard rudder vessel.

Prop walk: Outboards and stern drives are generally not affected by side blade thrust of a propeller compared to inboard systems. Outboard systems can rotate and trim the direction of the propellers, thus almost eliminating any prop walk.

Docking: All types of vessels apply the same principles and approach to docking. An outboard/stern drive system greatly assists in controlling the movements of the vessel in tighter situations and when departing a dock. Stern drive systems allow the vessel to operate in close quarters by allowing the stern of the vessel to move away from the dock on a tight turning axis.

Twin engine applications: The use of twin systems allows the vessel to rotate in any direction without moving forward or astern, by engaging one unit forward and the other astern.

Trim: The stern drive and outboard propulsion systems allow for control of trim that helps in establishing proper planing of the vessel in rough or smooth waters.

Jet drives

A jet drive is powered by a strong water pump that propels the water through a jet nozzle. The jet can be rotated to control the direction of water flow, thus controlling the direction of the vessel. Jet drives do not have rudders and require thrust to steer; therefore they do not have the same maneuverability as stern drives or outboards at slow speeds and while docking. Jet drives have no neutral position, so as long as the engine is operating the vessel will be moving.

3. Berthing and departing from a dock

There are many variables that effect a boat's movement through the water. The Master or operator of the vessel must understand these variables and navigate through the complex problems that may exist. Knowing your vessel's characteristics and the effects the environment can play will only come from repetitive "hands on" experience coupled with some basic principles outlined in this chapter. When you are coming alongside a dock, wharf, or other vessel, consider these basic principles in advance of your maneuver:

- **Think ahead.** Understand the situation that is before you and what you will need to do to accomplish the task. If you are operating the vessel with a crew, ensure they are briefed prior to executing your plan.
- **Go slowly.** It is always best to approach or depart from a berthing slowly. Engine power can be your best friend or your worst enemy. You should understand that a vessel in the water will have momentum, and the surge of engine power will cause a reaction to the vessel's own movement.
- **Practice.** Get a feel for your boat and try different situations to understand how your boat will react. Eventually you will be able to anticipate what your boat will do as you apply power and helm controls. Include in your practice different environmental conditions such as tide, currents, and wind. Once you have a good handle on your vessel's capabilities you will be able to control your vessel's movements in any conditions.

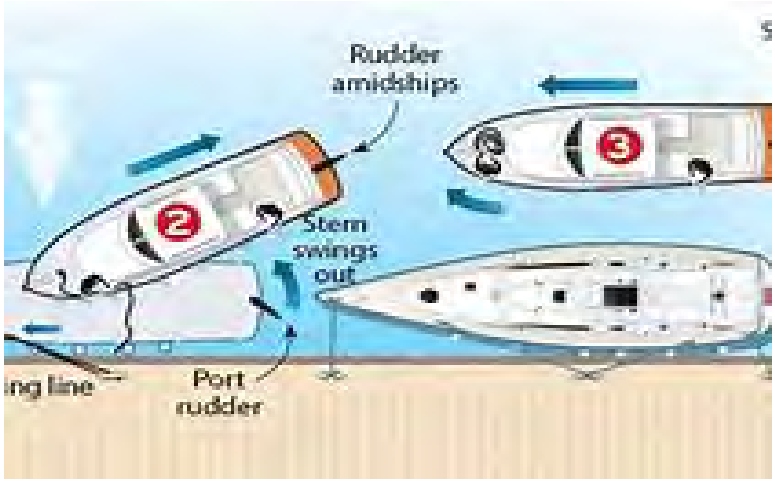
Departing from a dock

- Ensure your pre-departure checks are complete, the crew is briefed, and all equipment is secure.
- Ensure you understand the impacts of the currents and wind that will affect the departure of your vessel, and plan for them.
- Allow the engine to warm up for a few minutes while checking all gauges for proper readings.
- Complete a cursory examination of the area for any hazards or obstructions, including other vessels.
- All fenders should be brought into the vessel and prepared for sea after departing from the dock.

Spring lines

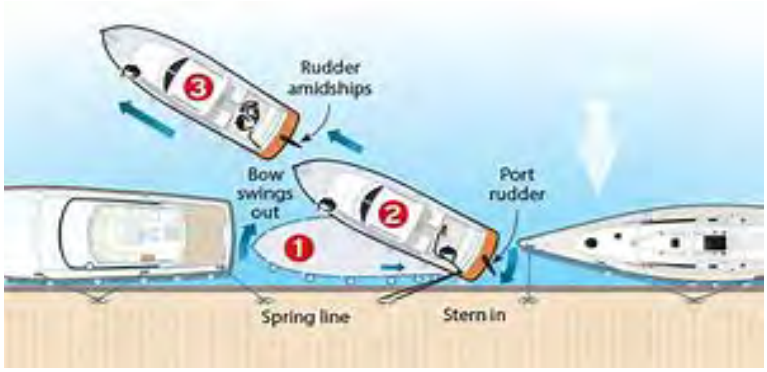
Spring lines can assist the vessel in departing from the dock. Generating forward thrust with the forward spring line attached will push out the stern of the vessel. This works well when the wind is pushing your vessel against the dock. If it is best to have the bow pushed off the dock first, then have the aft spring line attached with the vessel in forward gear.

When using spring lines, it is best to have the lines rigged for slipping, which maintains both bitter ends of the line on the vessel making the release of the spring line easier. To prevent fouling with the propeller(s), caution should also be exercised to ensure no mooring lines fall into the water uncontrolled.



Swinging out the stern

The aft spring line attached with the engine operating astern will cause the bow to push out. This is helpful when the wind is parallel to the dock and there is no room to maneuver aft.



Swinging out the boat

Berthing (docking)

When a vessel is making its final approach to a dock, the speed of the vessel should be slow and controlled. The general angle of approach should be approximately 45 degrees. (This angle can vary depending on the direction of the current and wind.)

Once the vessel is within a few feet of the dock, begin to turn the vessel parallel to the dock. As the vessel achieves this position, turn the engine(s) towards the dock and shift the vessel into reverse. This will do two things; stop the forward movement of the vessel and bring the stern into the dock. The forward momentum of the vessel combined with the engine controls should allow the vessel to stop its forward movement and drift parallel into the dock. The reverse thrust of the engine should only be enough to stop the vessel. If necessary, return the engine back into the neutral position to stop the stern from hitting the dock.

Docking a vessel perfectly under a variety of conditions requires practice and knowing the vessel's specific characteristics. Having twin engines can make the maneuver easier; however, inexperienced vessel operators can make mistakes that can result in causing damage to the dock, the vessel, or other vessels in the area. Some of the most common mistakes include:

- **Bad angle of approach:** (**< 45 degrees**) Many operators come in at too shallow an angle, decreasing the vessel's momentum needed to bring it to the dock from a parallel position. (**>45-degree angle**). Too sharp an angle can cause too much momentum allowing the vessel's bow to hit the dock before the final turn can be made. However, when too much wind is present and blowing away from the dock, a sharper angle is sometimes needed.
- **Too much or too little speed:** The vessel needs some speed to create the momentum to reach the dock but not too much to lose control. Again, wind and current will affect the speed used on a vessel's approach.
- **Completing the final turn too early or too late**: A wide turning radius will not provide enough momentum to bring the boat to the dock. An experienced operator would use a short turning radius, which still provides enough momentum for the vessel to slide into the dock.

4. Turning circles and other maneuvering characteristics

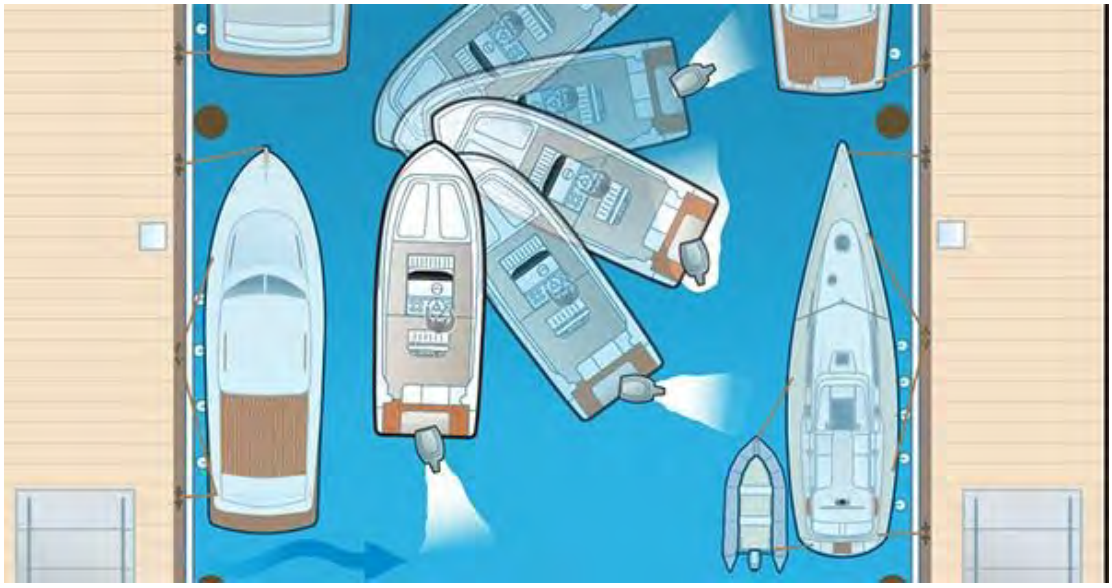
Turning

Many new vessel operators do not appreciate that a vessel turns as a result of the thrust from the engine swinging the stern to either port or starboard. Although the bow appears to change position, it does not. The pivot point on a vessel when moving forward is approximately one third aft of the bow; therefore, the rotation of the vessel occurs at the stern, swinging the vessel and the direction of the bow. Going astern, the pivot point is towards the stern, operating somewhat similar to a car.

Other factors that need to be taken into consideration, particularly at slow speeds, are prop walk and the vessel's momentum; all of which affect the movement of the stern.

Why is this important?

The stern is the area of the vessel that is likely to hit another vessel, dock, or other object in the tight operating area of a marina. While the operator of the vessel looks forward towards the bow, behind him or her is a swinging stern. Pay careful attention to the position of your stern. As the vessel maneuvers around corners and into its berth, the potential to make contact is ever present.



Swinging stern

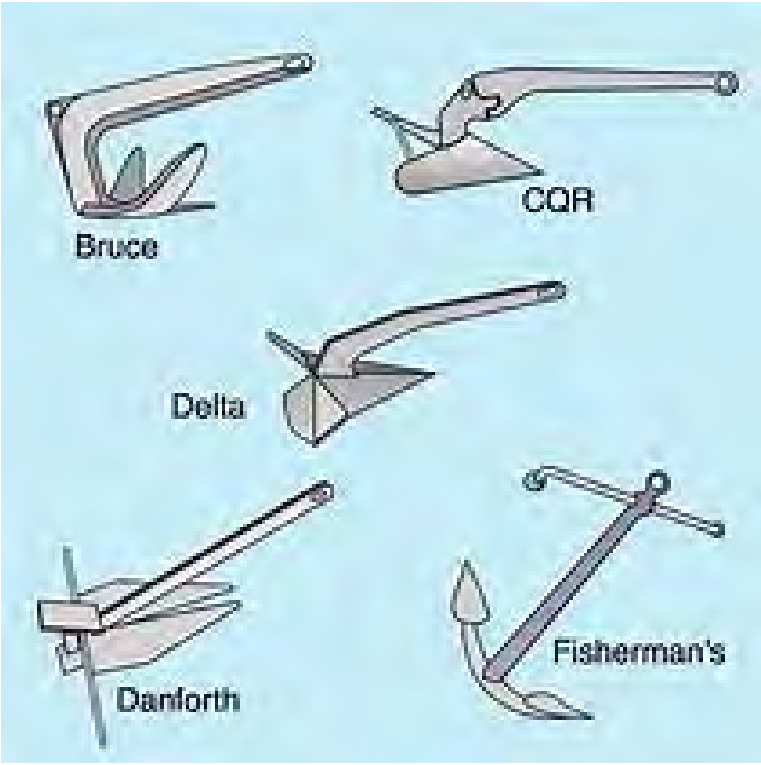
5. Anchoring and types of small vessel anchors

An anchorage is determined by finding an appropriate area that is protected from the prevailing elements, has shallow but sufficient depth of water to allow the vessel to float throughout tidal cycles, and is away from other vessels and land to ensure the swing of the vessel is unobstructed. Consideration must also be given to the bottom terrain and the type of anchor to be used.

Anchoring is a critical skill to understand and master. Vessel operators must understand how to anchor their vessels, both in normal conditions and in emergencies. When an automobile breaks down alongside a road, it usually comes to a complete stop and is not affected by the environment. When a vessel breaks down at sea, it continues to move in the direction of the current and wind until it crashes onto a shoreline, which can cause serious injuries to passengers and crew if not mitigated.

Types of anchors and when to use them

Anchors do not hold to the bottom of the waterway by sheer weight. They are designed to dig into the bottom terrain, so it is important to know the type of terrain beneath a boat in order to best determine the type of anchor to use.



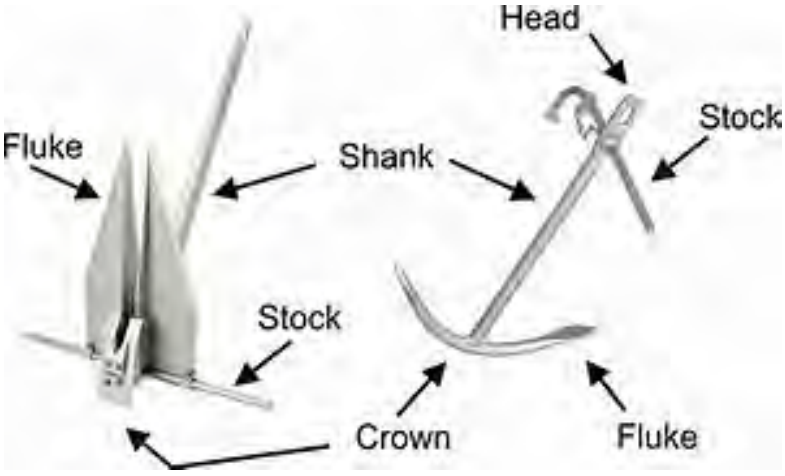
There are many types of anchors, but the three anchors typically found on small vessels include: a **plow** or **CQR** anchor, a **claw** or **Bruce** anchor and a **fluke** or **Danforth** anchor.

The various types of anchors have different characteristics that provide different advantages depending on the bottom terrain. The angle, length, and width of the fluke all contribute to its holding power. Longer shafts and wider flukes can perform better in muddier terrain as they allow more suction thus reducing the chance of the anchor breaking free.

Plow/CQR: These anchors offer good penetration into weed beds, grass, and muddy and sandy bottoms. Their drawbacks are that they are heavy and difficult to stow on smaller vessels with limited space.

Claw/Bruce: This anchor is popular due to its holding ability in a variety of different terrains. However, size and weight matter in its use in order to obtain optimum holding potential. These anchors are sold in a variety of weights and sizes and must be properly fitted to the size of the vessel.

Fluke/Danforth: The Danforth anchor is the most popular style of anchor found onboard small vessels. It is light, with foldable flukes that make it easy to stow. It has excellent holding properties in sand and mud and is one of the cheaper anchors to purchase.



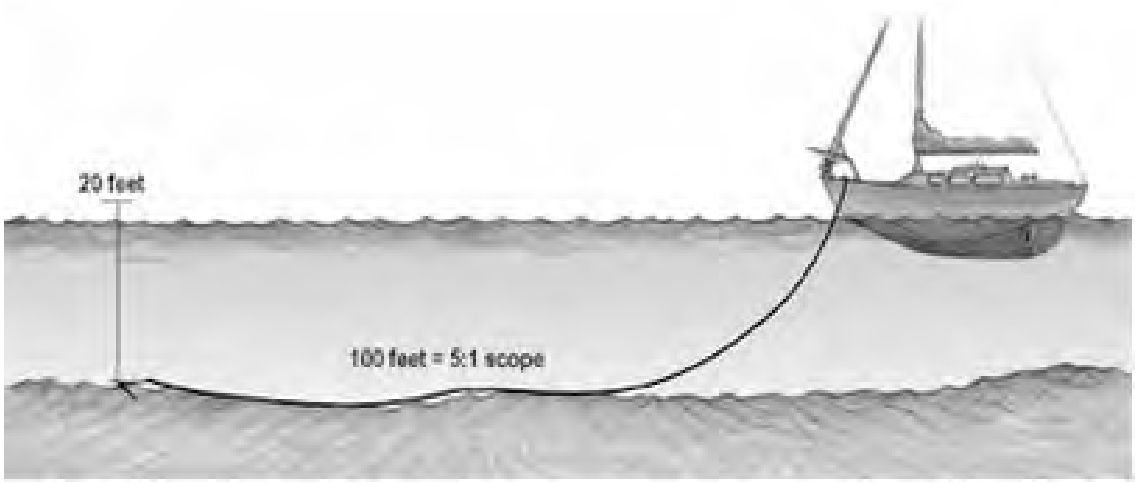
Anchor parts

General principles of anchoring

Anchor rode: In order for an anchor to work, the shank of the anchor must be secured to a length of chain. The weight of the chain keeps the shank and anchor parallel to the sea bottom and facilitates the pulling of the anchor to embed its flukes into the bottom terrain. At the end of the chain, an anchor line is attached leading up to the boat. The totality of the anchor line and chain is referred to as the anchor rode. On larger vessels, chain only is attached from the anchor to the vessel.

Scope is the ratio of water to rode. This means ensuring your vessel-to-anchor rode will have sufficient angle and slack or "catenary," and will minimize the potential for drifting during extreme wind and large tide changes. For example, a 7:1 scope means that for every foot of water, anchoring requires seven feet of rode. Recommendations for length of scope under various circumstances include:

- **3:1** scope for short stops
- **5:1** scope for moderate winds or overnight
- **7:1** scope for moderate to strong winds



Setting the anchor

1. Before anchoring, you must determine the nature of the bottom terrain and the depth of the water. Consideration must also be given to the projected tides and weather conditions, particularly if you will be anchoring for a longer period of time.
2. If other vessels are present, ensure that you leave enough room for your vessel to swing around your anchor point and not interfere with the other vessels.
3. Position your vessel over the point where you want your anchor to lie.
4. Under control, lower your anchor until it hits bottom. Reverse the vessel to allow sufficient rode to be released based on the calculations you have already made.
5. When satisfied with the length of rode, stop and secure the rode to the anchor cleat or bit. When secured, reverse the vessel again to assist the anchor to plow into the bottom; you will notice your vessel can no longer move astern and the anchor rode will be under a small degree of stress.
6. Finally, check the position of the anchor periodically by choosing points along the shore and checking the relative bearings to your vessel.

Weighing (retrieving) the anchor

When you are ready to retrieve the anchor, go forward of your vessel and take in the anchor rode to prevent fouling the line in the propeller. Have someone assist you to determine which direction the rode is taking and steer the vessel so that the rode is dead ahead. Once the vessel is directly over the anchor, stop the vessel and bring in the anchor. Ensure the anchor is clean of debris from the bottom.

Retrieving a fouled anchor

Sometimes an anchor may have some difficulty in dislodging from the bottom. If so, there are several methods to release the anchor:

- Position the boat directly over the anchor and secure it to a cleat. As the vessel moves up and down with the action of the waves, it will continue to bring in the slack line and let the bounce of the vessel assist in dislodging the anchor.
- Position the vessel directly over the anchor. Point the vessel against the current or wind. Slowly move the vessel opposite to the direction of the boats anchored position. This can free and dislodge the anchor from its original position.
- Bring the vessel closer to the anchor's position. Begin moving the vessel in a circular motion around the anchor, keeping pressure on the anchor rode. This will force the anchor out of its original position or dislodge it from a snag. Ensure that the rode is never close to the propeller.

CHAPTER 6 REVIEW

1. What is the fluke of an anchor?

2. What is the best angle at which to approach a dock?

3. How would a vessel operator use mooring lines to swing the stern of the vessel out to sea?

4. What is “prop walk”?

5. What is the most likely area of a vessel to make contact with another vessel, dock, or other obstruction?

6. What are three basic rules to follow before approaching a dock?

7. What is “scope” as related to anchoring?

8. How do stern drives differ from inboard engines with rudders in steering the vessel?

7. Navigation safety and collision prevention

Goals of this chapter

This chapter aims to provide the student with the basic understanding with regard to the navigation rules that are to be followed by all vessels at sea as set out in the *International Regulations for Preventing Collisions at Sea* (1972) and Canadian modifications ("Collision Regulations").

Learning outcomes

After completing this chapter, students will understand:

1. The terms "making way," "risk of collision," "stand-on vessel," "give-way vessel," and "safe speed"
2. "Collision Regulations" Section I: Conduct of vessels in any conditions of visibility
3. "Collision Regulations": Section II: Conduct of vessels in sight of another
4. "Collision Regulations": Section III: Conduct of vessels in restricted visibility
5. "Collision Regulations," Part C: Signs, shapes, and lights carried by vessels
6. International and Canadian distress signals
7. The benefits and requirements of using a radar reflector
8. "Collision Regulations": Part D: Sounds and light shapes

1. Marine traffic terms and definitions

Prior to the development of these rules, each country used its own set of guidelines and practices for how ships were to conduct themselves at sea. The various conventions and informal practices adopted separately by each country were oftentimes different and inconsistent with other nations, resulting in a rise of collisions at sea. Even navigation lights and aids to navigation were different, resulting in confusion and collisions.

Through technological advancements and modernization, power driven vessels began to replace sailing ships. With increased speed, extended range, greater carrying capacity and maneuverability, international trade increased and so did the collisions at sea. Over time, international standardization of conventions and practices were adopted, resulting in the *International Convention for the Prevention of Collision at Sea* in 1972. These rules have been updated as required to meet the demands of changing technologies and modern-day shipping practices.

The "Collision Regulations"

The Collision Regulations, found under the *Canadian Shipping Act, 2001,* govern the movement of marine traffic and provide regulatory guidance to reduce risk of collision at sea. These rules are commonly referred to as the "Coll Regs" or the "Rules of the Road." The information provided below highlights only some of the Coll Regs. It is your responsibility as the operator or Master of the vessel to be aware of all the Coll Regs related to the vessel and area you operate in.

To assist students in understanding these rules, interpretations of certain words and phrases is provided. As we proceed through the regulations, relevant meaning and context to certain phrases and words that have legal ramifications is also provided.

Making way: Being propelled through the water by sail, machinery, or oar.

Under way: Not anchored or made fast to the shore, or aground.

Risk of collision: Every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt such risk shall be deemed to exist.

Stand-on vessel: When meeting another vessel at sea, a vessel shall keep her current course and speed unless it is apparent that a collision cannot be avoided.

Give-way vessel: Every vessel that is directed to keep out of the way of another vessel shall, as far as possible, take early and substantial action to keep well clear.

Safe speed: Every vessel shall at all times travel at a safe speed so that it can take action to avoid a collision and be stopped within a distance appropriate to the prevailing circumstances and conditions.

Good seamanship: The art of properly operating a ship or a boat. It involves the knowledge or a variety of marine specialized subjects including, but not limited to, navigation and marine law, weather and forecasting, communications, boat handling, and other ship related competencies.

Note: The reference to the “practice of good seamanship**”** is often referred to in the “Collision Regulations.”

2. “Collision Regulations”: Section I: Conduct of vessels in any condition of visibility

Rule 2: Responsibility

Nothing in these Rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any neglect to comply with these Rules or of the neglect of any precaution, which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

Comments: This overriding rule means not only do you have to follow the Collision Regulations, but you must practice the principles of good seamanship in doing everything possible to avoid a collision.

Rule 5: Lookout

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

Comments: As the operator of the vessel, you must maintain a constant lookout at all times day or night, without exception, using all means available including electronic and radar, if fitted.

Most marine accidents result from an improper lookout (Rule 5 and Rule 6: Safe speed).

Rule 6: Safe speed

“Every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions.

By all vessels:

(a) the state of visibility
(b) the traffic density including concentrations of fishing vessels or any other vessels
(c) the maneuverability of the vessel with special reference to stopping distance and turning ability in the prevailing conditions
(d) at night the presence of background light such as from shore lights or from back scatter of her own lights
(e) the state of wind, sea and current, and the proximity of navigational hazards
(f) the draught in relation to the available depth of water”

Canadian modifications: In the Canadian waters of a roadstead, harbour, river, lake, or inland waterway, every vessel passing another vessel or work that includes a dredge, tow, grounded vessel, or wreck shall proceed with caution at a speed that will not adversely affect the vessel or work being passed, and shall comply with any relevant instruction or direction contained in any "Notice to Mariners" or "Notice to Shipping."

Comments: You are responsible for the damage created by your wake.

Rule 7: Risk of collision

(a) "Every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt such risk shall be deemed to exist.

(b) Proper use shall be made of radar equipment if fitted and operational, including long-range scanning to obtain early warning of risk of collision and radar plotting or equivalent systematic observation of detected objects.

(c) Assumptions shall not be made on the basis of scanty information, especially scanty radar information.

(d) In determining if risk of collision exists the following considerations shall be among those taken into account:

(i) such risk shall be deemed to exist if the compass bearing of an approaching vessel does not appreciably change,

(ii) such risk may sometimes exist even when an appreciable bearing change is evident, particularly when approaching a very large vessel or a tow or when approaching a vessel at close range."

Comments: The best way to determine risk of collision is to determine if the other vessel is approaching your vessel and if so, determine if the vessel is approaching on a steady bearing.

Rule 8: Action to avoid collision

(a) Any action to avoid collision shall be taken in accordance with the Rules of this Part and shall, if the circumstances of the case admit, be positive, made in ample time and with due regard to the observance of good seamanship.

(b) Any alteration of course and/or speed to avoid collision shall, if the circumstances of the case admit, be large enough to be readily apparent to another vessel observing visually or by radar; a succession of small alterations of course and/or speed should be avoided.

(c) If there is sufficient sea room, alteration of course alone may be the most effective action to avoid a close-quarters situation provided that it is made in good time, is substantial and does not result in another close-quarters situation.

(d) Action taken to avoid collision with another vessel shall be such as to result in passing at a safe distance. The effectiveness of the action shall be carefully checked until the other vessel is finally past and clear."

Comments: When a risk of collision is determined to exist, take early and substantial alteration of course or speed so that the other vessel knows you are taking action to avoid a collision. Make sure you are far past the vessel and safe before resuming your course.

Rule 9: Narrow channels

(a) "A vessel proceeding along the course of a narrow channel or fairway shall keep as near to the outer limit of the channel or fairway which lies on her starboard side as is safe and practicable.

(b) A vessel of less than 20 metres in length or a sailing vessel shall not impede the passage of a vessel, which can safely navigate only within a narrow channel or fairway."

Rule 10: Traffic separation schemes

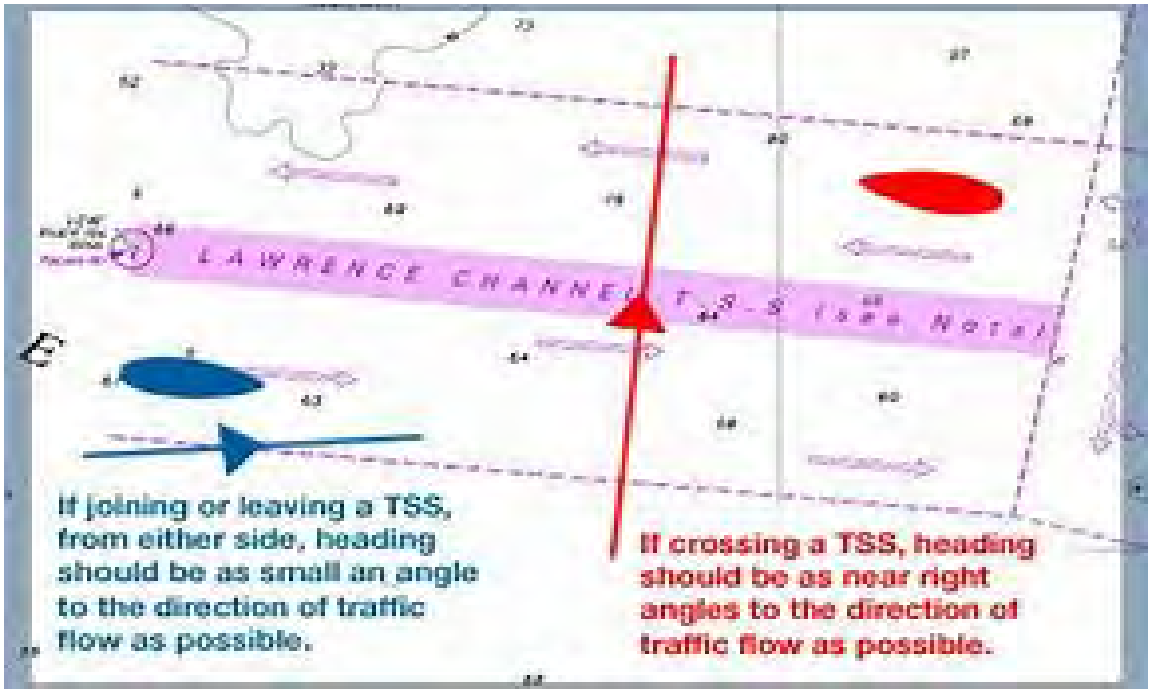
(a) A vessel using a traffic separation scheme shall:

(i) proceed in the appropriate traffic lane in the general direction of traffic flow for that lane;

(ii) so far as practicable keep clear of a traffic separation line or separation zone;

(iii) normally join or leave a traffic lane at the termination of the lane, but when joining or leaving from either side shall do so at as small an angle to the general direction of traffic flow as practicable.

(b) A vessel shall, so far as practicable, avoid crossing traffic lanes but, if obliged to do so, shall cross on a heading as nearly as practicable at right angles to the general direction of traffic flow.



Comments: Cross the traffic lanes at a 90-degree angle only. Join a traffic lane in the direction of traffic and at a small angle. If you have no business being in the traffic lane, then don't be there.

3. “Collision Regulations”: Section II: Conduct of vessels in sight of another

Rule 12: Sailing vessels

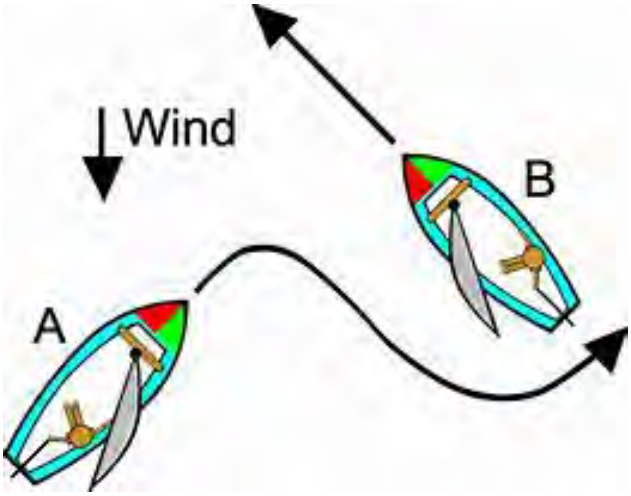
(a) “When two sailing vessels are approaching one another, so as to involve risk of collision, one of them shall keep out of the way of the other as follows:

(i) when each has the wind on a different side, the vessel which has the wind on the port side shall keep out of the way of the other,

(ii) when both have the wind on the same side, the vessel which is to windward shall keep out of the way of the vessel which is to leeward,

(iii) if a vessel with the wind on the port side sees a vessel to windward and cannot determine with certainty whether the other vessel has the wind on the port or on the starboard side, she shall keep out of the way of the other.

(b) For the purposes of this Rule, the windward side shall be deemed to be the side opposite to that on which the mainsail is carried or, in the case of a square-rigged vessel, the side opposite to that on which the largest fore-and-aft sail is carried.”



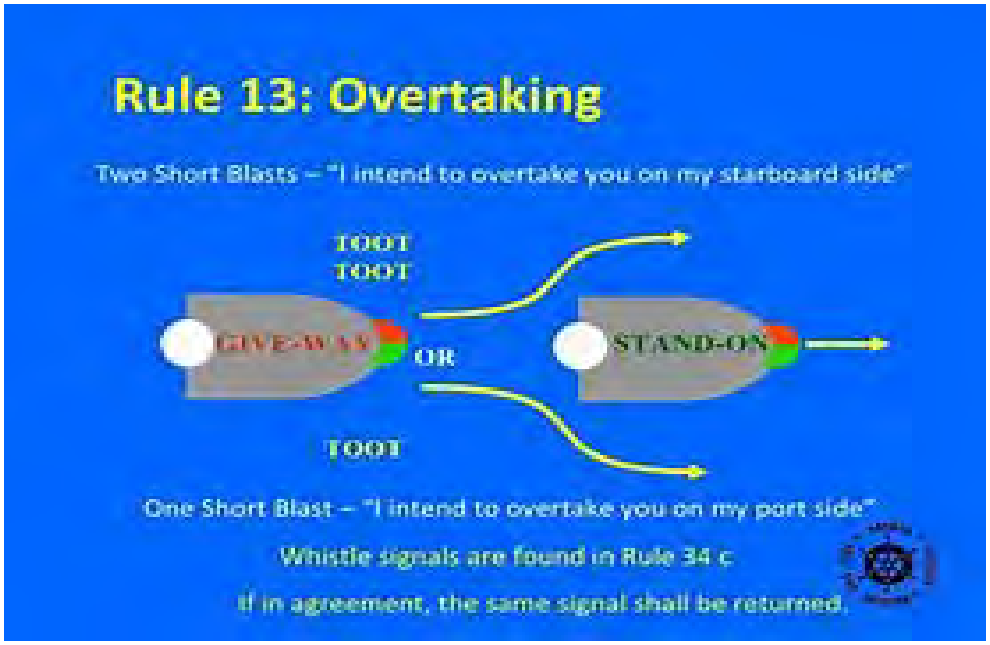
Comment: As the operator of a power-driven vessel, you are always the “give-way” vessel in situations where a sailboat is sailing without the aid of a motor. When using a motor, a sailboat is also a power-driven vessel.

Rule 13: Overtaking

(a) "Any vessel overtaking any other vessel shall keep out of the way of the vessel being overtaken.

(b) A vessel shall be deemed to be overtaking when more than 22.5 degrees (two points) abaft the beam or when that is, in such a position with reference to the vessel she is overtaking, that at night she would be able to see only the stern light of that vessel but neither of her sidelights."

Comments: The vessel that is overtaking is responsible to ensure she keeps out of the way of the overtaken vessel. This responsibility applies to **ALL** vessels. The vessel being overtaken has a responsibility to maintain her course and speed until the overtaking vessel is well clear and no risk of collision exists.

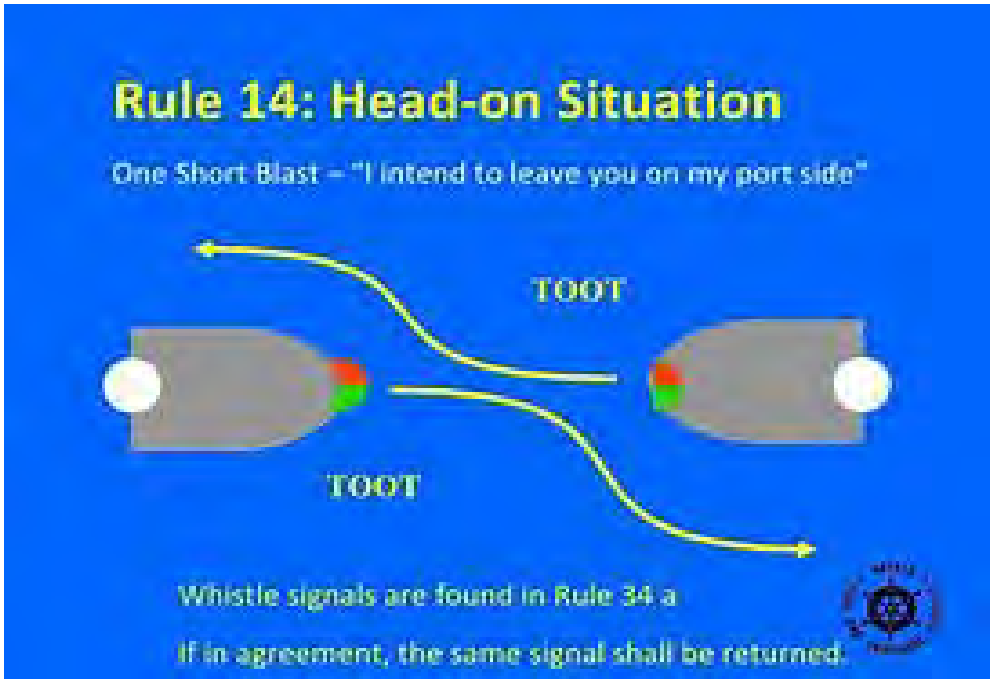


Rule 14: Head-on situation

(a) "When two power-driven vessels are meeting on reciprocal or nearly reciprocal courses so as to involve risk of collision, each shall alter her course to starboard so that each shall pass on the port side of the other.

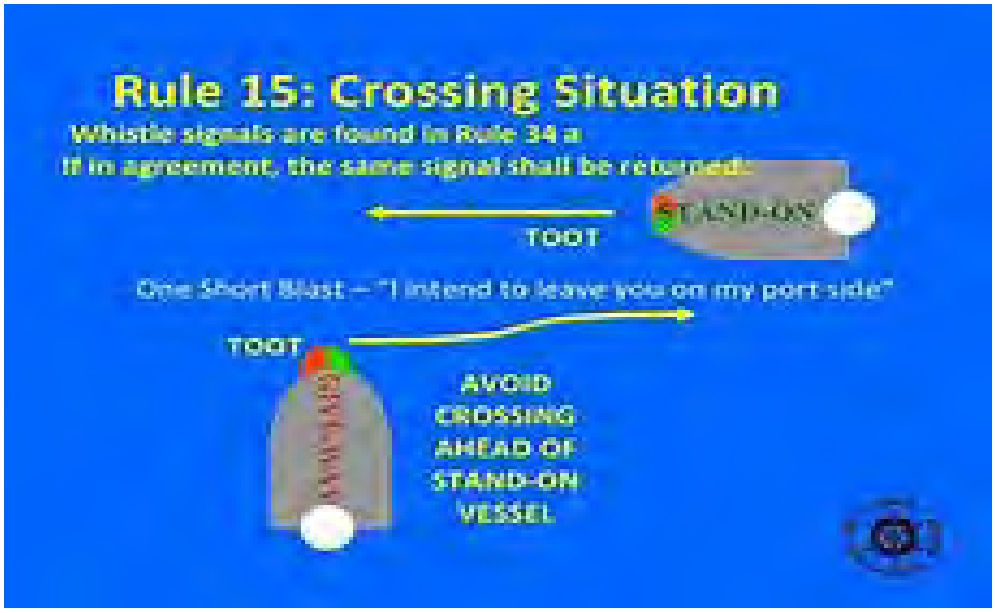
(b) Such a situation shall be deemed to exist when a vessel sees the other ahead or nearly ahead and by night she could see the masthead lights of the other in a line or nearly in a line and/or both sidelights and by day she observes the corresponding aspect of the other vessel.

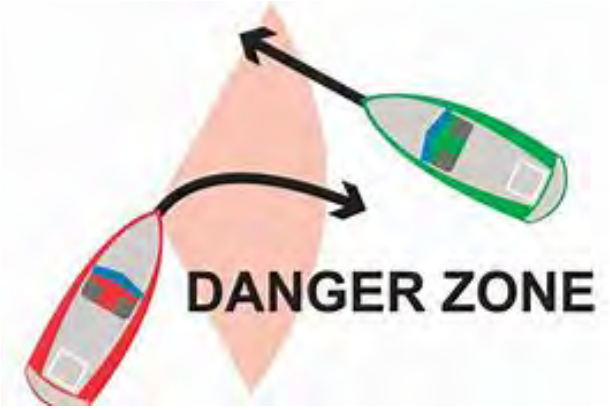
(c) When a vessel is in any doubt as to whether such a situation exists she shall assume that it does exist and act accordingly."



Rule 15: Crossing situation

(a) **"When two power-driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way and shall, if the circumstances of the case admit, avoid crossing ahead of the other vessel."**





Comments: Always remember that in a crossing situation, a vessel coming from your starboard side is in your danger zone and you must keep out of the way. At night when you see the green sidelights of another vessel that means “GO” for the other vessel.

Rule 16: Action by give-way vessel

Every vessel which is directed to keep out of the way of another vessel shall, so far as possible, take early and substantial action to keep well clear.

Comments: When your vessel is responsible to keep out of the way you must ensure that any course alteration or the reduction of speed can be clearly observed by the stand-on vessel. Small changes of course are **NOT** recommended.

Rule 17: Action by stand-on vessel

(a) (i) “Where one vessel is to keep out of the way, the other shall keep her course and speed.
(c) Two power driven vessels crossing shall not alter course to port for vessel on her own port side.”

Comments: Once the give-way vessel is determined, the stand-on vessel is responsible to maintain her course and speed.

Rule 18: Responsibilities between vessels

“Except where Rules for Narrow Channels, Traffic Separation Schemes, and Overtaking otherwise require:

(a) A power-driven vessel underway shall keep out of the way of:
(i) a vessel not under command

(ii) a vessel restricted in her ability to maneuver
(iii) a vessel engaged in fishing
(iv) a sailing vessel."

4. “Collision Regulations,” Section III: Conduct of vessels in restricted visibility

Rule 19: Conduct of vessels in restricted visibility

(a) “This rule applies to vessels not in sight of one another when navigating in or near an area of restricted visibility.

(b) Every vessel shall proceed at a safe speed adapted to the prevailing circumstances and condition of restricted visibility. A power-driven vessel shall have her engines ready for immediate maneuver.

(c) Every vessel shall have due regard to the prevailing circumstances and conditions of restricted visibility when complying with the rules of Section I.

(d) A vessel which detecting another vessel by radar alone, shall take avoiding action in ample time to:

(i) avoid alteration to port for a vessel forward of the beam, other than for a vessel being overtaken;

(ii) avoid an alteration of course toward a vessel abeam or abaft the beam.

(e) Except when it is determined that a risk of collision does not exist, every vessel which hears forward of her beam a fog signal, shall reduce her speed to be the minimum at which she can be kept on her course and navigate with extreme caution until danger of collision is over.”

Comments: When operating in restricted visibility, radar is a must. When a vessel is identified ahead of you, determine the distance and if risk of collision exists. If no risk of collision exists, continue to monitor. If risk of collision exists, take avoiding action, altering your course to starboard. If coming too close, reduce speed or take all way off and monitor with extreme caution. Remember:

- Always sound your fog signal every two minutes.
- Reduce your speed but maintain steerage way.
- Navigate cautiously until clear of risk of collision.
- Stop if necessary.
- Restricted visibility starts before you enter the fog.

5. “Collision Regulations,” Part C: Signs, shapes, and lights carried by vessels

Navigation lights and signals

Lights and shapes on a vessel are provided to let other vessels know of your presence at sea and the direction of travel your vessel is going. Lights are used when operating between sunset and sunrise or restricted visibility and are distinctive in colour and angle of projection. They can also reveal the disposition of a vessel: if it is towing, disabled, or working. Shapes perform the same function as lights except during the daylight hours and can indicate the activity being conducted by the vessel and what special purpose the vessel is engaged in. All vessels must be fitted with lights for its intended purpose.

Rule 20: Application of lights and shapes

(a) “Rules in this Part shall be complied with in all weathers.

(b) The Rules concerning lights shall be complied with from sunset to sunrise, and during such times no other lights shall be exhibited, except such lights as cannot be mistaken for the lights specified in these Rules or do not impair their visibility or distinctive character, or interfere with the keeping of a proper lookout.

(c) The lights prescribed by these Rules shall, if carried, also be exhibited from sunrise to sunset in restricted visibility and may be exhibited in all other circumstances when it is deemed necessary.

(d) The Rules concerning shapes shall be complied with by day.”

Comments: Only the lights for navigation should be used when operating at night. No other lighting, such as deck lights, should be illuminated while under way. Additional lighting can confuse other vessels in determining your speed and direction in assessing risk of collision.

Rule 21: Definitions of terms

Masthead light: A white light placed over the fore and aft centreline of the vessel showing an unbroken light over an arc of the horizon of 225 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on either side of the vessel.

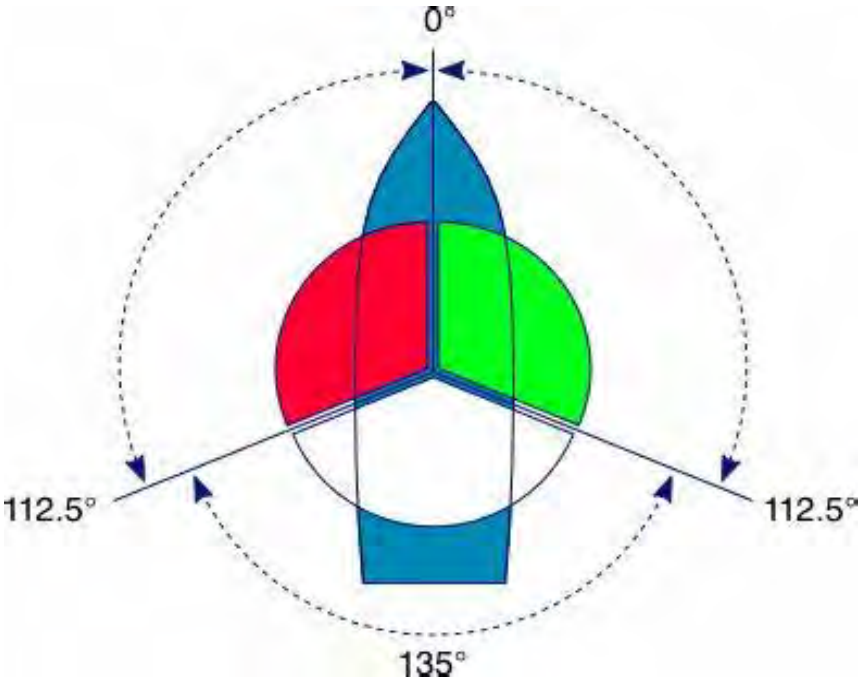
Sidelight: A green light on the starboard side and a red light on the port side each showing an unbroken light over an arc of the horizon of 112.5 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on

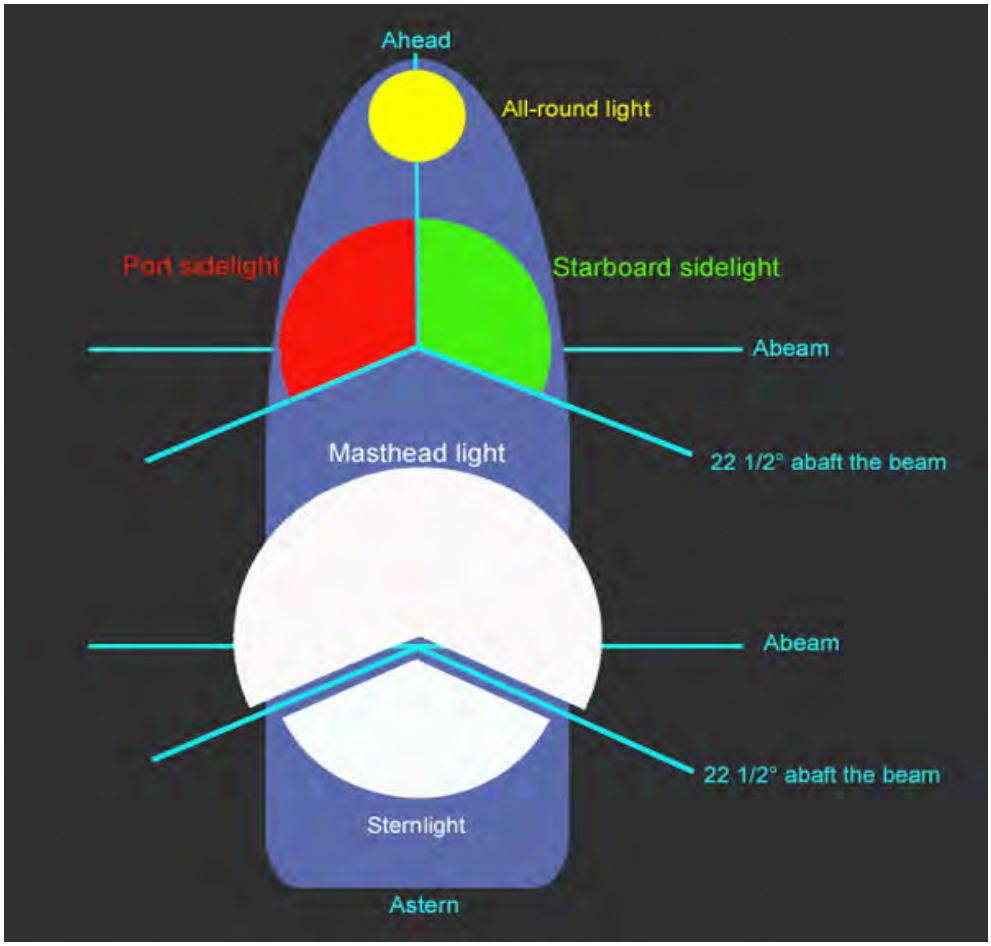
its respective side. In a vessel of less than 20 metres in length the sidelights may be combined in one lantern carried on the fore and aft centreline of the vessel.

Stern light: A white light placed as nearly as practicable at the stern showing an unbroken light over an arc of the horizon of 135 degrees and so fixed as to show the light 67.5 degrees from right aft on each side of the vessel.

Towing light: A yellow light having the same characteristics as the “stern light” defined in paragraph (c) of this Rule.

All-round light: A light showing an unbroken light over an arc of the horizon of 360 degrees.



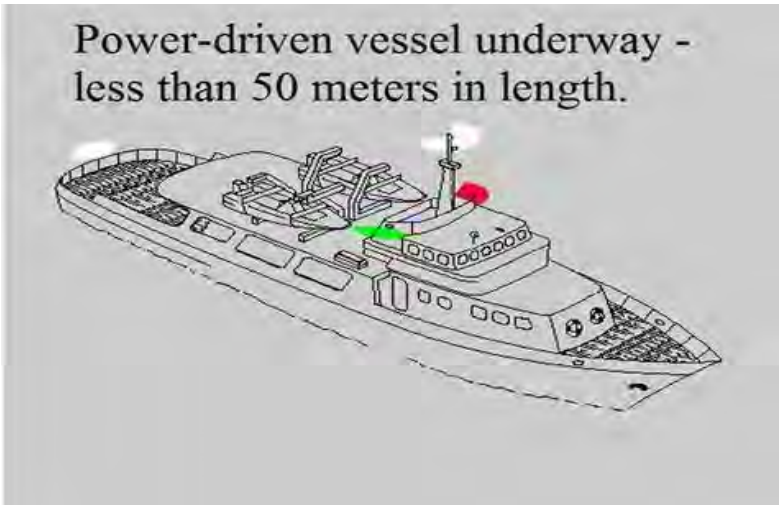


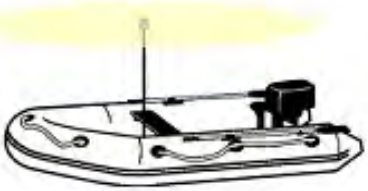
Rule 24: Power-driven vessel

"A power-driven vessel underway shall exhibit:

i) a masthead light forward,
ii) a second masthead light abaft of and higher than the forward one; except that a vessel of less than 50 metres in length shall not be obliged to exhibit such light but may do so,
iii) sidelights,
iv) a starlight.

(d) (i) A power driven vessel less than 12 metres may in lieu exhibit an **all-round white light** and sidelights."



Vessel length	Typical appearance	Lighting requirements
Power Vessels		
Under 7 metres and less than 7 k nots		Must exhibit a white all round (360 degree) light and, if possible, separate or combined sidelights
Under 12 metres		Must exhibit one of the following: • Separate or combines sidelights, a masthead light and a stern light • Separate or combined sidelights, an all round white light Masthead or white all round light shall be carried at least 1 metre above the sidelights.
12 metres to 20 metres		Must exhibit one of the following: • A masthead light, separate sidelights and stern light or • A masthead light, combined sidelights and stern light. The masthead light shall be carried at least 2.5 metres above the gunwale. Combined sidelights shall be carried at least 1 metre below the masthead light.

Rule 24: Towing vessels

a) "A power-driven vessel when towing shall exhibit:

- two masthead lights in a vertical line. If the tow exceeds 200 metres, three such lights;
- sidelights, a stern light;
- a yellow towing light in a vertical line above the starlight;
- when the length of the tow exceeds 200 metres, a diamond shape where it can best be seen.

b) A vessel or object being towed, other than vessels partially submerged or inconspicuous shall exhibit: sidelights, a stern light, and if the tow exceeds 200m, a diamond shape where it can best be seen."





Comments: A power-driven vessel that is not normally engaged in towing operations (e.g., assisting a broken-down vessel) is not required to display the lights and shapes as stated above. However, all possible means should be used to indicate the relationship between the two vessels while engaged in towing.

Rule 25: Sailing vessels and vessels under oars

(a) "A sailing vessel underway shall exhibit:

(i) sidelights;
(ii) a starlight.

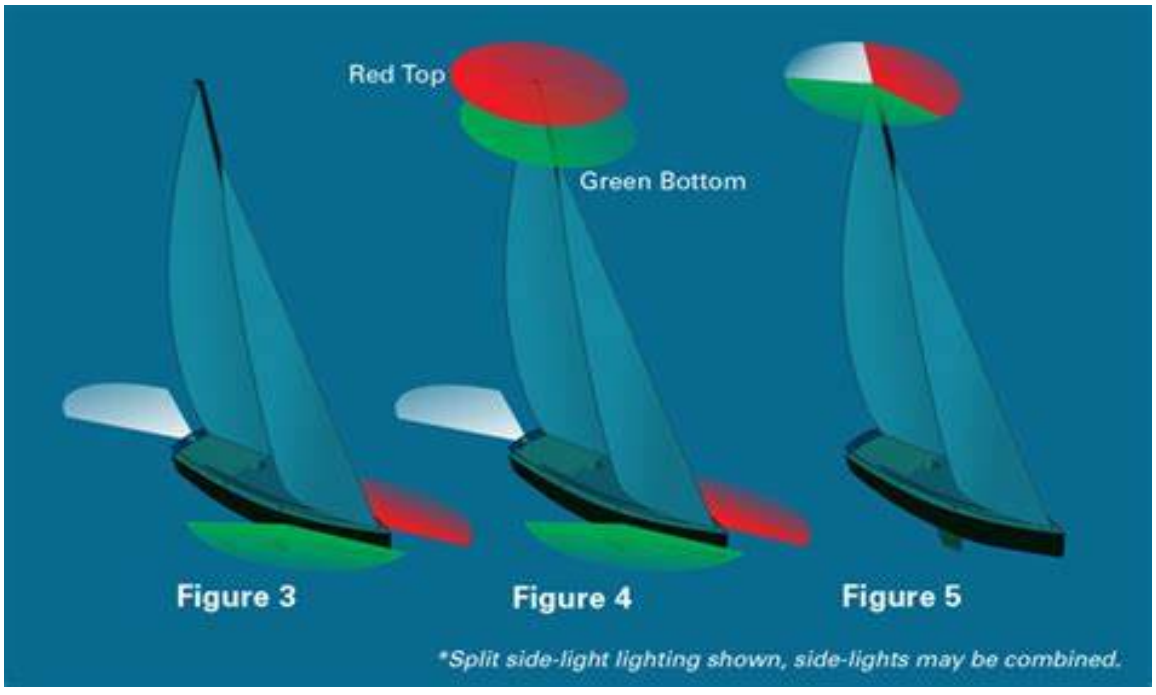
(b) A sailing vessel less than 20 metres may display one combined lantern at or near the top of the mast.

(c) A sailing vessel may, in addition display, two all-round lights, vertical, the upper being red and the lower green.

(d) (i) A sailing vessel of less than seven metres in length shall, if practicable, exhibit the lights prescribed in paragraph (a) or (b) of this Rule, but if she does not, she shall have ready at hand an electric torch or lighted lantern showing a white light which shall be exhibited in sufficient time to prevent collision.

(ii) A vessel under oars may exhibit the lights prescribed in this Rule for sailing vessels, but if she does not, she shall have ready at hand an electric torch or lighted lantern showing a white light which shall be exhibited in sufficient time to prevent collision.

(e) A vessel proceeding under sail when also being propelled by machinery shall exhibit forward where it can best be seen a conical shape, apex downwards."



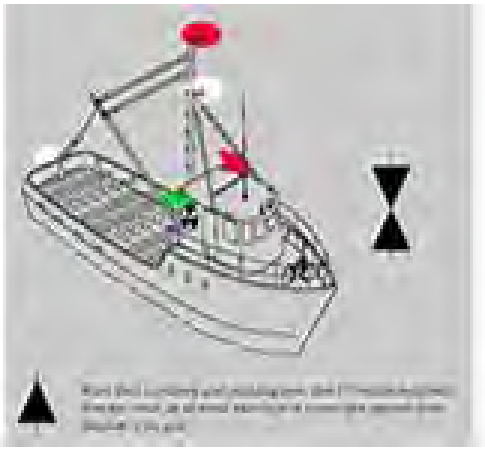
Rule 26: Fishing vessels

(a) "A vessel trawling shall exhibit: two all-round lights, green over white, or a shape consisting of two cones, apexes together.

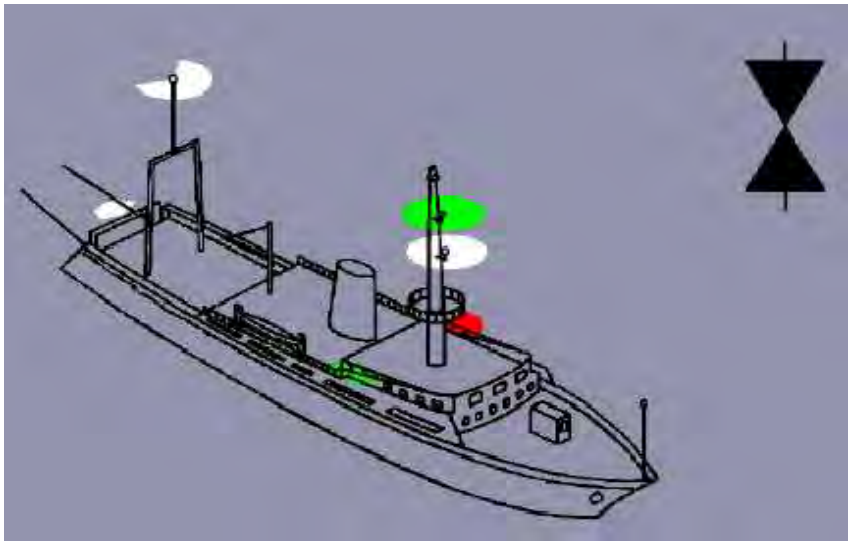
(b) (iii) when making way through the water, in addition — sidelights and a stern light.

(c) A vessel engaged in fishing, other than trawling, shall exhibit:

(i) two all-round lights red over white, two cones with their apexes together;
(ii) when outlying gear extends >150m horizontally from the vessel, an all-round white light or a cone apex upwards in the direction of the gear;
(iii) when making way through the water, in addition — sidelights and a stern light."



Fishing



Trawling

Comments: A fishing vessel engaged in trawling is not considered a fishing vessel pursuant to the Collision Regulations. That includes both commercial fishing trolling and sport fishing in any capacity.

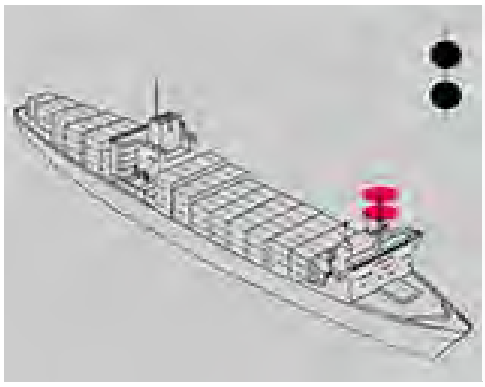
Rule 27: Vessels not under command or restricted in their ability to maneuver

(a) "A vessel **not under command** shall exhibit additional lights or shapes:

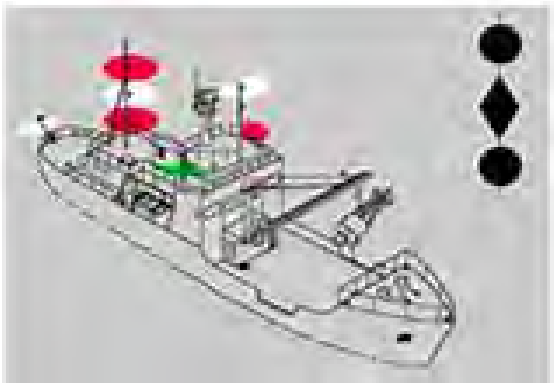
(i) two all-round red lights in a vertical line where they can best be seen;
(ii) two balls or similar shapes in a vertical line where they can best be seen.

(b) A vessel restricted in her ability to maneuver .. shall exhibit additional lights or shapes:

(i) Three all-round lights three shapes, vertically presented, red – white – red;
(ii) Three shapes, vertically presented, ball – diamond – ball. "



NUC

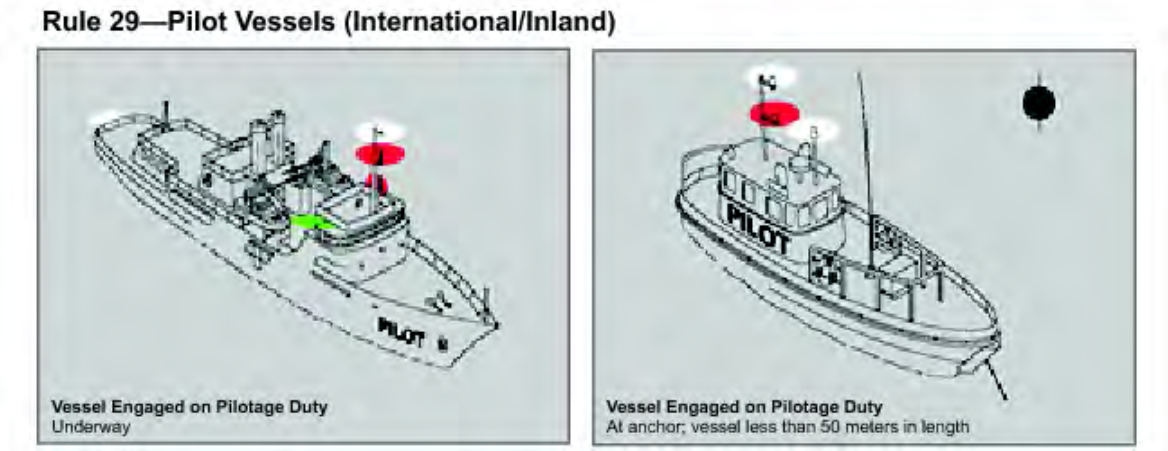


RAM

Comments: A vessel not under command is a vessel that is in trouble. It could **have** a broken steerage system, a fire onboard**,** or other mechanical problems that limit **its** ability to function. **It may be** engaging in working activities such as dredging and diving operations, all of which limit the ability of the vessel to operate under normal circumstances.

Rule 29: Pilot vessels

The vessel will display near the masthead, two all-round lights white over red.



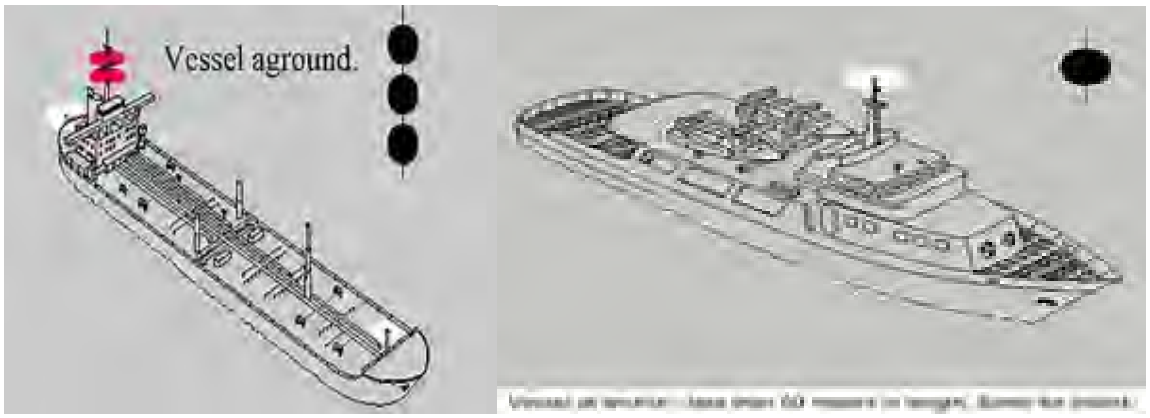
Rule 30: Anchored vessels and vessels aground

(a) "**A vessel greater than 50 metr**es **at anchor shall exhibit where it can best be seen:** Forward, an all-round white light or ball. Aft, at a lower level an all-round white light.

(b) A vessel less than 50 metres at anchor may exhibit an all-round white light instead of paragraph (a).

(c) A vessel aground shall exhibit in addition, where they can best be seen:

(i) two all-round red lights in a vertical line
(ii) three *balls* in a vertical line (daytime)."



Rule 31: Seaplanes

Seaplanes exhibit lights and shapes as closely similar in characteristics and position to water vessels as possible.

6. “Collision Regulations”: International and Canadian distress signals

Annex IV: Distress signals

Distress signals are internationally recognized actions taken by a vessel to indicate a requirement for assistance. They are only to be used for distress, which is defined as serious or imminent danger and the need for immediate assistance.

Running out of fuel is not a distress, however running out of fuel in 35 knots of wind where your vessel is about to run into rocks creating an imminent danger to life would be considered a distress.

Note: it may be illegal to use these signals for any other purposes.

(a) a piece of orange-colored canvas with either a black square and circle or other

(b) a dye marker

(c) a gun or other explosive signal fired at intervals of about a minute

(d) a continuous sounding with any fog-signaling apparatus

(e) rockets or shells, throwing red stars fired one at a time at short intervals

(f) a signal (SOS) in the Morse Code

(g) a signal sent by radiotelephony consisting of the spoken word “MAYDAY”

(h) the International Code Signal of Distress indicated by N.C.

(i) a signal consisting of a square, above or below it a ball

(j) flames on the vessel (as from a burning tar barrel, oil barrel, etc.)

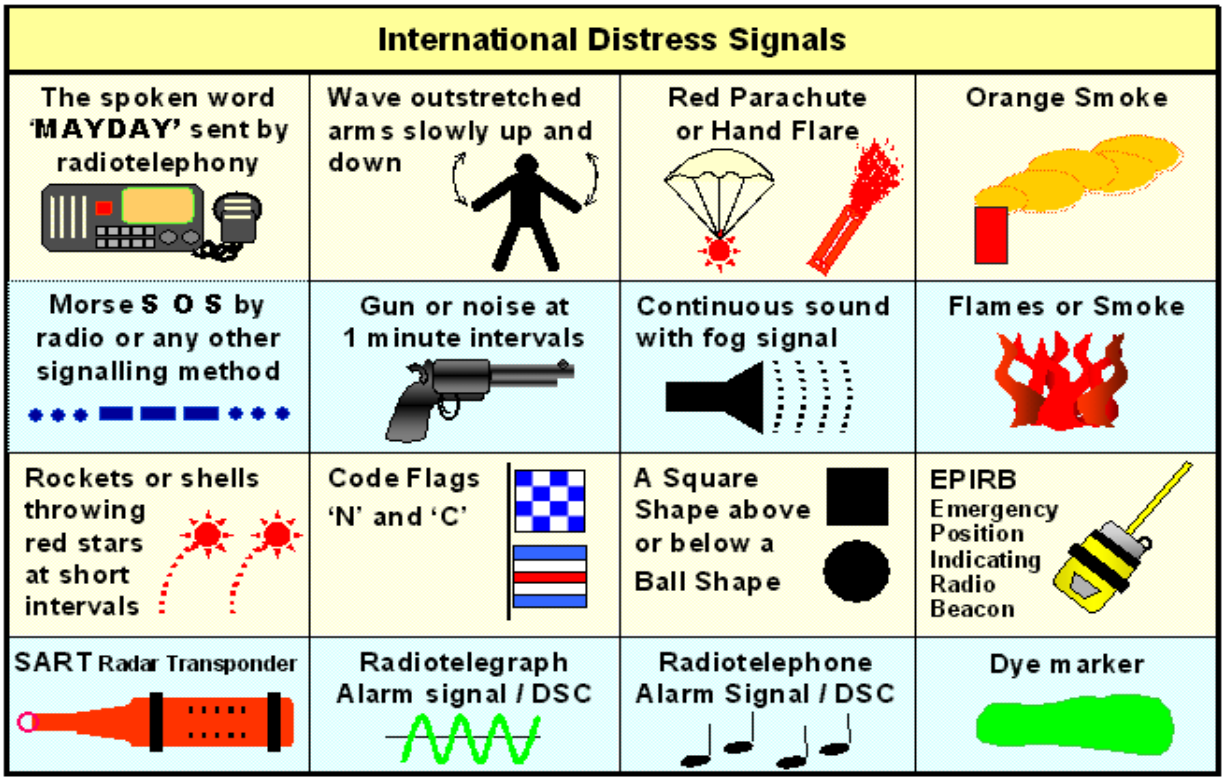
(k) a rocket parachute flare or a hand flare showing a red light

(l) orange-coloured smoke

(m) slowly and repeatedly raising and lowering outstretched arms

(n) the radiotelephone (digital) alarm signal

(o) signals transmitted SART EPIRB by emergency position-indicating radio beacons.



Distress signals — Canadian modifications

(a) "A square shape or anything resembling a square shape;

(b) A high intensity white light flashing at regular intervals of 50 to 70 times per minute."

7. The benefits of, and requirements to use, radar reflectors

Background

Transport Canada Bulletin No. 07/2008 was issued as a reminder to mariners operating small vessels of the importance of complying with the requirements for using radar reflectors.

In the past several years, there have been incidences of smaller vessels being run down or swamped by larger vessels operating in restricted visibility or heavy weather due to not being detected on radar.

Smaller vessels tend to make poor radar contacts due to their construction material such as fiberglass and their lower profile presentation on the water. Visual contact is reduced even more in rough weather and night operations where wave height and shore lighting can limit or completely eliminate visual contact of a small vessel. In restricted visibility where radar and sound signals are the only means to detect other vessels, it is important for vessels to be properly fitted with radar reflectors.

Though AIS (Automatic Identification System) is utilized by many commercial and pleasure craft vessels, it is still not as reliable for immediate detection and tracking as radar systems. Not only is it important for a larger vessel to detect the presence of a small vessel but equally important to track movement in real time to assess risk of collision.

Transport Canada, *TP 1861: Standards for Navigation Lights, Shapes, Sound Signal Appliances and Radar Reflectors* provides guidance for owners and operators of small vessels on proper installation of radar reflectors.





8. “Collision Regulations,” Part D: Sounds and light shapes

Rule 32: Definitions

Short blast: a duration of one second.

Prolonged blast: a duration of four to six seconds.

Rule 34: Maneuvering and warning signals

“When, **in sight of one another**, a power-driven vessel maneuvering, shall indicate that maneuver by the following signals on her whistle:

(a) **one short blast** to mean “I am altering my course to starboard”**;**

(b) **two short blasts** to mean “I am altering my course to port”;

(c) **three short blasts** to mean “I am operating astern propulsion.”

(d) Vessels in sight approaching each other and failing to understand the actions of the other, or if in doubt, shall immediately give at least **five short and rapid blasts.**

(e) A vessel nearing a bend or obscured shall sound **one prolonged blast** and shall be answered with a prolonged blast by any approaching vessel.”

Rule 35: Sound signals in restricted visibility

(a) “A power**-**driven vessel making way shall sound **for** not more than **two** minutes **one prolonged blast**

(b) A power**-**driven vessel underway but stopped shall sound at intervals of no more than **two** minutes **two prolonged blasts** in succession with an interval of about **two** seconds between them.

(c) NUC, RAM, SV, FV or towing, **one prolonged followed by two short blasts**

(d) A vessel being towed if manned, one prolonged followed by three short blasts

(e) A vessel at anchor shall at intervals of not more than one minute ring the bell rapidly for five seconds. A vessel at anchor may in addition sound one
short, one long, and one short blast, to warn of her position.

(f) A vessel less than 12 metres shall not be obliged to give the above signals.”

SUMMARY OF SOUND SIGNALS

By vessels in sight of one another (Sound signals)

Types of vessel	Description	Signal
Altering course to starboard	1 short blast	
Altering course to Port	2 short blasts	
Engaging my engine astern	3 short blasts	
Your intention not understood	5 short blasts or more	

In a Narrow Channel/Fairway (Sound signals)

Rounding a bend	One Long blast	
Overtaking on your starboard	Long, long, short	
Overtaking on your port	Long, long, short, short	
Front vessel in agreement	Long, short, long, short	

In Restricted Visibility (Fog Signals)		Description	Max Interval
Making way		1 prolonged blast	2 min
Underway		2 prolonged blast	2 min
Not under command Restricted in ability to manoeuvre Engaged in fishing Engaged in towing Sailing vessel Towing vessel		1 Prolonged 2 short	2 min
Last vessel of tow		1 Prolonged 3 short	

Note:
1 prolonged blast = 4 to 6 seconds duration
1 short blast = about 1 second duration

CHAPTER 7 REVIEW

1. What is the difference between a vessel not under command and a vessel restricted in its ability to maneuver?

2. What lights are required for a vessel under way and making way?

3. What angle of lighting does a stern light project?

4. Define the responsibilities of the “stand-on” vessel.

5. In a crossing situation which vessel is the “give-way” vessel?

6. How does the operator assess risk of collision with another vessel?

7. When must you maintain a proper lookout when your vessel is underway?

8. You are in restricted visibility and you hear one long blast directly in front of you. What is the state of the vessel and what should you do?

9. You are approaching a fog bank. What protocols should be implemented as you enter the area?

10. List three distress signals.

8. Maintaining vessel stability

Goals of this chapter

This chapter provides students with a basic understanding of the theory and practical application of small vessel stability, related cargo positioning, and other circumstances that can impact a vessel's ability to perform safely at sea. Transport Canada's *Small Fishing Vessel Safety Manual* –TP10038 provides a basic understanding of theoretical and practical applications to vessel stability, and is referenced in this chapter.

Learning outcomes

After completing this chapter, students will understand:

1. The principles of vessel stability
2. Load distribution and trim for small vessels and proper stowage of equipment and cargo
3. Hazards of the free-surface effect and loose water (or fish) on deck
4. Reserve buoyancy and watertight integrity
5. The principle of freeboard, and the effects of freshwater and saltwater
6. Hazards of icing conditions

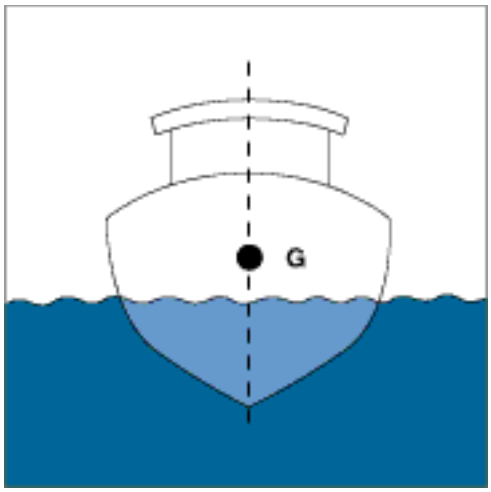
1. Principles of vessel stability

A vessel's ability to remain upright in the water is referred to as vessel stability. In technical terms, stability is a measure of a vessel's ability to resist capsizing and its ability to self-right. This is particularly relevant, as small vessels are exposed to a multitude of conditions that can cause them to capsize. Most vessels are designed to maintain a high level of stability in water through built-in flotation, hull design, and other means that resist capsizing and **foundering** (filling with water).

A well-constructed vessel alone does not alleviate the Master from responsibility to ensure the vessel is properly fitted, cargo and passengers are properly stowed and positioned, and the vessel is operated safely when at sea in hazardous conditions.

Vessel stability is a complex subject; however, some basic concepts can provide operators with an understanding of proper stability and the basic protocols needed to ensure the vessel will operate safely at sea. The following illustrations and descriptions are taken from the *Small Fishing Vessel Safety Manual* - TP10038

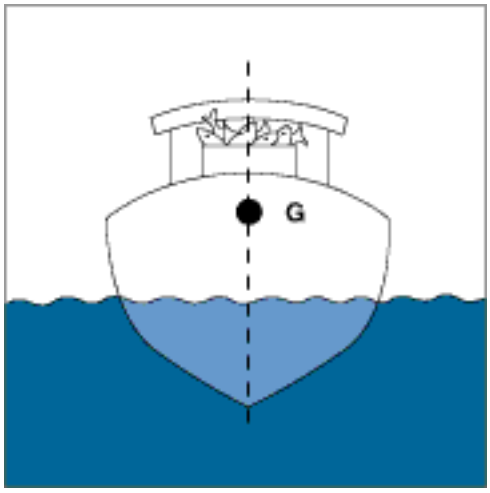
Centre of gravity



"The centre of gravity (G) is the point at which the whole weight of the vessel can be said to act vertically downward. As a general rule, a lower centre of gravity means a more stable vessel."

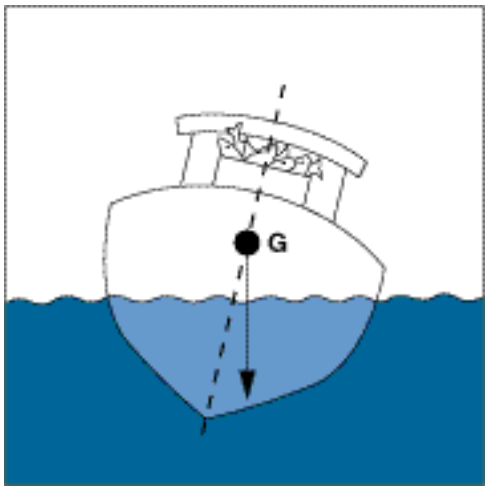
Comment: Any object that displaces water will have the force of gravity acting upon it as the force of the water pushes upward. A vessel is designed to have its centre of gravity low and on its centreline to ensure the vessel will remain upright, with its decking parallel to the waterline when not affected by other forces. A

vessel is designed to easily upright itself anywhere in the range of 0–10 degrees — this is known as **initial stability.**



“The centre of gravity changes, depending on where weight is distributed on the vessel. For example, a heavy load placed high on deck will produce a higher centre of gravity, and less stability, than a load stored below deck.”

Comments: The higher the centre of gravity the less stable a vessel will be and the ability of a vessel to self-right will be reduced. Additionally, objects placed off the centreline on only one side of a vessel will cause a vessel to list, affecting the vessel’s centre of gravity. Therefore, always stow gear low and balanced on each side of the vessel and as close to the centreline as possible.

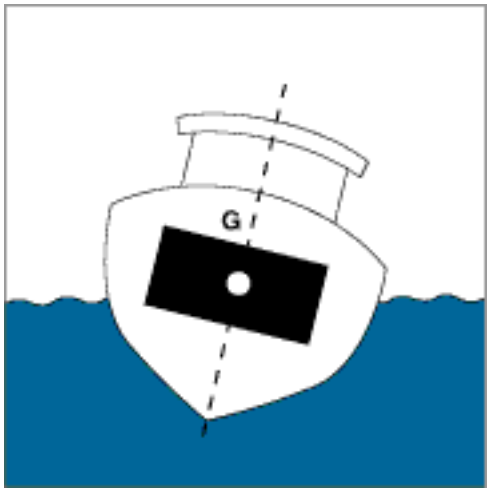


“A vessel with a high centre of gravity is "top heavy." If it lists or heels to one side, the centre of gravity pushes down in the direction of the list. The danger of capsizing is much greater.”

Comments: With more weight placed higher on the vessel, it may seem that that vessel is level on the water. However, the effects on the vessel’s ability to upright itself will be reduced, particularly in rough seas taken on the beam of the vessel.

Heel

The term **“heel”** refers to a temporary angle of a vessel in the water caused by external forces such as wind. When the external forces subside, the vessel will return to the upright position. The term **“list”** refers to a permanent angle of tilt. The cause of this is due to a shift in the centre of gravity.



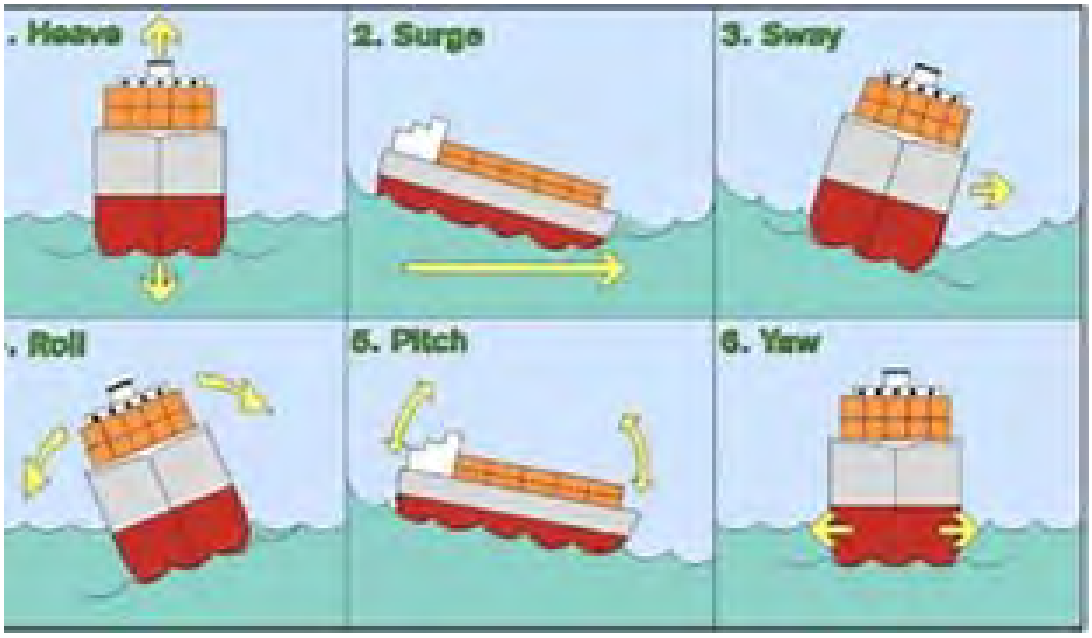
When a vessel with full tanks heels over, the contents of the tank do not shift. The tank's centre of gravity does not change, so it does not affect the vessel's stability.

Comments: Any equipment, fuel, or other weight that can potentially shift when a vessel is at sea, can alter the centre of gravity of the vessel, reducing its ability to self-right. Full fuel tanks don’t allow the shifting of weight in a vessel. When cargo or fuel can be moved when at sea, this is known as the **free-surface effect** (discussed later in this chapter).

2. Load distribution and trim for small vessels

As previously discussed, the centre of gravity of a vessel is one of the critical factors in determining its stability. A vessel's design characteristics will give it the ability to upright itself: however, the addition of weight in the form of cargo, fuel, liquids, and passengers can alter the vessel's stability characteristics and trim and affect the performance and safe operation of the vessel. Environmental forces such as wind and waves can also affect a vessel's profile in the water, possibly causing the following motions:

- **Heave:** Up and down motion lifted by the waves
- **Surge:** Sliding forward or back
- **Sway:** Side to side movement
- **Roll:** Side to side motion of the vessel
- **Pitch:** Up and down motion of the bow and stern
- **Yaw**: Side to side motion of the bow and stern



To counteract environmental factors affecting the movement of a vessel, the loading of cargo requires careful consideration and is a critical factor in the stability and performance of a vessel.

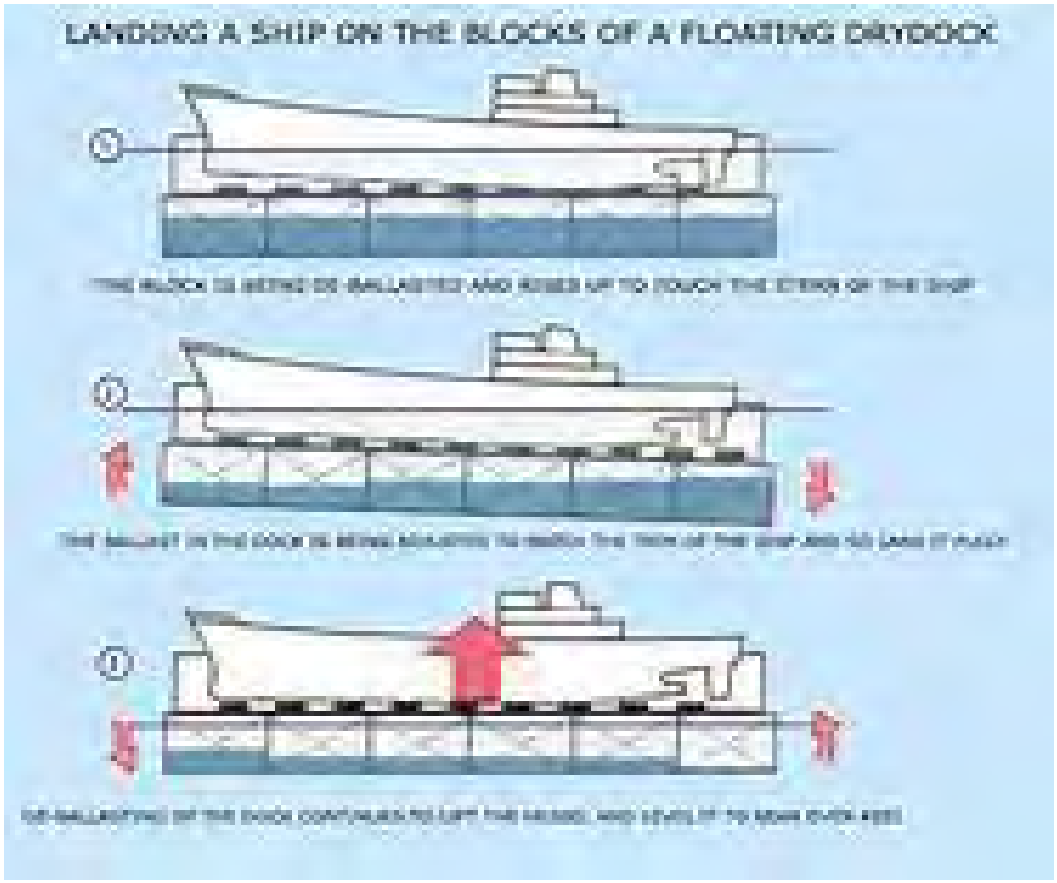
Trim

The trim of the vessel refers to how the vessel is balanced in the water on a longitudinal plane from bow to stern. If the vessel sits on the water evenly, this is

known as an **even keel**. How a vessel is trimmed can affect its performance, its propeller's efficiency, and other operating characteristics.

A vessel is trimmed positive (that is, trim by the stern) when the bow is higher than the stern and trimmed negative when the vessel's bow is deeper in the water than the stern (that is, trim by the bow).

Trim can also be changed when the boat is moving. Outboard engines and stern drives can change the propeller angle in the water (bow up or down), thereby trimming the vessel for various sea conditions. On larger vessels, trim is determined by the careful placement of cargo and ballast on the ship.



Precautions when loading and unloading cargo

Loading and unloading cargo from a vessel can immediately affect the stability of the vessel. Consideration should be given to the priority of items being loaded or unloaded, the weight and the impact on the vessel's centre of gravity.

Here are some considerations that apply to small vessels:

- Cargo should be evenly distributed and securely placed as low as possible in cargo spaces.
- The same considerations should be made with cargo above decks.

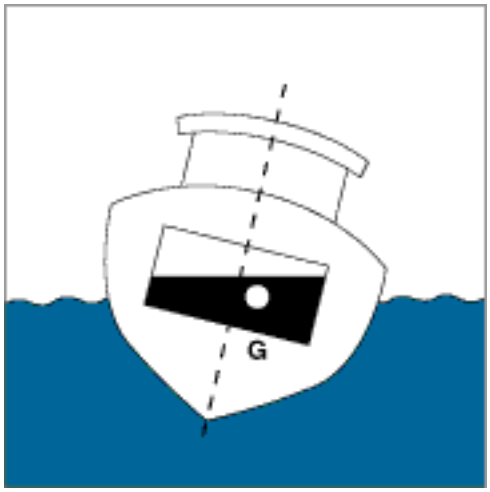
- Passengers should be distributed equally in designated seating areas. Directions should also be given to passengers regarding movement on the vessel. The movement of passengers to one side of a vessel (e.g., for viewing a passing whale) can significantly alter the stability of a vessel.
- Do not overload the vessel. Know your vessel's free-board requirements and stay within those parameters.
- Recognize excessive weight in the bow and stern area (trim). Too much weight in the stern or bow can cause swamping and undermine the stability of the vessel. This can be particularly dangerous in rough weather.
- Ensure your fuel tanks and ballast are full (if necessary) to increase vessel stability.
- All hatches should be closed with scuppers and drains unobstructed.
- Fishing vessels need to pay significant attention to the storage of fish and other related substances that can easily move within the vessel.

3. Hazards of the free-surface effect

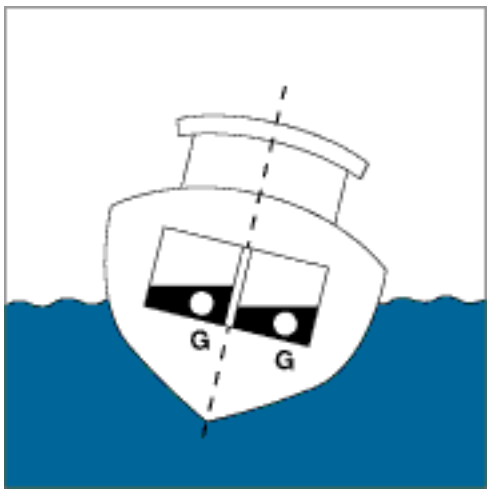
The **free-surface effect** is a situation where the shifting of weight of a substance on a vessel's decks can significantly alter the centre of gravity and stability of a vessel. This can cause a vessel to **flounder** (fill with water and sink) or capsize. In generally terms, the free-surface effect refers to the movement of a liquid or substance that is only partially restrained on a vessel allowing its position to move by the forces of gravity and seas on a vessel. In reality, any substance that can move while a vessel is at sea can be considered to have free-surface effect.

Liquids or fuel can move in any direction due to the forces of gravity. This equally applies to fish, sand, gravel, or any other item that is not securely in place. The free-surface effect is instantaneous due to the shifting and movement of the object's weight to the lower side of the vessel (gravitational pull). This effect will immediately cause the vessel's centre of gravity and stability characteristics to change, oftentimes in an unfavourable way, and increases the potential for capsizing or foundering.

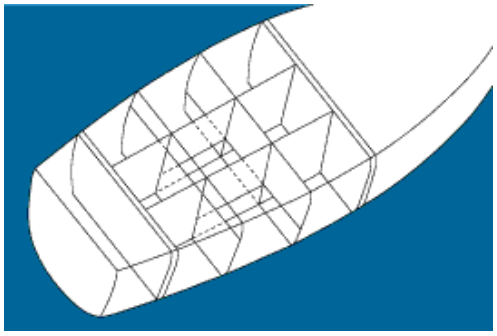
The free-surface effect can be greatly reduced by keeping water and fuel tanks full and having smaller compartments in place for cargo storage, limiting its movements.



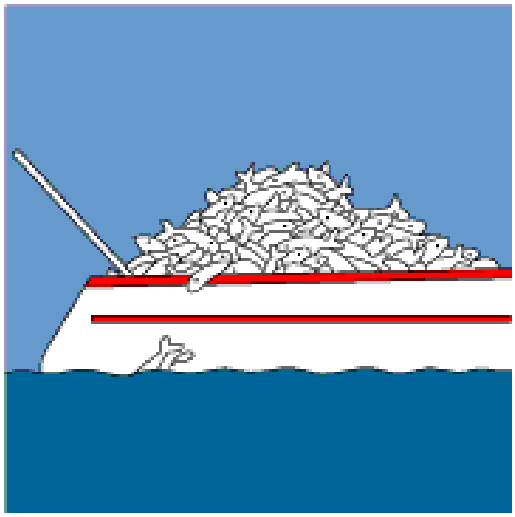
In a partly filled tank or fish hold, the contents will shift with the movement of the boat. The free-surface effect increases the danger of capsizing.



“When a vessel with partially filled spaces heels over, the contents of the spaces will shift. The centre of gravity moves over to the side, making the vessel less stable. To avoid this free-surface effect, try to have as few partially filled tanks and compartments as possible.”



“You cannot always avoid partly filled spaces. By dividing a tank into two equal parts with a baffle, the free-surface effect is greatly reduced. Using boards to divide fish wells into compartments will also help.”



“Fish left loose on deck have the same effect as water. Fish should be properly stowed in the hold as soon as possible to maintain stability.”



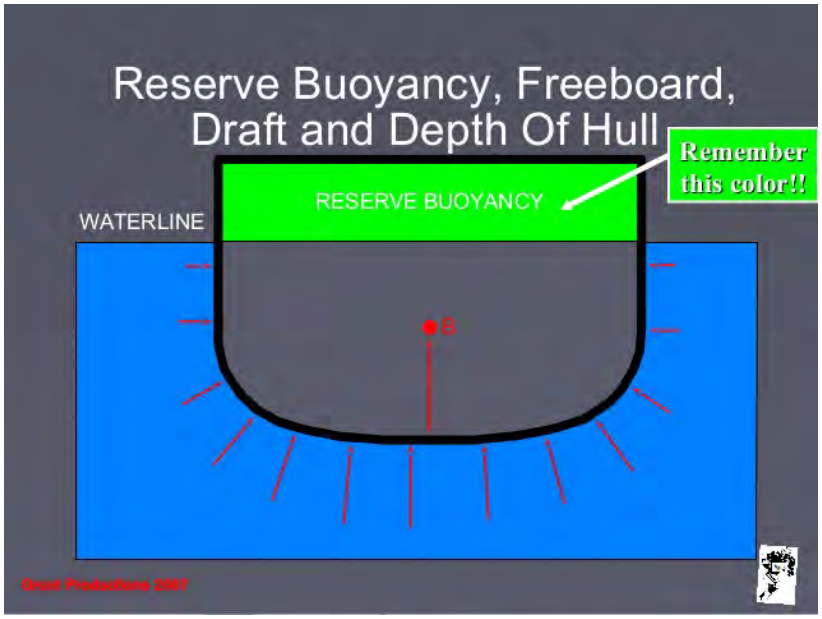
“When water is shipped on deck and unable to escape, it creates a large free surface. It also adds weight high in the vessel. Freeing ports (scuppers) are vital for removing shipped water and maintaining stability.”

Comments: Too much water in a vessel increases weight and instability. The slightest listing in any direction will cause a gravitational pull of the water towards the direction of the list. For example, great care is exercised with a fire onboard a vessel to control the amount of water used to put out the fire.

4. Reserve buoyancy and watertight integrity

A vessel will float when the buoyancy of the displaced volume of water equals the displacement weight of the vessel (Archimedes Principle).

Any volume of a vessel's structure above the waterline that can be kept watertight will provide the vessel with additional buoyancy. This can be referred to as reserve buoyancy.



Watertight integrity

In order to preserve the reserve buoyancy, all decks on a vessel exposed to the environment should be secured and watertight.

The watertight integrity of a vessel can be maintained and functional for the movement of the crew through openings through the bulkheads of the vessel.

Hatches, doorways, skylights, and portholes should be closed while at sea.

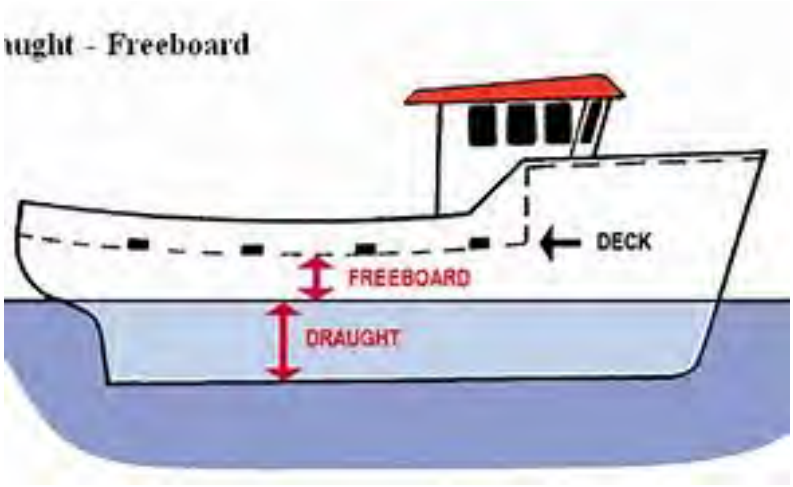
5. The principle of freeboard and the effects of freshwater and saltwater

Checking stability with a loaded vessel

Vessels that are unstable in the water will not self-right as quickly when subjected to sea conditions on their beam. Additionally, trim should be examined to determine an even keel or slightly bow up, and that ensure sufficient freeboard exists.

Freeboard

Freeboard is a measurement between the waterline and the top of the gunwales of a vessel. It provides a safety margin for the vessel keeping water from entering the decks. Freeboard needs to be sufficient to allow a vessel to withstand a roll or other motions caused by the seas. When a vessel is overloaded the freeboard will be too low allowing the decks to be submerged in water.



Freshwater allowances (FWA)

When loading a vessel and examining the level of freeboard, consideration must be given to the vessel's movement from saltwater to freshwater or vice versa.

As salt water is denser than freshwater, a vessel loaded in salt water will float more than with the same weight in freshwater.

This can present a significant risk factor for vessels with loaded cargo entering a river system or lake from a saltwater environment. This equally applies in the reverse when a vessel loaded in freshwater will be more buoyant when going to a saltwater environment.

Loaded fishing vessels often enter river systems with their cargo. When the river flow runs against a tidal direction or wind, choppier sea conditions will exist. This

situation coupled with the vessel entering freshwater with less freeboard will compound the problem and can put the vessel at risk of foundering or capsizing.

Every vessel will react differently to the transition from fresh to saltwater and will require special calculations to provide accurate projections.

The **Plimsoll mark** is a marking on the hull at the amidships section of a ship that provides a visual indicator of the maximum limit of load a ship can take.

6. Hazards of icing conditions

The most hazardous and common form of icing on a ship is **freezing sea spray**.

Icing conditions on vessels is not a common risk for mariners operating in lower latitudes on the West Coast but it can present serious risk to vessels in northern latitudes and colder climates in other parts of Canada.

Icing on vessels from freezing sea spray is an extremely dangerous situation. Heavy ice can quickly accumulate on various parts of a vessel, compounded by its formation on rigging and structures high above its decks.



How sea spray is formed

Seawater freezes at approximately -2 degrees Celsius. If the surrounding air temperature is below this, then the seawater landing on the vessel will freeze and stick rigidly to the vessel. Formation of ice can begin between temperatures of -3 to -8 degrees Celsius. These temperatures coupled with winds between 16 to 30 knots and above can compound the problem formulating substantial amounts of ice in a short period of time.

Freezing rain

We are familiar with freezing rain on road surfaces rendering the surface slippery. On vessels, this is equally the case, and though this is a concern a vessel will accumulate weight as freezing sea spray.

Ice danger to vessels

The rapid accumulation of ice weight and its location on a vessel can significantly alter its centre of gravity, resulting in reduced stability. There have been numerous ships, small vessels, in particular fishing vessels, that have capsized, foundered, or have been rendered disabled due to the accumulation of ice on board.

Smaller vessels and fishing vessels with extended rigging are particularly vulnerable to the accumulation of ice on many exposed surfaces, outweighing the vessel's inherent stability with a smaller hull/superstructure ratio. Vessels with larger and deeper hulls and less exposed structures have a greater ability to withstand icing.

One of the most serious results of sea spray on the vessel is the restriction in maneuverability and stability. The weight of ice will reduce the free board of the vessel, increase the draft, and raise the centre of gravity. Depending on the direction of travel, relative to the wind and sea direction, trim, ineffective propeller function, and other conditions can put the vessel at risk. The accumulation of ice also makes the decking and outside movement extremely difficult and unusable.

Accumulation of ice on rigging, antennas, and radar domes can affect communication and navigation and shut down deck operations.

Operating in icing conditions

Icing on a vessel presents a serious risk. The following suggests may be helpful:

- Check the weather synopsis and forecast before departure and take the necessary precautions.
- Before leaving port, remove all ice from the vessel.
- Minimize the potential for free-surface effect on loads, fuel, and ballast.

CHAPTER 8 REVIEW

1. What does the term “freezing sea spray” mean and what dangers exist?

2. List three concerns when loading and unloading cargo.

3. What is reserve buoyancy?

4. Define the “free-surface effect” and describe how it would impact a vessel’s stability.

5. What does the term “watertight integrity” mean?

6. What is the difference between roll and pitch of a ship’s movements?

7. Define stability. Is a log floating in the water stable? Explain.

8. How is the free board on a vessel measured, and why is it important?

9. What is the difference between the heel and list of a vessel?

10. Can the centre of gravity change on a vessel? If so, how?

9. Safety working practices and safe vessel culture

Goals of this chapter

This chapter describes the basic safety working practices aboard vessels, and outlines the importance (and responsibility) of adhering to a culture of vessel safety.

Learning outcomes

After completing this chapter, students will:

1. Understand the necessity for keeping the vessel shipshape
2. Know the hazards within the marine workplace, the precautions necessary when working aloft, and the precautions to be taken when entering confined spaces
3. Demonstrate the signals for directing winch or crane operations
4. Know the standard industry procedures for safe refueling operations
5. Understand the care of lifejackets, PFDs, anti-exposure suits, and fire detection and extinguishing equipment
6. Know how to use flares: types, safety, storage, and disposal
7. Understand safety in towing (including distress assistance)

1. Keeping the vessel shipshape

It is of paramount importance that owners and operators of a vessel recognize the responsibility for maintaining a safe vessel and safe-oriented working protocols for the ship's company at all times. *The Small Commercial Vessel Safety Guide* - TP 14070 (referenced in this chapter) provides the regulations and safety guidelines for owner and operators and is an excellent reference manual for small commercial vessel operators.

Vessel maintenance

The purpose of maintaining a vessel in proper working order comes down to safety. A vessel that is poorly maintained poses an extreme safety risk to the vessel and crew.

Periodic and scheduled maintenance inspections are a must, and also must be recorded to ensure the vessel is ready for safe operations. Appendices 4 and 5 of *The Small Commercial Vessel Safety Guide* - TP 14070 provide a sample of a maintenance schedule that can be changed to meet the specific needs of your vessel.

Some inspection items include:

- **Hull inspection**: Inspect annually through-hull fittings, cleats, stations, doors, and hatches.
- **Machinery**: Inspect and replace oil, filters, coolants, bilge pumps, spark plugs, thermostat, hoses, electrical parts, and out drives as needed or at the suggestion of the manufacturer.
- **Electrical systems**: Inspect and test all circuits for loose or corroded wiring, test batteries, and ensure proper ventilation.
- **Other systems**: Inspect fuel tanks, hose fittings, lubrication fittings, hydraulics, trim, anchoring system, safety equipment (e.g., life jackets, flares, fire extinguishers, life rafts, radios, antennas, and other equipment as required).

Compliance checklist

Pursuant to *The Small Commercial Vessel Safety Guide* - TP 14070, the authorized representative (owner or designate) is responsible for ensuring that the vessel meets the regulatory requirements of the vessel's maintenance record. The purpose of the checklist is to verify that the vessel and equipment comply with the basic safety requirements. The *Small Vessel Compliance Program* details the checklist compliance reporting guidelines for small non-pleasure vessels.

2. Hazards within the marine workplace

Hazards in the marine environment are constant. To mitigate risk, one of the highest priorities for the vessel's safety is a well-maintained vessel and a trained and competent crew that follows proper procedures at all times, not just in emergencies.

Commercial vessels, in particular fishing vessels, have a high predisposition for accidents. However, the risk of accidents can be greatly reduced when the following general precautions (TP 10038) are taken:

Housekeeping: Ensure the deck is tidy and that all equipment, ropes, and gear are properly stowed.

Deck gear: This should be always tied down and secured to prevent "free-surface effect" and the shifting of the vessel's centre of buoyancy and centre of gravity.

Secure cabin: The galley is a potential source of fire; ensure all items including utensils, drawers, and cooking products are secure.

Pursuant to *The Small Commercial Vessel Safety Guide*: "Every vessel owner and operator must provide all information, instruction, training, and supervision needed to protect the health and safety of crewmembers. This includes training related to the vessel's safety policy and procedures. Employees must be made aware of foreseeable hazards and the steps they should take to avoid accidents and injury."

This responsibility is also included in Federal legislation under the *Marine Occupational Safety and Health Regulations of Canada* and under the *Canadian Shipping Act, "*Safe Working Practices Regulations."

General safety rules

These safety rules should be stated in your vessel's/company's safety rules documents and it is equally your responsibility to know and understand them before becoming operational on a vessel. Here are some general rules reflected in the *Canada Shipping Act:*

- Work to be carried out must not endanger any other person not involved with the work.
- Protocols designed to reduce risk must be in place.
- All loading and unloading of equipment must be performed and inspected prior to use.
- A qualified person must be in charge at the work site.

- All workers must take measures to ensure their own safety and use all safety equipment necessary.
- Safety equipment shall be used for its designated purpose only.
- A person shall report any work conducted in an unsafe manner.
- A person working in an isolated area shall ensure oversight is provided at regular intervals.
- No person shall work when deemed or suspected to be impaired.
- Any person who becomes aware of an accident shall forthwith report the accident.

Precautions when working aloft

(*TC Safe Working Practices,* Sections 47–53)

Countless serious and fatal accidents result from falls from bosun's chairs, portable ladders, and other working places aloft or outboard.

Some general safety provisions are as follows:

- Workers should wear the appropriate safety devices including harnesses, helmets, and personal flotation devices (PDF).
- Below areas should be clear and secure from other passing personnel. Tools should be passed up as required.
- When coming down from a work site, use the appropriate ladder.
- Inspect and test all ropes before commencing work.
- Inspect all cradles, staging, bosun's chair, or portable ladders before using.
- Proper clothing should be worn, including footwear and helmets.
- If possible, safety nets should be in place.

Precautions when entering a confined space

(*TC Safe Working Practices*, Sections 30–32)

Many deaths have occurred in recent years when crewmembers have entered areas where air could not support life. This may occur due to lack of air or the presence of toxic gases. Any confined space may be deficient in oxygen. Here are some general rules to apply when entering a confined space:

- Never enter a confined space without the permission of the owner or Master.

- Once the space is opened, a qualified person must ensure the space is safe to enter by testing and ventilating the area.
- Breathing apparatus must be used in certain areas and must be ready at all times with safety lines.
- Only qualified crew knowing protocol and emergency procedures may work in confined spaces.

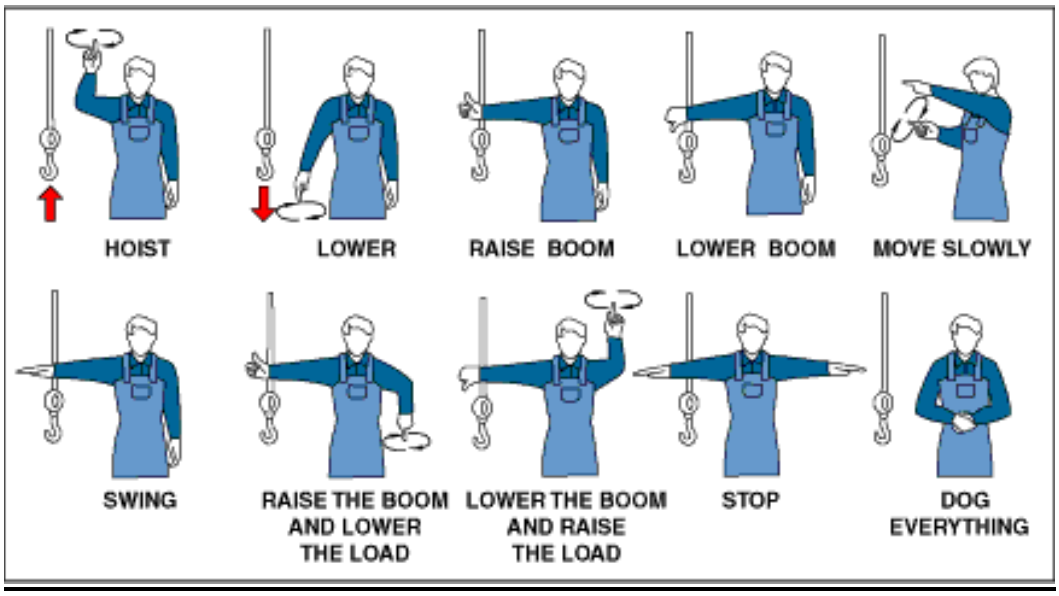
3. Winch and crane operations

(*Small Vessel Safety Manual* TP-10038)

Loading and unloading a vessel in port or at sea can be a complicated and dangerous process. It is imperative that standard communication protocols are established and that qualified personnel are used for these operations.

In order to function safely, the winch or crane operator must communicate directly with the deck hands to properly control the cargo being moved.

Standard signals have been established as follows:



4. Procedures for safe fueling

By design, fuel is a highly flammable and explosive material. Regardless of whether your vessel uses gasoline or diesel, risk is always present, and the same safety procedures must be followed to refuel safely (TP 10038):

1. Moor the vessel securely and have a fire extinguisher readily available and designed for flammable liquids (Class B fires).
2. Turn off the engine and ensure all crew members and passengers not involved in the refueling procedure leave the vessel.
3. Ensure that stoves, pilot lights, heaters, or any other potential open flame is extinguished. Absolutely no smoking. Consideration should be given to turning off the battery switch.
4. Close all hatches, doors, and ports. This will contain the ignition and movement of any gases within the vessel. Any portable fuel tanks or propane tanks should be removed.
5. Do not use any electrical systems while refueling. (As mentioned, it is best to turn off the battery switch, cutting off all electrical circuits within the vessel).
6. When fueling, ground the fuel nozzle against the filler pipe to reduce static electricity. Pay attention and do not overfill.
7. Ensure any spill is properly cleaned, then run the blower for at least five minutes while ventilating the cabin and enclosed spaces.
8. Check for vapour and odours with a “sniffer” device and by smell.
9. Once fueling is done, start the engine and allow passengers/crew to re-board vessel.

5. Personal protective equipment and fire protection equipment

Pursuant to the *Canada Shipping Act, Safe Working Practices Regulations,* personal protective equipment on a commercial vessel shall comply with Canadian Standards Association for specific equipment or where a high standard exists by a provincial authority.

General principles for clothing

There are a number of regulations that address the use of helmets and footwear where specific risks exists but, in general terms, operators and crew of a vessel need to use common sense in providing and wearing clothing for expected and unexpected environment conditions. Sea state, weather, sun, wind, and rain change the dynamics of exposure to crew, and can only be addressed by the appropriate clothing. Some principles to follow include:

- Always dress for the weather and have extra clothing for changes in conditions. This includes hats, sunglasses, protective shells, and both lighter and heavier clothing depending on the conditions.
- Wool and other synthetic products can be excellent choices for layered clothing. Wool offers great insulation properties and can continue to retain heat (but is heavy) when wet. Synthetic materials such as polypropylene are designed to keep moisture away from the body and offer excellent insulation properties. There are also many marine grade jackets, shells, and exposure suits that have features including insulation, flotation, and visibility.
- Insulated and shielded work boots are often mandatory on work vessels. Also consider waterproof or insulated gloves, and use safety glasses and sunscreen when required.
- Cotton is a poor choice for working on a vessel. Cotton soaks up water like a sponge and holds it to the skin. As the water evaporates, the heat is pulled away from the body making the person cold.

Firefighting equipment

The size and number of fire extinguishers found on a vessel is determined by the size and use of the vessel. The extinguishers must be approved by Transport Canada and specific to the type of fire being fought.

There are basically two types of firefighting equipment found on most small vessels: portable extinguishers and installed fire suppression systems. Both

systems require regular and scheduled maintenance by both crew and professional inspectors.

Lifejackets, personal flotation devices (PFD)'s, and anti-exposure suits

Anyone falling overboard, whether day or night, is an extreme emergency situation that has life threatening consequences. The water temperature and climate in the BC Coastal waters and the Pacific Northwest compounds the problem of exposure, limiting survival time in the water. Most people that have drowned were not wearing a flotation device.

Wearing a life jacket, PDF, or anti-exposure suit will increase your chances of survival by providing:

- Flotation
- Insulation
- Mobility
- Visibility
- Protection

Flotation devices approved by DOT

Lifejackets are designed to keep a person's head above water and help them maintain a proper breathing position**.** All commercial vessels are required to have approved TC lifejackets to fit each person on board. These life jackets are also SOLAS (Safety of Lives at Sea) approved.

Life jackets are generally bulky and are not meant be worn to work aboard a vessel. Its specific function is during emergencies when a possibility of evacuating the vessel exists**.** An approved TC lifejacket is not a PFD (see below).





Note: Only lifejackets satisfy the requirements for life-saving equipment on commercial vessels. A lifejacket is donned when potentially evacuating a vessel. They are more buoyant than PFDs, and they do a better job of keeping one's mouth out of the water.

Personal flotation devices (PFDs): Approved PFDs can be worn instead of lifejackets during the regular operations of a vessel and on pleasure crafts. A PFD is designed to be worn constantly but will not keep a person's head in a proper position above the water line. These vests come as standard flotation models or inflatable models.



Anti-exposure suits: These suits are often referred to as flotation suits. They can be a good choice when operating in colder weather conditions. These suits not only provide floatation but also protection and insulation. They are often seen on open rescue vessels, and they can provide 15 pounds of positive buoyancy. With tie-down straps to reduce water flow and hood attachments, these suits provide floatation and visibility, and can extend a person's survival time on the water far longer than a conventional PFD.



Immersion suits: Immersion suits (also known as survival suits) are designed to provide the best protection from cold water and exposure by not allowing water to enter the suit. All immersion suits should be TC approved. These suits are used in emergencies when the possibility of entering the water exists.

Immersion suits operate on the same principle as a diving dry suit. A neoprene material provides insulation from the cold water and significant buoyancy and sealed seams keep all water out. As such, it is imperative that the suits are properly sized and fitted for crew individuals to ensure a proper seal and comfort.

All crew members should practice periodically donning their suits and ensure they are properly maintained.



Care and maintenance of lifesaving equipment

Scheduled maintenance of safety equipment is imperative and should be a part of every vessel routine. Salt water can be very corrosive on equipment and cause malfunctions. Therefore:

- Periodically inspect, clean, and lubricate lifejackets and other PPE. Use only soap and fresh water to clean.
- Make small repairs to suits by patching or sewing, but suits with severe damage should be discarded.
- Allow equipment to dry thoroughly before stowage.
- Keep all life-saving equipment away from oils, gasoline, or solvents.
- Regularly practice donning your survival suit so you are effective during an emergency.

6. Flares: Types, safe use, storage, and disposal

All pyrotechnic signals (distress flares) must be approved by Transport Canada. Flares are only authorized for use for a period of four years from the stamped date of manufacture. Once exceeding the expiry date, the flares should be properly disposed of.

The purpose of a flare is to attract attention and indicate your location.

Note: Flares are a TC mandated safety equipment item. It is illegal to activate a flare unless there is grave and imminent danger to life and/or to the vessel.

How to use a flare

There are many types of flares that serve different purposes and applications. The first steps to ensure the flare will work when needed are to store it in a watertight and dry container and periodically inspect it. (There are specially made containers for flares.)

Flares should be accessible to all crew members and the crew should be trained in their proper use. In general:

- Never look directly at a flare when it is ignited.
- Always try to use a heavy work glove when igniting a flare to avoid the possibility of injury.
- Determine the wind direction and your location on the vessel before launching the flare. The wind should be behind you and blowing the smoke or projectile away from the boat.
- Drop the empty flare in the water after use, not in your vessel.
- Ensure other personnel are clear of you before igniting the flare, and never point the flare at another person.
- If a flare doesn't work, place it in a bucket of water until you are able to properly dispose of it.

The best way to approach the proper use of a flare is to read the manufacturer's instructions on its use.

To dispose of flares, contact your local RCMP or CCG office for direction.

Types of flares

There are four types of flares used in distress:

Type A: Parachute flares



These can reach elevations of about 305 metres (1,000 feet) and project a red light for approximately one minute.

Type B: Multi-star rocket flares



These are discharged by flare gun. Each flare sends one to three red star bursts of light into the sky for up to 15 seconds.

Type C: Hand-held flares



These provide a long-lasting projection of red light at the surface. Each lasts up to one minute.

Type D: Smoke flares



These are activated from a canister thrown into the water. The canister emits a long-lasting volume of orange coloured smoke. These flares are used only in daylight conditions and each lasts for up to approximately three minutes.

Required flares for types of vessels

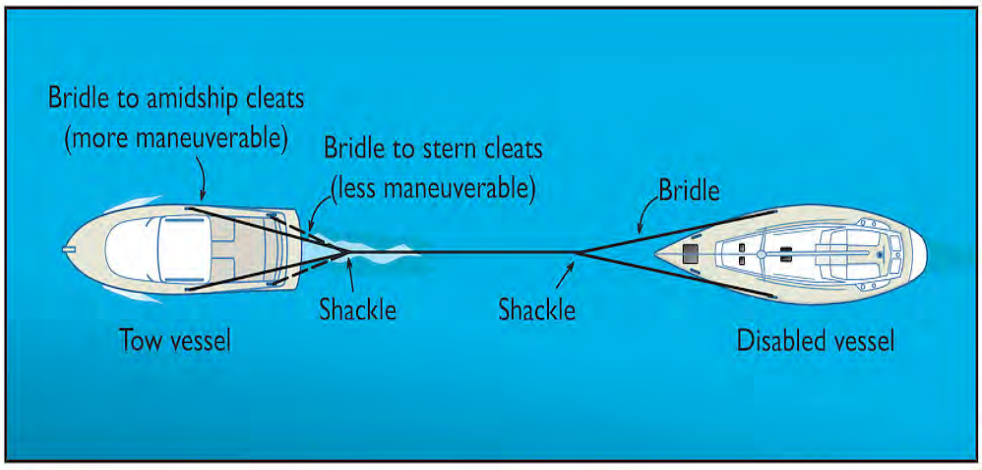
As per TC regulations, different vessels are rated for different types and sizes of flares. The Master or owner should check the regulations to determine the requirements for their vessel.

- Vessels less than 6 metres require 3: Types A, B, or C.
- Vessels between 6-8 metres require 6: Types A, B, or C.
- Vessels between 8-20 metres require 12: Types A, B, C, or D.

7. Safety in towing (including distress assistance)

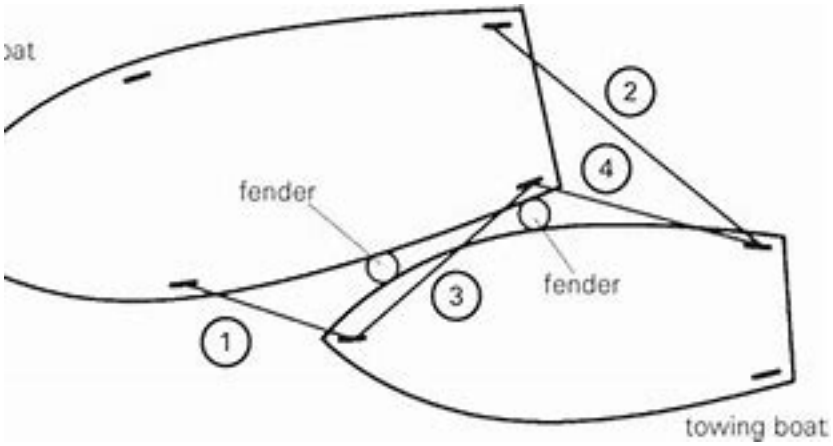
There will be times when a vessel (even your own) will require assistance by towing. Safety is the first and foremost consideration when assessing and carrying out a towing operation. Here are some basic principles and safety guidelines to follow when attempting to tow another vessel:

1. **Stop and assess:** Before attaching a line, ensure the vessel is stable and will not cause any danger to your vessel. Determine: Is oil in the water? Is the vessel listing? Why is the vessel inoperable?
2. **Safety and communications:** Ensure you have a plan and that communications are set up with the towed vessel. All persons should be wearing a PFD. Keep the towline attachment point as low as possible and as close to the centreline as possible. All rigging on the towed vessel should be out of the water.
3. **Environmental conditions:** How far are you from shore? What are the weather conditions and sea state, visibility? What are the tides and current?
4. **Setting up the tow:** Find a secure point on which to attach the towline; low and centered is preferable. You may have to use a brindle—two short, attached pieces of rope that can be secured to two points on the towed vessel and then attached to the main towline. Make your approach to the towed vessel, taking into account the environmental conditions.



5. **Attaching the line:** When attaching the line, ensure you proceed slowly to draw out the slack. Take off all the way as the slack line is picked up, and slowly increase thrust to avoid jerky movements. In rougher weather, you may need to use a lighter line to help throw over the towline to the towed vessel. Have lots of line available for the tow. Try to secure the towline centred on your vessel and away from the propellers.

6. **Towing in line:** Ensure you have sufficient distance between the two vessels. Try to keep constant tension using sufficient catenary (loop in the tow line that provides sufficient tension and absorption between the two vessels) on the towline allowing for a smoother tow. The amount of line used in towing should be enough so that each vessel can crest the waves at the same time and there is some slack in the line to act as a shock absorber. Make sure you keep sufficiently away from other vessels and docks when turning, to account for the larger turn radius. When in tighter waters, shorten the distance between the two vessels. Ensure you communicate with the towed vessel regularly.
7. **Side Tow:** Once the towed vessel is closer to port and more control is required to bring the vessel alongside, a side tow may be required. Stop the tow in a protected place. Determine on which side the tow should resume.



In this illustration, you will notice that the towing vessel is located astern to the towed vessel. This allows better control of the towed vessel. The bow line and stern line are used to keep the vessels together, but the tow strap is the line that takes all the tension and tows the boat.

CHAPTER 9 REVIEW

1. What is the difference between a PFD and a lifejacket?

2. What is a B flare?

3. What do you do if you observe a fellow crewmember working in an unsafe manner?

4. List five safety requirements when refueling a vessel.

5. What is the first thing to do once you have determined to tow another vessel?

6. Name three safety precautions when lighting a C flare.

7. What line takes the strain in a side tow?

8. How can you determine you have sufficient line out in a stern tow?

10. Marine weather and forecasts

Goals of this chapter

This chapter defines the origins and reliability of marine forecasts and notes where they can be found. It also explains the significance of marine weather forecasts and warnings, and describes the effects of wind and weather on a small vessel at sea.

Learning outcomes

On completion of this chapter, students will understand:

1. The origin and reliability of marine forecasts and where to obtain one
2. The significance and differences of marine weather warnings, small craft warnings, and gale and storm warnings
3. The association of wind shift and barometer movement
4. Small vessel operating procedures in bad weather
5. The significance of sea states, including land effects and deflection
6. Dangers associated with thunderstorms, and how to recognize the squall line

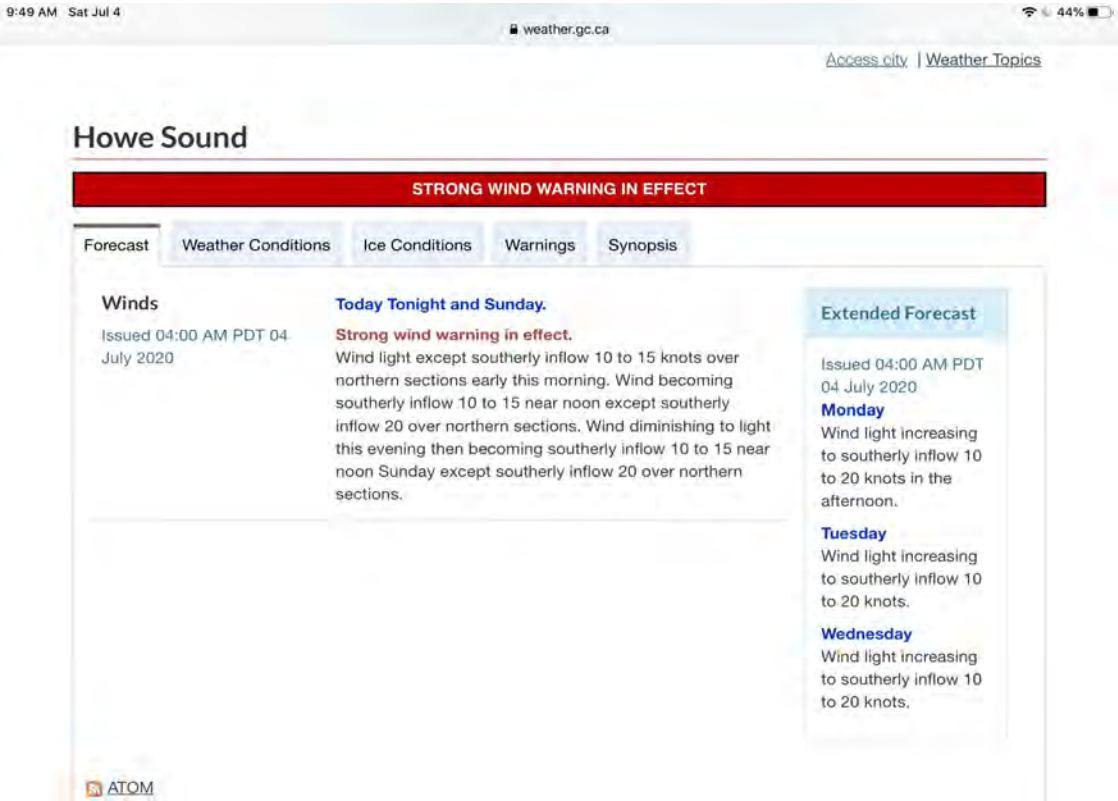
1. The origin and reliability of marine forecasts

By today's standards, a marine forecast is a result of the global integration of satellites, ships, weather buoys, radar systems, and ground stations that are observation posts and marine data collection facilities designed to track weather and create weather forecasts. The information is collected globally and in real-time, and processed through high-speed computers to create weather patterns and prediction models for safe marine transportation across oceans and in specific regions.

The origins of marine weather forecasts began in the 1860s with Admiral Fitzroy as he attempted to anticipate weather systems and provide that information to other mariners. The infrastructure of reporting and collecting weather has expanded greatly; however, reliable weather forecasts are still only accurate up to a 24-hour period.

Where to obtain a weather forecast

The following graphic is an example of a weather forecast issued by environment Canada. Further to the current forecast, the information contains weather conditions, ice warnings, weather warnings, and the weather synopsis.



There are many forecast platforms available today. Television, the Internet, VHS radio, CCG radio stations, weather buoys, and cellphone apps specific to the marine environment that utilize multiple projection models providing current and projected wind conditions, current sea state, forecasts, and others.

Vancouver and Victoria weather radio broadcasts continuously on 162.400 MHz. Other weather frequencies can be found at: http://www.msc.gc.ca/msb/weatherradi/weatherradio

Environment Canada forecasts

Environment Canada provides a marine forecasting service to mariners and the marine industry. The forecast enables mariners to make informed decisions about marine weather conditions and projections that may impact their safety, security, or operations. Forecasts are issued four times a day and weather warnings are issued as required. The marine forecast is specific to a particular region with a 24-hour outlook. The forecast may also include wave height and visibility reports. The types of marine forecasts include the following:

Regular marine forecast

The regular marine forecast (issued 2–4 times a day for a 24-hour period) gives a description of marine winds and weather, visibility, and/or freezing spray (if applicable), expected over the marine district. It also states any marine warnings or watches that may be in effect.

Extended marine forecast

The extended marine forecast (issued twice a day for up to five days) is meant for longer range planning purposes and therefore **only** gives a description of the marine winds expected over the marine district. Marine wind warnings are not included with the extended marine forecast because of the greater potential for forecast variability in the long-range outlook The synopsis gives a general picture of the position and motion of the weather features (i.e., highs, lows, and fronts).

Technical weather synopsis

The technical marine synopsis is issued with the regular marine forecast, and its time period of coverage corresponds to the time period of coverage of the regular marine forecast.

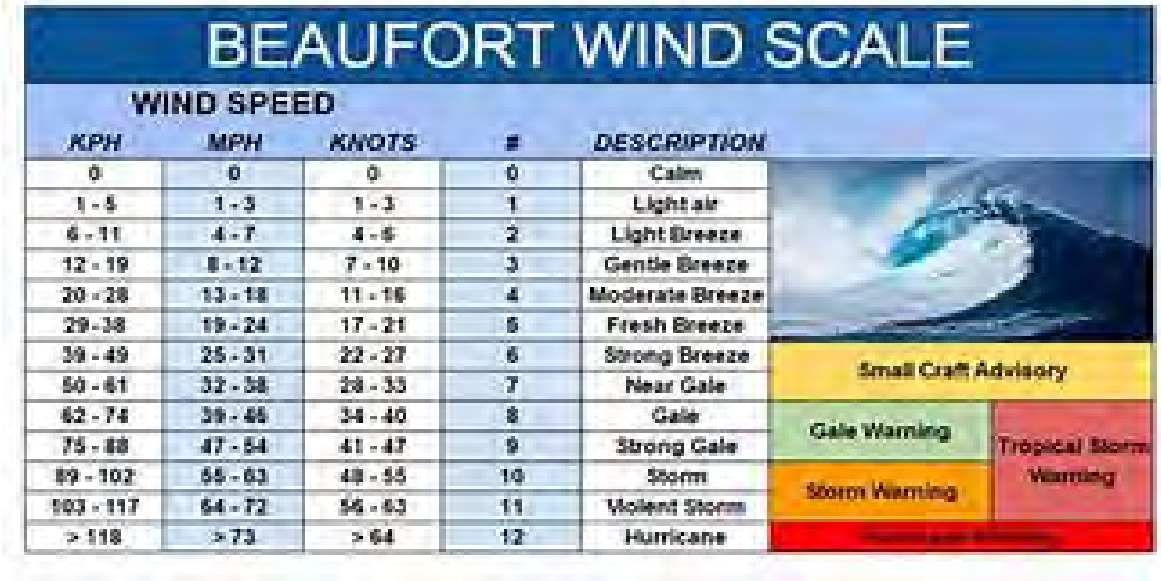
Marine weather statement

A marine weather statement is a non-scheduled bulletin that is issued on an “as needed” basis. It is used in special circumstances to describe the synoptic situation or potentially high impact marine weather expected to occur beyond the period of coverage of the regular marine forecast. This type of marine weather statement is issued at the forecaster’s discretion.

2. Significance and differences of marine weather warnings

It is extremely important to be weather conscious as part of your duties as an operator or Master of a small vessel. Many vessels run into problems as a result of wind and sea state, particularly when not being diligent in checking the weather in advance. Critical for the operator of a small vessel is the direction of the wind, the height and length of the swell and waves, visibility, and whether the winds are increasing or decreasing.

Environment Canada, through its daily marine weather broadcast, provides categories of wind for mariners using the **Beaufort sea scale** (recognized internationally), which provides wind speed, wave height, and sea state.



Environment Canada marine weather forecasts also simplify the marine conditions and sea states using the following terminology that can be immediately reference and assessed by mariners:

Light winds: wind speed under 11 knots.

Moderate winds: winds between 12–19 knots.

Small craft warning (strong winds): winds that may exceed 20 knots but not more than 33 knots.

Gale force winds: sustained wind speeds between 34–47 knots.

Storm warning: sustained winds over 48–63 knots.

Other weather terms and definitions

Sea breeze: an on-shore breeze. Common during hot days where a pressure difference between land and sea is created.

Land breeze: an off-shore breeze created by the reverse of air pressure between land and sea when the land masses begin to cool during the evening.

Katabatic wind: generated on high steep slopes of land where cool air begins to fall along the land gaining momentum and creating high winds at the bottom.

Combination of wind and sea state: when sea state and wind are opposing each other, a larger sharper wave and sea state will be created. Winds and sea in the same direction will flatten the sea state, giving an impression of calmer seas.

Swells: typically found in open seas where the wind passes over the water created by weather systems hundreds of miles away.

Fog: a low cloud over the surface of land or sea. It is defined when the visibility is reduced to less than one nautical mile. Fog occurs when water vapour in the air reaches its saturation point and begins to condense into a liquid state. When air reaches it saturation point by lowering the surrounding ambient temperature, fog will occur. Fog is very common in areas close to the sea where the different in heating and moisture content between the two surfaces meet.

3. Association of wind shift and barometer movement

Wind is the most significant environment condition that a mariner will face when at sea. Therefore, preparation and forecasting wind is a critical component for the small vessel operator to prepare for. One of the measures used to determine a change in weather, and therefore increase or decrease in wind speeds, is through barometric pressure.

Understanding barometric pressure

Also known as atmospheric pressure, barometric pressure refers to the weight of the air on the earth's surface. As the weight of air increases and decreases due to changes of altitude and temperature, so will the effects of the weather and subsequently the wind.

A rising barometer reading usually means mild weather with lighter winds. A lower barometer reading is indicative of a "low pressure system' and likely stronger winds.

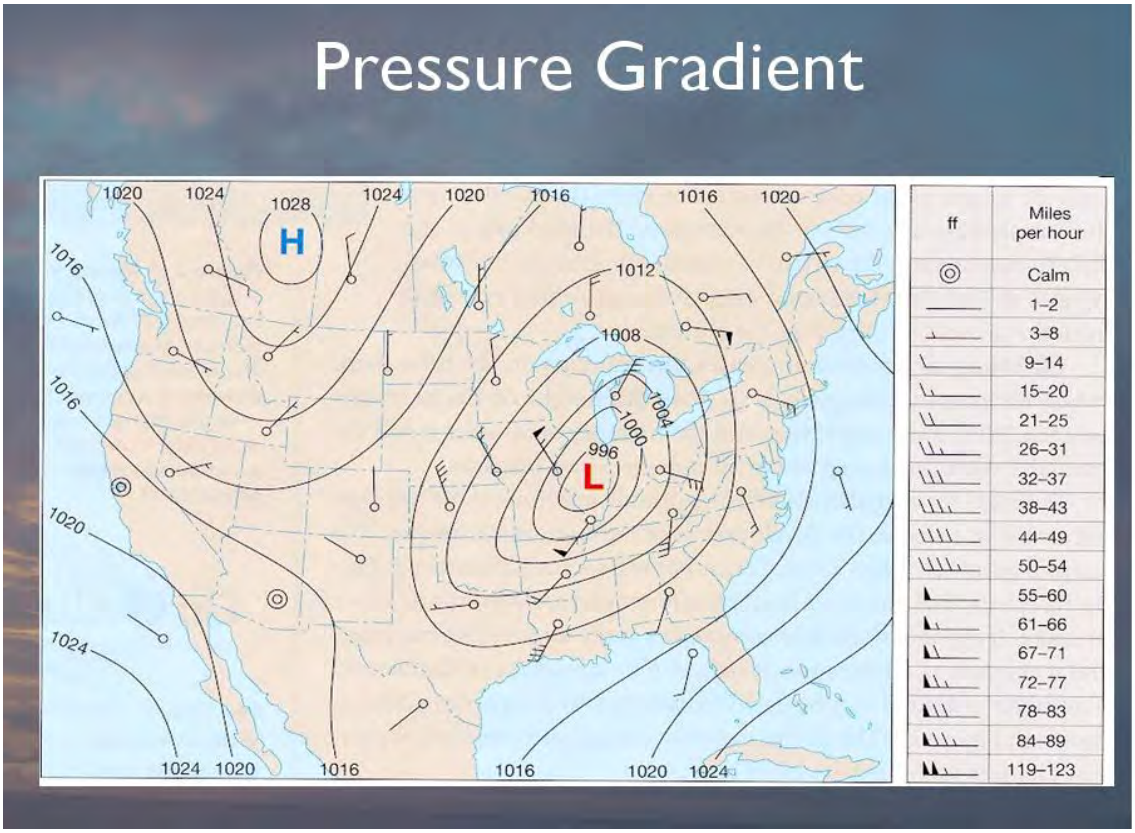
The standard atmospheric (atm) is 1,013.25 millibars (or 29.92 inches) of mercury. Anything above this reading is "high pressure," and below is "low pressure."

The pressure difference or gradient between a high- and low-pressure system will determine the strength and speed of the wind. As the pressure drops, the pressure gradient increases, with associated high winds.

Pressure gradient

Note on the following graphic: The circular lines indicate the change in pressure. In the **low (L),** the closer the lines are together the stronger the winds will be**.** In the **high (H),** the lines are further apart, indicating lighter winds.

Winds in a low-pressure system will circulate counterclockwise but clockwise in a high-pressure system (Northern hemisphere).



Winds are always identified by the direction they are coming from

Using barometers and forecasts as tools

As a general rule, a falling barometer will indicate that a low-pressure system is arriving, and that winds will likely set in under the following conditions:

- When the winds are from the south and southeast with a dropping barometer, a low-pressure system is approaching from the north or northwest. The winds will then change to northwesterly as the system passes through.
- When the winds are approaching from the east or northeast and the barometer is falling, the storm is approaching from the south and southeast.

Generally, the faster the barometer drops the more intense the storm. Winds coming from eastern quadrants indicate foul weather; with winds from western quadrants indicating fair weather.

Buys-Ballot's Law

Buys-Ballot's Law states that when a person is facing the wind, to their right and slightly back will indicate the centre of the low.

Note: This is also a good way to know where the storm is coming from.

4. Small vessel operating procedures in bad weather

Checking the weather

Every vessel operator should know the limitations of their vessel. Knowing the current and projected weather forecast, tides and currents, and sea state in advance and during seagoing operations is a critical component to the safety of the vessel and crew.

A term often used in marine related activities is "**situation awareness**." This concept is a mind-set that takes into account the totality of circumstances and conditions that face the mariner in real time and in the immediate future.

Situational awareness is real, and statistically most accidents at sea are in part a result of a lack of situational awareness.

Safety guidelines for operations in severe weather

The Small Commercial Vessel Safety Guide provides reference materials, including the following guidelines for operations in severe weather:

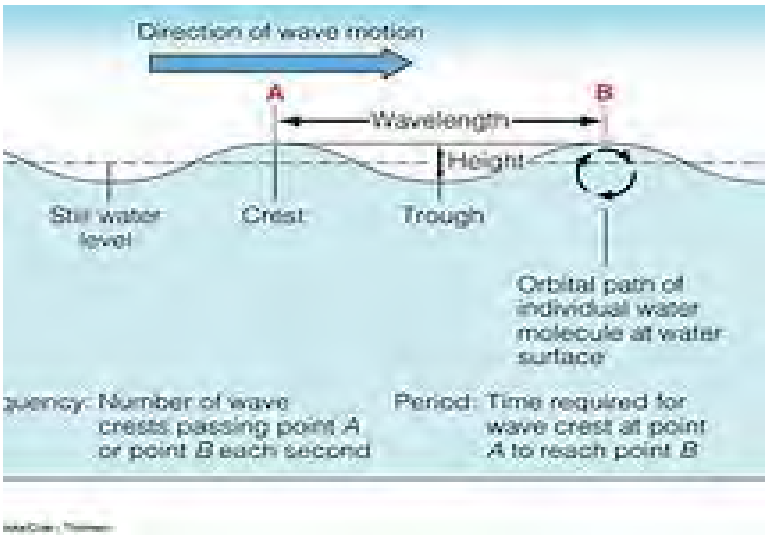
- Turn on your navigation lights.
- Reduce speed to match sea conditions.
- Maintain enough power to allow steering.
- Have crew and passengers put on lifejackets. On small boats, seat passengers as low as possible and near the centreline.
- Close and secure all doors, hatches, and other openings.
- Make sure that cargo and other objects are secure.
- Make sure that all overboard drains that are designed to be open at sea and freeing ports are open and clear.
- Head for the nearest port of refuge or shore that is safe to approach, if possible.
- Direct the bow into the waves at about a 45-degree angle, if possible.
- Keep bilges free of water.
- If your engine fails, run out a sea anchor on a line from the bow to keep the boat headed into the waves.
- If you have concerns about the safety of your vessel or crew, make early radio contact with the Canadian Coast Guard radio station to advise them of your concerns. Do not wait until it is too late.

5. Effects of various sea states

Mariners should understand the impact various sea states will have on their vessel's operations. In addition, sea state—its direction and wave height—will change when encountering land. The mariner should understand the potential dangers that exist with a changing wave pattern.

The relationship between wind and waves

Waves are a result of the effects of wind onto the surface of water. Waves are generated from weather patterns and storms some distance away and not by local winds. As a weather pattern develops, the wind speed on the water surface creates the wave energy moving in the same direction as the wind. The stronger the wind the larger the wave height (**swell**) will be and distance between waves (**wavelength**) will increase**.** The top of the wave is called the crest and the bottom is called the trough. The height of the wave is measured from the still water level.



Wave reflection

Any object in the path of a wave will cause the wave to reflect. This includes underwater obstructions, reefs, and sand bars. These obstructions can change the characteristics and cycles, and in particular, the wave's direction of travel. The type of obstruction will largely determine the amount of reflection the wave will have as it bounces off the obstruction in another direction.

Wave refraction

Refraction refers to the bending of the wave. When a wave moves onto shallow water, the vertical cycle of the wave will begin to bend forward. This is noticeable at the crest of the wave where the wave begins to collapse,

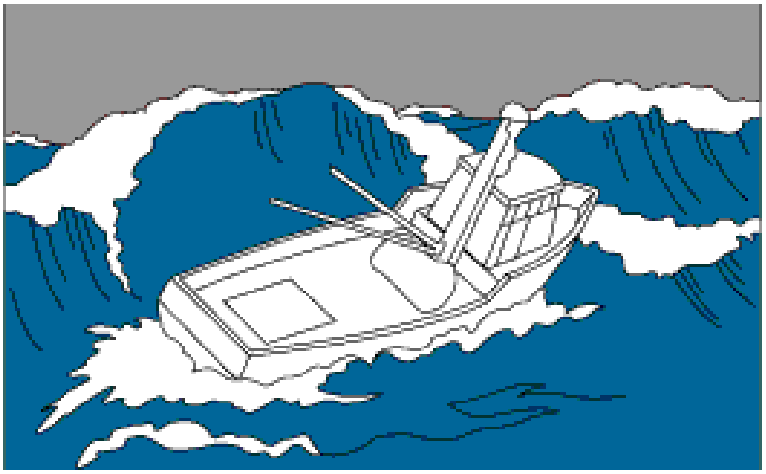
essentially “**breaking**.” These waves tend to form close to shore, rocks or islands and meet with other similar waves causing turbulent forces that are very dangerous for small vessels**.**

Mariners need to understand and appreciate the significance of the action of waves and sea state and their effects on small vessels. Particular attention should be paid to waves close to shore that are subject to wave reflection and refraction.

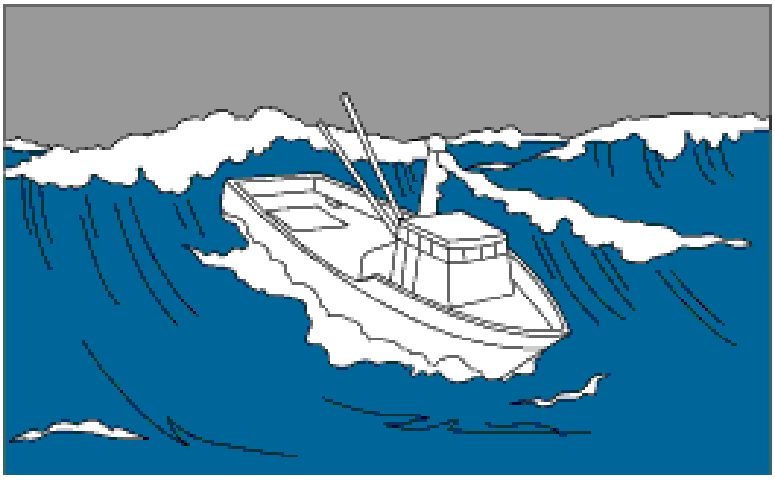
Effects of sea states on small vessels

Transport Canada’s *Small Fishing Vessel Safety Manual* refers to severe sea states and the necessary safety precautions.

Severe seas of any kind are dangerous if you are not prepared. You should take special care in the following situations.

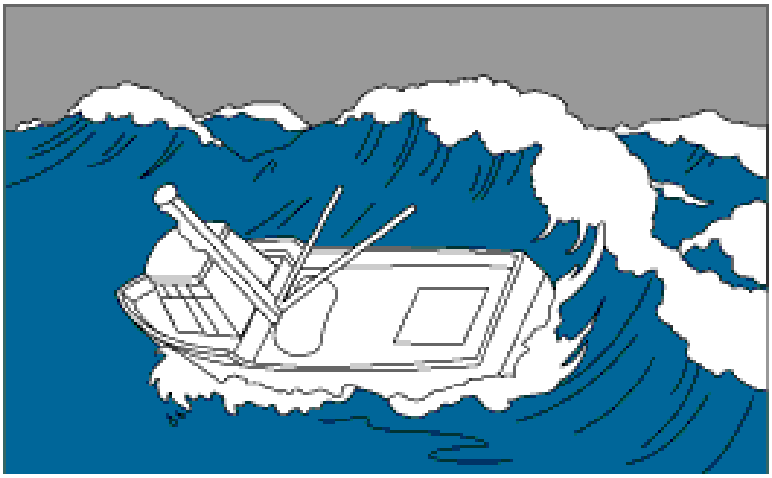


“In beam seas, excessive roll can cause cargo to shift, creating a dangerous list. This could cause the vessel to capsize. Strong breaking waves could also capsize the vessel.”

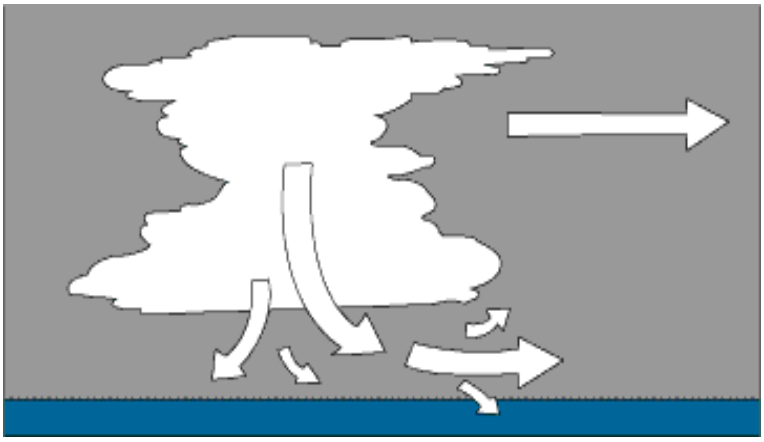


“In following seas, a vessel may lose stability on a wave crest. If the vessel is overtaken by a wave crest, broaching may occur.”

Comments: Broaching is an involuntary change in a vessel’s direction towards the wind resulting in loss of control.



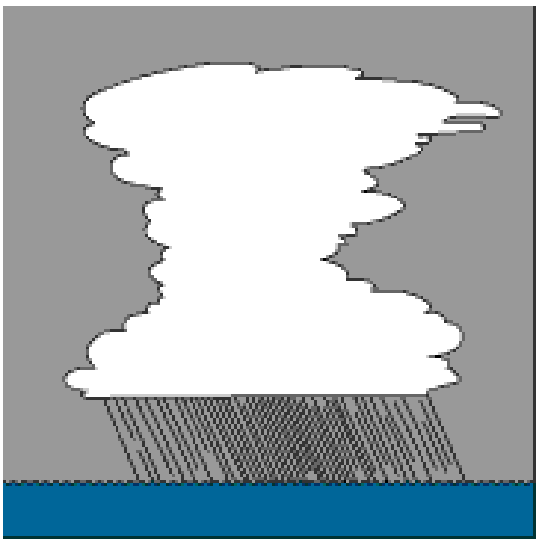
“In quartering seas, the problems of beam and following seas are combined. Quartering seas represent the most dangerous situation in severe weather.”



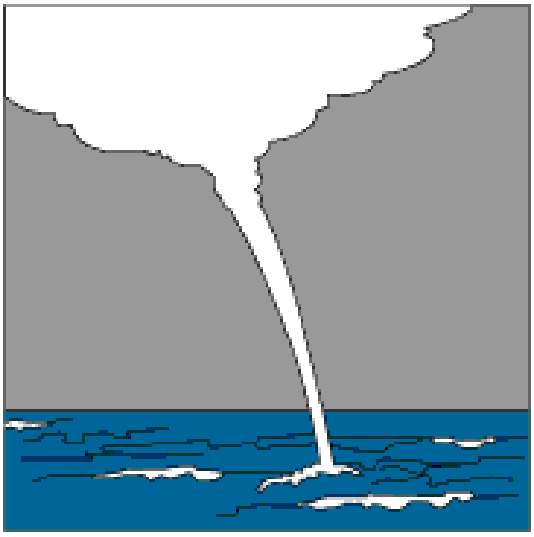
“The strongest winds in a thunderstorm usually precede the storm centre itself, in a zone up to three miles long. Gusts up to 50 knots can be expected in this zone. The winds blow downwards from the cloud, and they are especially dangerous for small vessels.”

Comments: Small vessel operators should have a complete understanding of the potential danger associated with thunderstorms and **line squalls**.

The danger associated with thunderstorms is the severe and immediate shift in winds. These winds can shift drastically and oppose the direction of the seas causing a confused and dynamic change in the sea state and the vessel’s stability. Line squalls are the frontal line of an approaching thunderstorm and the area most likely to have severe wind changes.



“The heaviest rain occurs directly under the thunder cloud, leading to poor visibility. Heavy rain lasts from five to 15 minutes. Thunderstorms normally last less than one hour.”



“Waterspouts may occur during a thunderstorm. A waterspout is a funnel of cloud reaching from the base of the thunderstorm cloud to the water, which may suck up water into the air. It usually lasts less than 15 minutes. Although immature waterspouts may be very small, they can become extremely violent without warning.”

CHAPTER 10 REVIEW

1. What is the difference between a weather forecast and a weather synopsis?

2. When are weather warning issued?

3. What are the crest and trough of a wave?

4. How many weather forecasts are issued in each 24-hour period?

5. What are the dangers associated with operating a small vessel close to shoals or rocks?

6. List the significant dangers associated with thunderstorms.

7. What are the dangers in a quartering sea?

8. Define situational awareness.

9. How is a barometer used, and what do its readings indicate?

11. Using radar for navigation safety

Goals of this chapter

This chapter describes the basic principles of radar, including start-up procedures, interpreting readings, using the main function controls, and determining positioning.

Learning outcomes

On completion of this chapter, students will understand:

1. The basic principles of radar and its functions, including start-up procedures and making operating adjustments
2. How to interpret radar images
3. Using radar for positioning, taking bearings, and measuring distance
4. Using radar to avoid collision

1. The basic principles of radar and its functions

The term RADAR is an acronym for Radio Detection and Aiming. A radar system is designed to instantaneously detect—through obstructions such as fog, rain and snow, and clouds—the presence, size, and distance of objects. It is also able to measure location, course, and speed of an object. Radar is an extremely useful tool, particularly when operating a vessel at night or in restricted visibility.

Marine radars usually operate in short-range, compared to other radar applications, and are used to detect other ships and landmasses in the area of operations.

How radar works

Radar operates on the principle of reflected energy, otherwise known as an "echo." A radar unit can also operate as a receiver from transponder signals such as radar beacons (racons), or SAR transponders. A radar unit emits a narrow beam of microwave radio energy outward from the vessel at around 1,000 waves per second. The beam reflects off the object, returns to the vessel, and displays an image on a screen for the operator to view.

Because radio energy beams travel at the same speed, the radar unit can measure the time in which the beam returns to the vessel to determine the distance of the object from the vessel. The bearing of the object can also be determined based on the echo and the angle at which the radio beam strikes the object.

A radar unit can also act as a receiver to pick up signals from another transmitter (or racon).

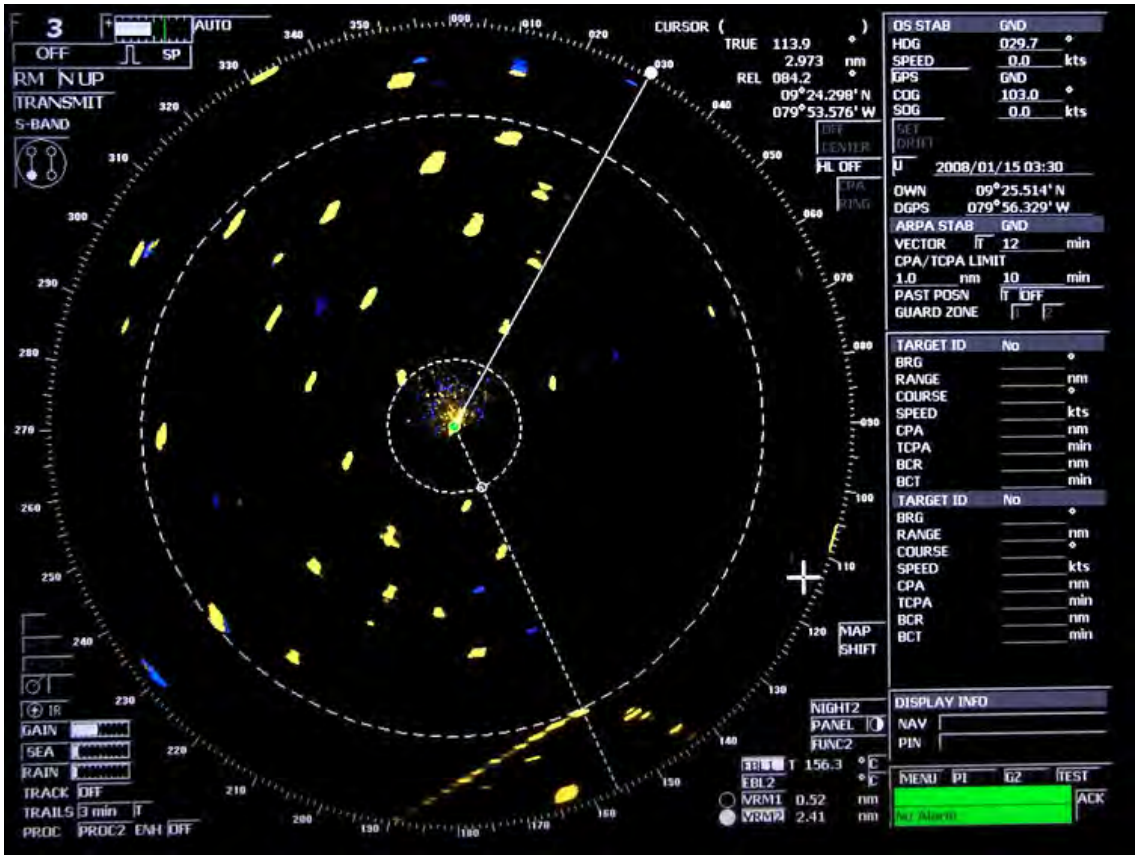
Another significant advantage of radar is that it is a self-contained system that does not require satellites or delays in receiving a returning signal. Radar projects 360 degrees around a vessel, thus providing instantaneous information on other ships and their positions.

Basic start-up procedures

For radar to operate effectively it needs to be properly set up. Many systems are similar in function but the technology may be different. It is not possible to detail the unique operations of all radar systems, and so individual study and practice is required.

Once turned on, radar requires adjustments to establish the accuracy of the image. Many radar systems have automatic modes for various adjustments that

work well; however, the operator should constantly check these through “**cross-referencing**” and by studying the visual display**.**

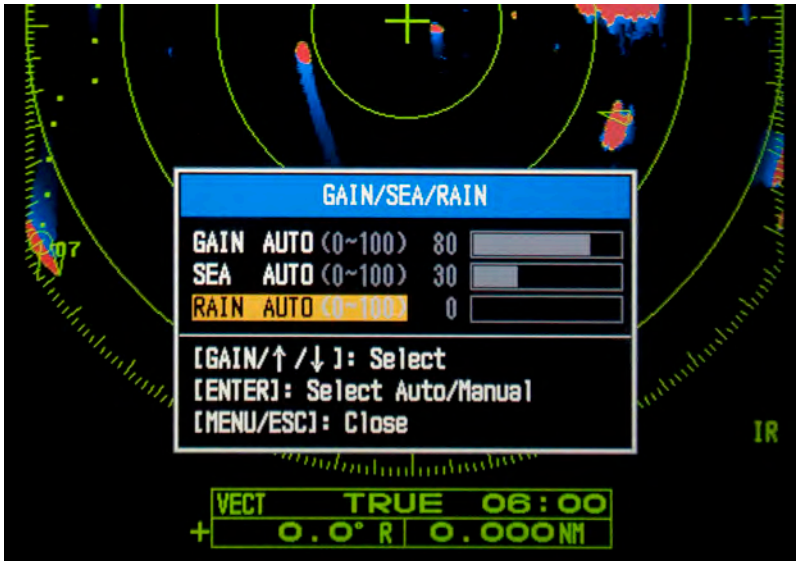


General screen display

Radar systems are generally oriented in a heads-up position, placing your vessel in the centre of the screen, which allows identification of targets and land masses in 360 degrees.

Cross-referencing: It is a good practice to ensure that your radar system is checked for accuracy by comparing distances, relative bearings, and accuracy of images on the screen through vision and GPS instruments.

Sensitivity adjustment: This refers to how defined a radar system identifies a target. Too much sensitivity can distort the reading and too low sensitivity adjustment can eliminate the target.



Gain, sea, and rain

Gain is the radar term for sensitivity adjustments, and it needs to be set where the target is visible without other interference on the display. Gain can be adjusted for targets identified at longer ranges. Too much gain will clutter the screen.

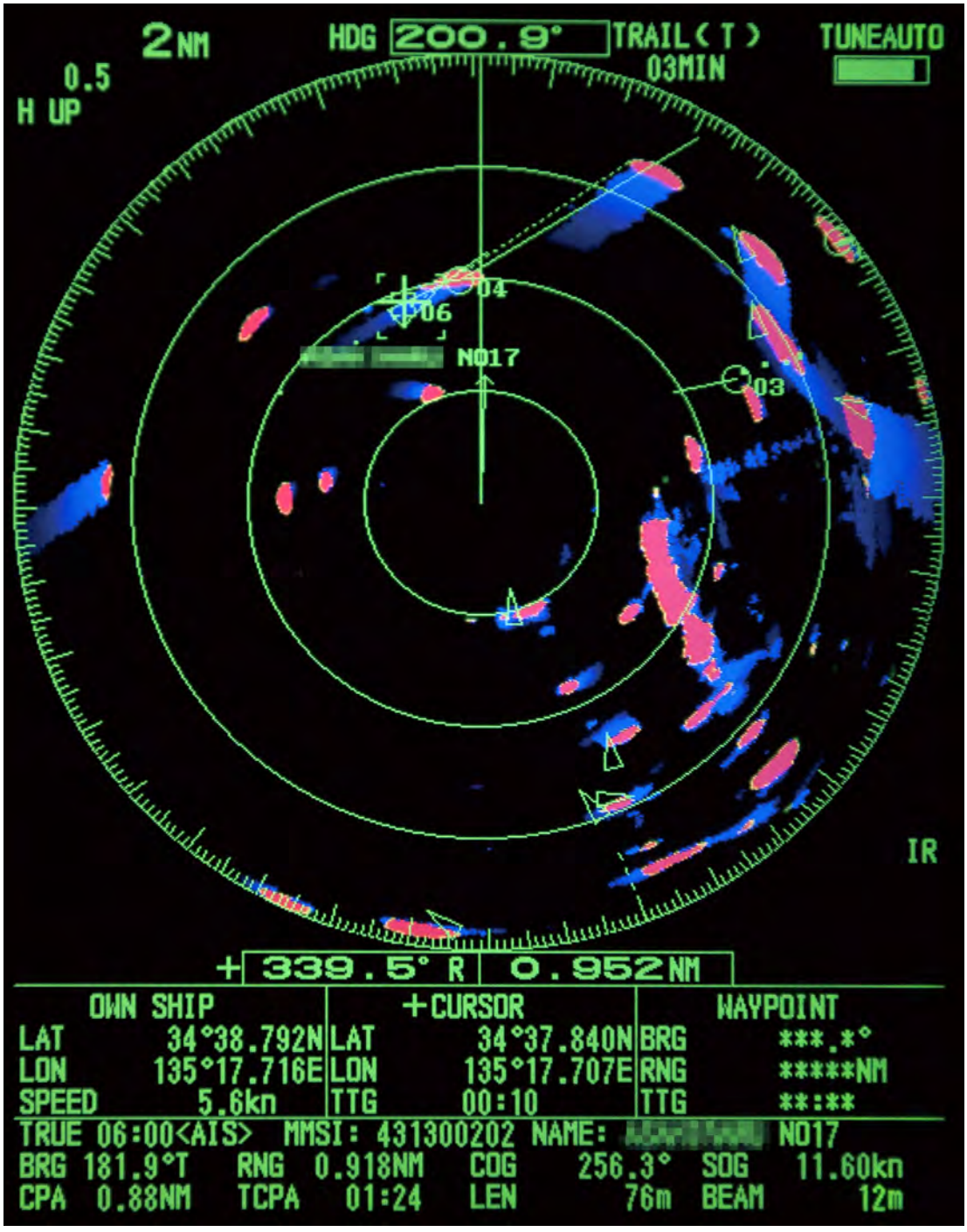
Sea adjustment is used to reduce the clutter caused by larger seas that interfere with the echo.

Rain adjustment also adjusts clutter from heavy rain that may interfere with the echo.

Operating adjustments

Ranging

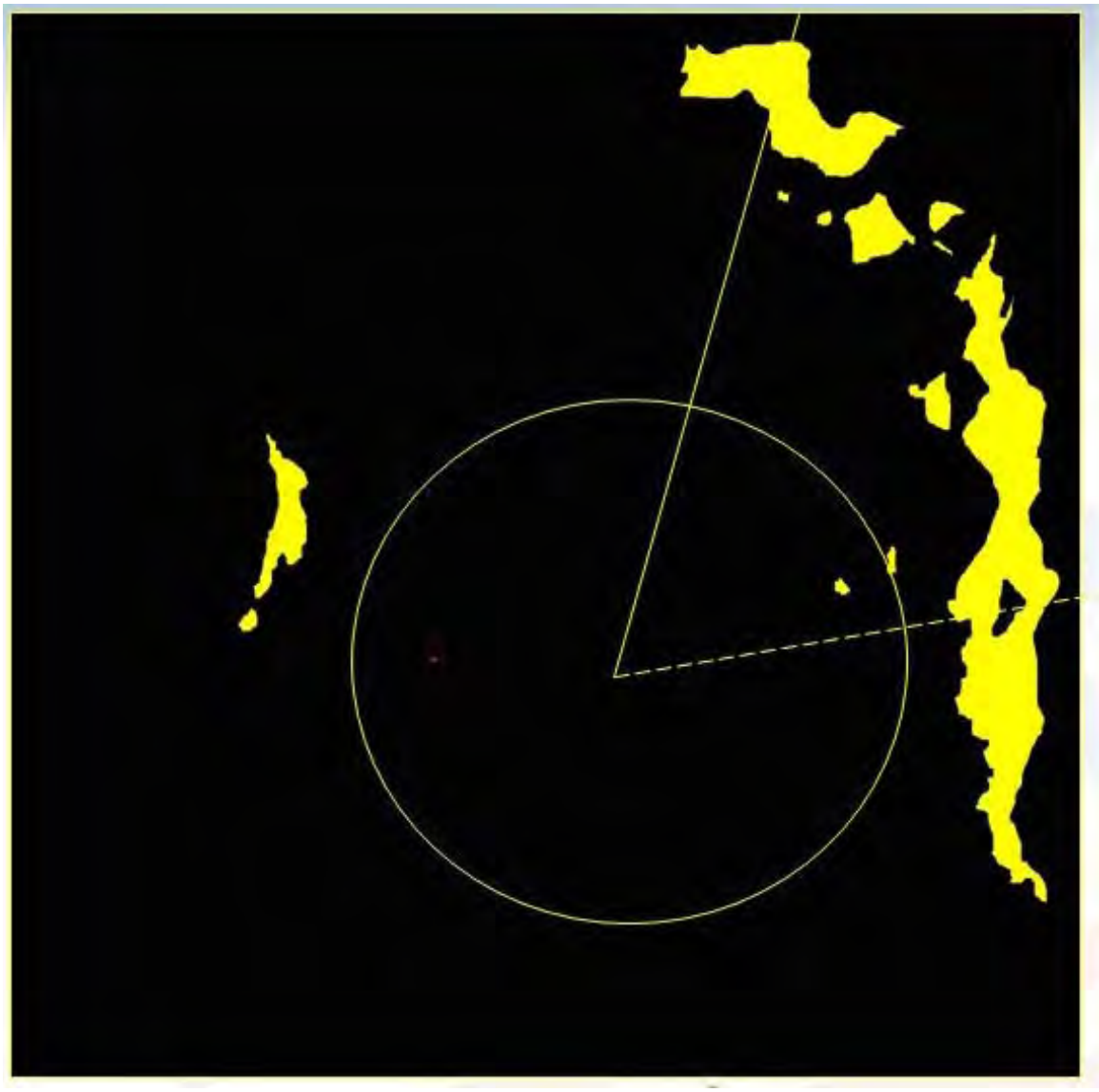
Radar can extend the radar picture both farther away (in nautical miles) and at very close quarters. This is a very useful function, and it should be used regularly by radar operators to assess collision risk further away and to examine finer detail closer in. In the following example, the scale is two nautical miles, with each circle representing half a nautical mile (top left-hand corner). The scale can be adjusted for longer ranges.



VRM (variable range marker)

The VRM function allows the radar operator to determine accurate distances of a target or land by establishing an adjustable electronic ring over any target and displaying it on the radar screen. This feature can also provide a safety perimeter

(safety bubble) for collision avoidance or a safety boundary for vessels travelling near land. A VRM can also be used in radar assisted turns.



EBL and VRM at work

Comments: The red ring depicts the VRM and can provide adjustable distances or ranges from land.

EBL (electronic bearing line)

The EBL is usually displayed as a dotted line that can be adjusted 360 degrees around the radar screen. Most radar units have two EBLs that can determine the relative bearing of a target. Once a target is identified on radar, the EBL can be placed on the target to assess whether the target is on a steady bearing towards your vessel or drawing right or left. The EBL can also be used to assist in course alterations by providing a relative course bearing in advance of a turn.



Comments: The target has been identified at a relative bearing of 215 degrees using the EBL. From the three distinct displays, the range of the target is closing in on a steady bearing using the VRM. This is a good example of the use of both VRM and EBL for collision avoidance.

2. Interpreting radar images

Radar emits a beam of HF radio waves in a 360-degree rotation, picking up objects as the beam travels for a brief moment. Because of this, the radar picture is not perfect and may not reflect the actual size of the object.

Large echoes or pulses on radar that are not well defined often appear as large or small blips on the radar screen (often referred to as “painting” a target). This often depends on the strength of the signal, the position of the target and its height, construction of the vessel, and exposure to metal from which the radar needs to reflect a signal.



Radar reflectors

Radar reflectors are portable metal structures that can be secured onto vessels that are not made of metal to provide radar with an object to reflect from.

Signals may come and go on each rotation of the radar and should be carefully monitored and assessed visually as well. Adjustments in gain and other controls may be necessary to define the target with more confidence. If in doubt as to the existence of the possible target, **slow the vessel down to confirm.**

In many cases, a larger ship may not appear as big as a smaller vessel. A rounded fiberglass vessel, wooden boat, or inflatable boat may not appear on the radar screen at all or not until it is very close by.

Modern radar

Modern and powerful radar units with wider beams have greatly improved the ability of radar to capture targets at farther distances, and they are able to track vessel course and speed and closest point of approach (CPA.

Radar interpretation: Notes and tips

A few notes to better understand radar interpretation:

- Any target moving down a screen at the same speed as you are proceeding is a stationary target, like a buoy.
- If a target does not move on your screen, then it is traveling on the same course and speed as your vessel.
- If a target is moving up or down the screen, then it is travelling in the same direction but at a slower or faster speed.
- If a target is moving at an angle away from you, then it has a different course and speed.
- If a target is approaching you on a steady bearing… you are on a collision course.

To become competent on radar takes… PRACTICE, PRACTICE, PRACTICE

3. Using radar for positioning

Radar is extremely effective tool to determine a vessel's position. It does not require a visual reference of points on land, and is effective in restricted visibility. Using radar will confirm land mass and help the navigator confirm their location.

Radar is best used for navigation in conjunction with a GPS unit (see Chapter 12) and depth soundings when required. It is important to ensure any distance reading taken from a radar unit has a solid foundation to its structure. For example, a flat lower level beach does not make a good radar target as it has no solid features for a signal to reflect from. High land structures, cliffs, rocky points of land, metal structures, or land-based aids to navigation should be used.

Range and bearings

Using a radar unit in conjunction with a GPS system is the best practice for confirming a position along coastal water and in restricted visibility. Here are some protocols that can best assist the navigator:

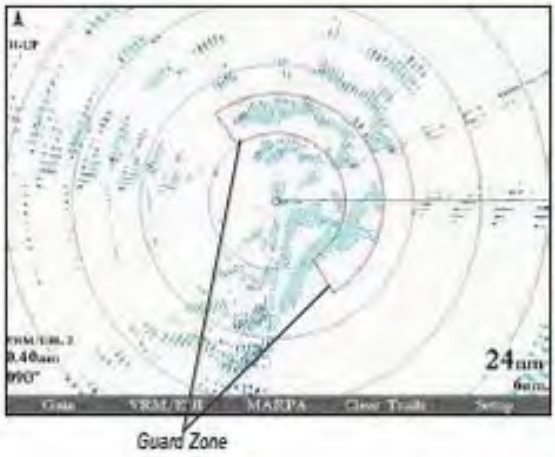
- Make sure the landmarks identified on a GPS or chart can be confirmed on the radar unit
- Set your VRM and EBL on the identified point of land that will provide you with a range and bearing. Note the time.
- Read the distance on the VRM. Compare the distance on your GPS or chart to the point of land to confirm and cross-reference.
- Take another VRM distance off another point of land and compare with your GPS position or chart measurement.
- On many radar and GPS systems you can use your cursor placed on a point, which will also provide distance and relative bearing.

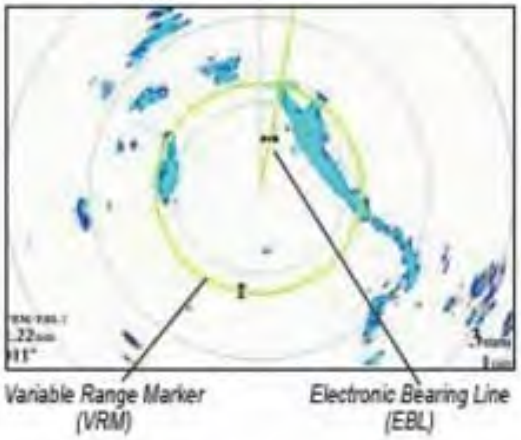
Establishing a bearing

Use your EBL off the same point you measured a VRM. The EBL will provide a relative bearing. In order to find the true bearing of that point, also take into account your heading. The true bearing of a point follows this formula:

Relative bearing + ships heading = true bearing.

Therefore, if a vessel is travelling east on a course of 90 degrees and you take a radar bearing of 135 degrees, then the true heading would be 225 degrees.


24nm
Guard Zone


Variable Range Marker
(VRM)
Electronic Bearing Line
(EBL)

4. Using radar to avoid collision

The radar screen used by the navigator provides a visual reference of land masses and other targets in the surrounding area. The vessel will be oriented in the centre of the screen and the relative bearings of the objects will move in various directions from the screen's centre.

It is extremely important to note:

- Objects that are approaching your vessel on a steady bearing
- Action to take to avoid collision with the object.

Assessing collision risk

Pursuant to the Collision Regulations you are required to use all available means to identify risk of collision and to take early and substantial action to eliminate this risk. Utilizing radar to determine this risk at night or in restricted visibility is crucial. Radar will even assist the navigator to assess collision risk during normal visibility when another vessel is at a distance. Many radar systems can determine speed, direction of targets, and the closest point of approach (CPA) to assist in evaluating collision risk.

When assessing collision risk using radar, follow these general principles.

1. Maintain a proper lookout including the monitoring of an active operational radar unit.
2. Ensure in open water that your radar unit is ranged out to identify targets at a distance to plot and assess risk. Range in when appropriate.
3. When a target is identified and the risk of collision exists, determine who is the stand-on vessel and who is the give-way vessel.
4. If you are the give-way vessel, make a course or speed alteration and plot the changes on your radar screen to ensure that the target vessel is no longer on a steady bearing and will pass ahead of your vessel or down your port or starboard side at a safe distance.
5. Use your VRM to establish a safe distance away from the vessel.
6. Use your EBL to establish a bearing line to the target vessel. If the target follows the bearing line towards your vessel, you are on a collision course. If the target vessel falls off your bearing line, your vessel will pass safely.
7. In restricted visibility, any vessel forward of your beam will require you to make an alteration of course to starboard. If the target vessel is too close, then reduce speed. It is important to assess radar targets at a far distance to assess risk of collision and to be able to take corrective action.

CHAPTER 11 REVIEW

1. Briefly, how does radar work?

2. What is the purpose of a radar reflector?

3. What is a VRM and what is it used for?

4. What is an EMB and what is it used for?

5. When do you use radar when operating a vessel?

6. How do you determine your position with radar?

7. What is a relative bearing?

8. Identify the main controls to properly set up your radar.

9. What are some of the best and worse objects for a radar echo to pick up?

12. Using GPS to determine position

Goals of this chapter

This chapter provides the basic principles of electronic navigation aids such as global positioning systems (GPS). It describes basic start-up procedures and system functioning controls, and explains the level of reliability and errors associated with the using GPS.

Learning outcomes

On completion of this chapter, students will have a basic understanding of the correct use of a GPS, including:

1. How GPS works
2. Start-up procedures, functioning of the GPS device, and how to recognize correct data for the unit
3. Problems and errors, such as lack of reliability and the need to double-check a position

1. Global positioning systems (GPS)

A good operator/navigator of a small vessel prioritizes the safety of the vessel and crew while at sea. To accomplish this, the operator utilizes the totality of tools available to provide a safe voyage. The importance of using the electronic navigations aids fitted on the vessel, along with visual lookouts and charts, cannot be stressed enough.

Navigation is not done in isolation but in concert with all the instruments available to allow for cross-checking information to ensure that you are where your instruments say you are. It is also imperative that navigators realize that electronic navigation systems are not perfect and are subject to error.

How GPS works

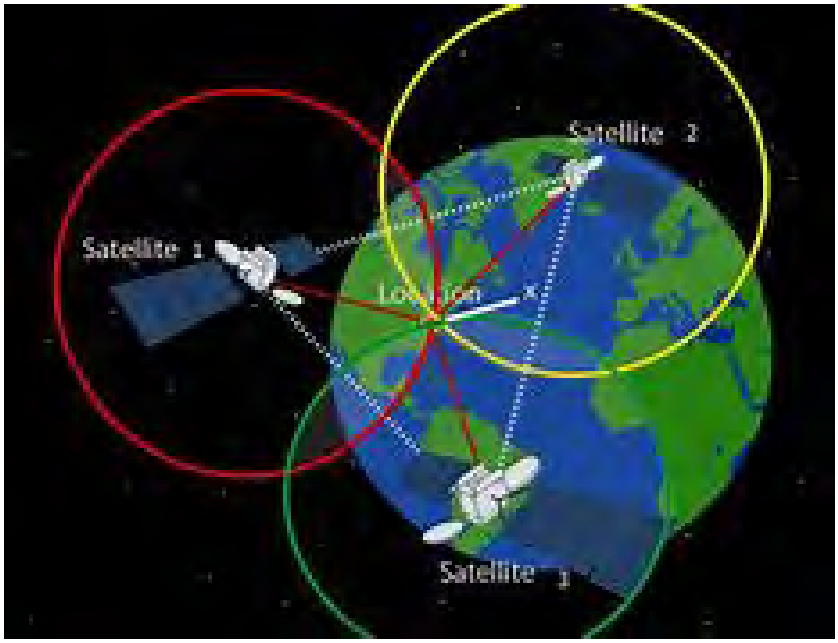
The GPS unit in your vessel acts as a receiver to capture satellite signals orbiting the earth. These satellites are designed specifically for this purpose. The basic principle surrounding the signal received from the satellites is a form of "triangulation." The receiver determines its position by measuring the distance and location of the orbiting satellites. This system is complex, and requires accurate timing of radio signals and built-in correction systems.

A GPS unit can be very sophisticated, with built in charts and multiple features, or simply a handheld device with basic features such as those used by backpackers. Regardless of size, GPS units require at least three satellite signals to establish a reliable fixed position. Additional satellites are even better, as they can triangulate a more accurate position.

Initializing a GPS

After you first turn on the power, the GPS will need to initialize (i.e., cold start-up). This means it must "find itself" in the world—a sort of "meet-and-greet" with satellites it has never met. This particularly applies to portable units used by backpackers that often change positions to begin their hikes requiring the GPS unit to figure out where it is. The operator of a small vessel who stays in a relatively small area of operation will need to initialize the GPS only once because the unit will have immediately memorized its position, allowing for quicker start-ups (i.e., warm start-ups).

The satellites used for GPS purposes are controlled by the US military. In previous years, the US inserted built-in errors on the satellites to reduce the accuracy of a GPS receiver. This was known as "selective availability." This is no longer the case; however, this could be changed for security reasons by the US military.



Differential global positioning system (DGPS)

DGPS is a system designed to enhance GPS accuracy. It uses a network of ground-based stations that transmit the difference between the GPS satellites and the location of the receiver error. The DGPS will only be of assistance to those vessels operating within range of the ground station.



Since the advent of DGPS and the removal of selective availability, GPS accuracy is unquestionably more accurate. However, though the position of the boat may be accurate, the surrounding rocks and coastlines depicted on the

chart may not be. It remains the responsibility of the navigator to cross-reference the vessel's position to ensure accuracy.

Summary of GPS functions

A GPS can provide a multitude of functions and calculations, simplifying the work of navigation. Some of these functions include the following:

- GPS provides current position and future position based on speed and distance.
- Integrated with electronic charts, GPS can plot courses and other functions.
- The system can mark MOB (man overboard), or provide a position for a DSC (digital selective calling) signal.
- GPS allows the insertion of waypoints, determines COG (course over ground), speed, and can establish courses and make adjustments for set and drift.
- The system provides tide and current tables.

2. GPS start-up procedures

A typical marine GPS system has many features that can be used by the operator. Many of these features are well beyond the scope of this chapter; however, there remain general function and set-up procedures that must be adhered to that, together with the electronic charts incorporated within the GPS display, will determine the level of accuracy of position..

If you have already initialized your GPS unit, it will not take long for the GPS to locate the satellites needed as you continue to operate in the same area. To establish proper set-up, ensure that the following GPS functions are turned on:

- **Differential GPS:** This will increase the accuracy of the GPS position.
- **HDOP** (Horizontal dilution of precision): refers to the number of satellites acquired (there should be four) and the degree of accuracy the GPS has on its position. The HDOP should be less than 1.5. If a reading is above this number, cross-reference your GPS position with a radar position.
- **Datum:** This refers to the electronic charts that are to be used for navigation within a GPS system. The charts that should be used are WGS-1984 (World Geodetic Survey). Ensure GPS settings are using these charts. If they are not, you could find yourself in a different position than the GPS marks.
- **Cursory position check:** When GPS is on, check to see if the position mark on your screen is where your boat is supposed to be at the dock.
- **Depth and contours:** Ensure that soundings and contours are turned on and that you have established colour of depth readings as required.
- **Orientation:** Should you orient charts in “heads-up” mode or “north-up” mode? The preference is north-up as it maintains a geographic alignment.
- **Cross-reference:** It is always a good practice to cross-reference your GPS position with a radar position**.**

Cross-referencing

Cross-referencing is standard protocol and procedure for operators and navigators to use in confirming their position at sea. It simply means to utilize all the navigation tools available and to check position between them. For example: a GPS position can also be confirmed by means of radar and, in shallower waters, corroborated by depth (as when a vessel passes over a reef).

Cross-referencing can be done visually, comparing position to points of land and other aids to navigation. No one navigation tool or technique should stand alone.

3. Problems and errors, lack of reliability, and the need to double-check a position

The accuracy of a GPS unit is determined by several factors, including the number and position of available satellites, the unobstructed exposure of the satellites to the GPS antenna, atmospheric conditions, and satellite clock errors.

GPS limitations: User beware

Though GPS unit manufacturers provide accuracy predictions under ideal conditions, a vessel operator should err on the side of caution.

In the days when navigation was practiced by charts alone, navigators were always aware of the margin of error in their calculations, and gave areas of danger a wide berth. With modern GPS systems, there appears to be a lack of caution on the part of some operators to provide the same margins of error as previously practiced with charts.

Since the advent of GPS and DGPS, the equipment used to navigate has a significantly high level of accuracy to pinpoint a position; however, electronic charts used today are largely based on paper charts and older surveys. At times, the integration and relationship between the GPS position and the plotting of that position on an electronic chart (e-chart) may not reflect the true position of the vessel. With a GPS unit's ability to "zoom in" to a position on an e-chart, the distortion can be amplified. Special caution and consideration must therefore be used with electronic charts.

Mariners may treat a GPS unit similarly to a radar unit in terms of accuracy; however, they are not the same. A radar unit transmits HF radio signals from the vessel and receives the information immediately, painting a more accurate picture of what land masses are in its proximity. A GPS unit receives a signal from a collection of satellites and places the position on charts that may not be perfectly accurate.

As charts and GPS units improve, so will the accuracy of positioning. Cross-referencing a GPS with radar and visual observations and bearings will provide the navigator with the confidence and situational awareness needed for the safety of the vessel.

General precautions

Reliability of position: Understand that the accuracy of the satellite depends on the location and number of signals the GPS can acquire to provide accurate horizontal and vertical data. This is best obtained by the GPS 's HDOP reading.

Charting position: A GPS unit provides historical information, with speed and course determined from past data. For example, If your vessel is stopped in the water or moving very slowly, the GPS unit cannot provide you with its course because there is no current movement data for the satellites to pick up.

Cross-referencing position: Using radar and depth sounder as tools to cross-reference is of paramount importance

Electronic navigation failure: Systems can fail, and reliance on paper charts and visual references becomes extremely important. Knowing your waters, landmarks, aids to navigation and their light phases can greatly assist in providing you with a safe return to port

CHAPTER 12 REVIEW

1. How many satellites are needed for an accurate GPS position?

2. What is HDOP and what does it mean?

3. What is DGPS and what does it do?

4. What is cross-referencing and how does it help the navigator?

5. What does it mean to “initialize” a GPS?

6. What are some functions of a GPS?

7. Describe a “warm start-up” for a GPS.

13. Planning and navigating a voyage with marine charts and publications

Goals of this chapter

This chapter provides students with a basic understanding and practical use of nautical charts to plan and execute a voyage.

Learning outcomes

On completion of this chapter, students will:

1. Understand the requirement to carry nautical charts on board
2. Demonstrate basic nautical chart reading
3. Perform course and position plotting
4. Know how to use nautical publications such as *List of Lights, Canadian Tide and Current Tables,* and *Notices to Mariners*

1. Carrying paper charts and nautical publications on board

General goals of navigation

Navigation is a system of processes and tools used by a vessel's operator to plan and travel a designated sea route and to determine the vessel's projected and current position while identifying and avoiding hazards.

Every operator, Master, or navigator of a vessel (whether small or large) and regardless of the form of navigation used, must be able to solve three basic problems when at sea—that is, how to determine:

1. The vessel's present position
2. The direction or course a vessel needs to follow to navigate between desired positions
3. Distance, time, and speed to accurately calculate the progress of the vessel's position and its arrival time.

To become a proficient navigator, there is much to learn that is beyond the scope of this course. The SVOP course learning outcomes provide students with a basic understanding and practical use of GPS and radar to determine the vessel's position (Chapter 12); however, when these systems fail, and they inevitably will, the operator must be able to identify the vessel's position regardless of circumstances and technology.

Canada Shipping Act requirements

Pursuant to the *Canada Shipping Act* (CSA), commercial vessels must carry the most recent edition of charts, publications, and documents published for the area of operations for the vessel. (These requirements are waived if the navigator has: sufficient area knowledge of shipping routes, sufficient aids to navigation, and knowledge of navigational hazards and weather patterns.)

The *Small Commercial Vessel Safety Guide* states the following:

- *Vessels must carry the navigation equipment and appliances as required by the* Canada Shipping Act*. All devices must be properly installed and in good working order.*
- *Vessels must carry a steering compass (other equipment when over 5 Gross tons).*
- *Every vessel required to carry charts must also carry navigating accessories necessary to permit the proper use of the chart to accurately determine the position of the vessel and at least one pair of binoculars*.

Why carry paper charts

In addition to modern navigational tools and the advancement of digital electronic charts, operators are also required to carry paper charts, which are considered a key navigational tool on nearly every ship. Paper charts are an excellent backup system for electronic failures.

Paper charts also:

- Allow navigators to establish routes and tracks and cross-reference electronic navigation systems
- Are a reliable way to plan a route and to understand the waters the vessel will be operating in
- Provide extensive information and detail of the surrounding waters.

2. Basic nautical chart reading

Many marine accidents and groundings are a result of loss of situational awareness resulting in the loss of the vessel's position. More specific to navigation, it is important to know where your vessel is **not** as it is to know where your vessel **is**. If, during the process of confirming your position, you determine you are not where you think you are, then "YOU HAVE A PROBLEM!"

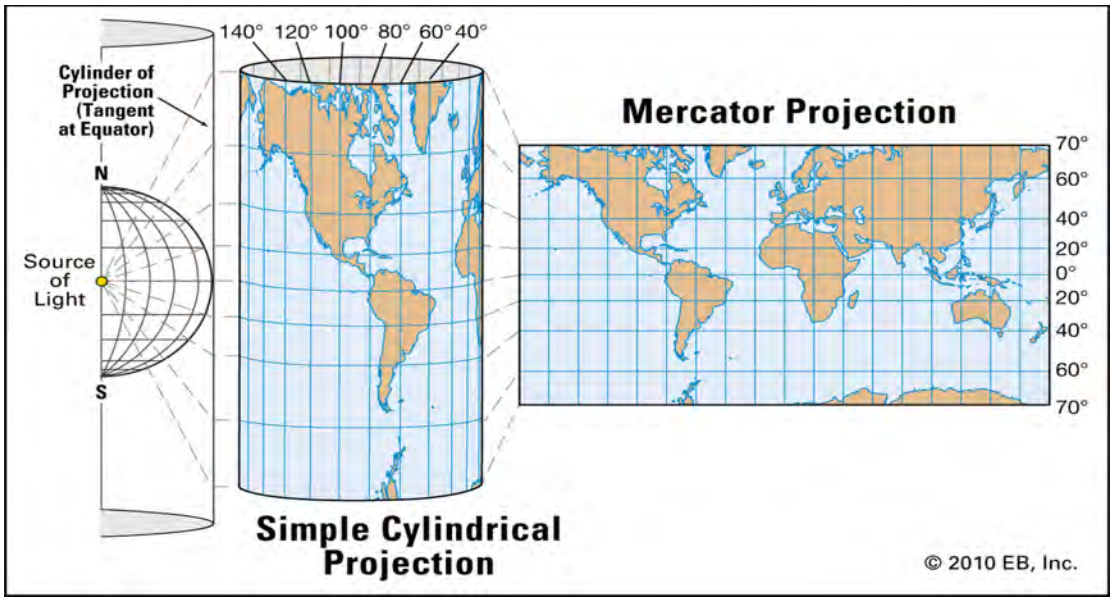
When you do not know where you are, you will need to use a chart to determine your position. Whether you are using a digital electronic chart on your GPS or a paper chart, these tools provide extensive information that can assist and confirm your position.

As the operator of the vessel, it is your responsibility to ensure the vessel is proceeding safely and that you are using all means available to determine your position, including electronic navigational aids, visual observations, physical aids to navigation, and reading and using charts.

Hydrographic charts

A topographical map is used for land, while a hydrographic chart is used for the marine environment. A marine chart is a paper representation of your environment. It provides a three-dimensional illustration of an area of water and land. Hydrographic charts allow the mariner to determine water depths and underwater hazards, coastline profiles, local aids to navigation, traffic routes, and much more**.**

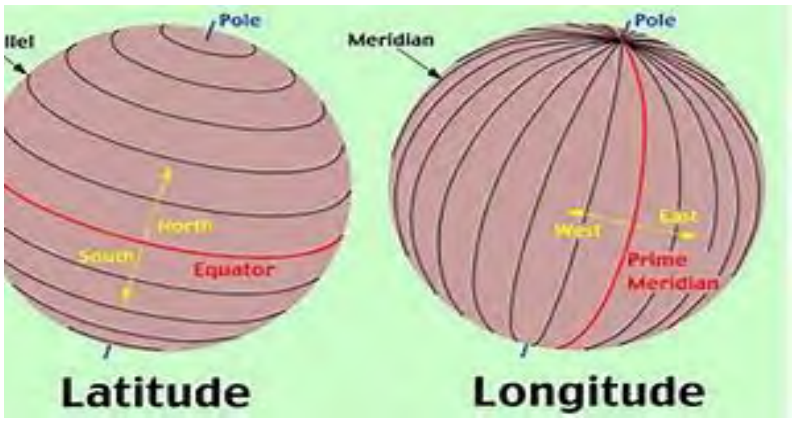
Mercator projection



Mercator charts are the most widely used charts for marine navigational purposes. Creating a chart is a complex process; in the case of a Mercator chart, the projection of the chart stretches the surface of the world onto a flat surface. This creates proportionality, functionality, and accuracy in part by altering northerly landmass areas, which appear larger than they actually are.

The system of longitude and latitude

The Earth is not perfectly round and tends to be flatter at both poles. To determine position on the globe, mariners have divided the surface into sections call “great” and “small” circles. Theses circles are the lines of longitude and latitude used to section off the earth into measurable parts. In general terms, the radius of the earth is taken to be 3,440 nautical miles (3,956 land miles, or 5,536 kilometres).



As you can see in the illustration above, the earth has been divided on two main axes: the prime meridian that runs through the North and South Poles (lines of longitude) and the Equator, which defines the halfway point between the poles (lines of latitude).This reference system for measurement is universally known as “the system of **longitude and latitude**.”

Longitude: The line of longitude commencing from a selected position on the Earth’s surface is called the Prime Meridian. These imaginary lines run through the North and South Poles, and are measured to the east and west. The Prime Meridian begins from 0 degrees and extends east or west through to 180 degrees, encompassing the Earth’s surface. When referencing a position of longitude, always indicate east (E) or west (W) to determine which line of longitude is referred to.

Latitude: The lines of latitude form a system of great circles beginning at the Equator and extending parallel to each other to the north and south. The Equator is considered 0 degrees and the lines of latitude extend from the Equator through to 90 degrees north and 90 degrees south, terminating at both poles. Therefore, when referencing positions in latitude, always state the parallels of latitude as being either north (N) or south (S). Charts show the lines of latitude from 1 degree to 90 degrees, terminating at each pole.

Chart distance measurements

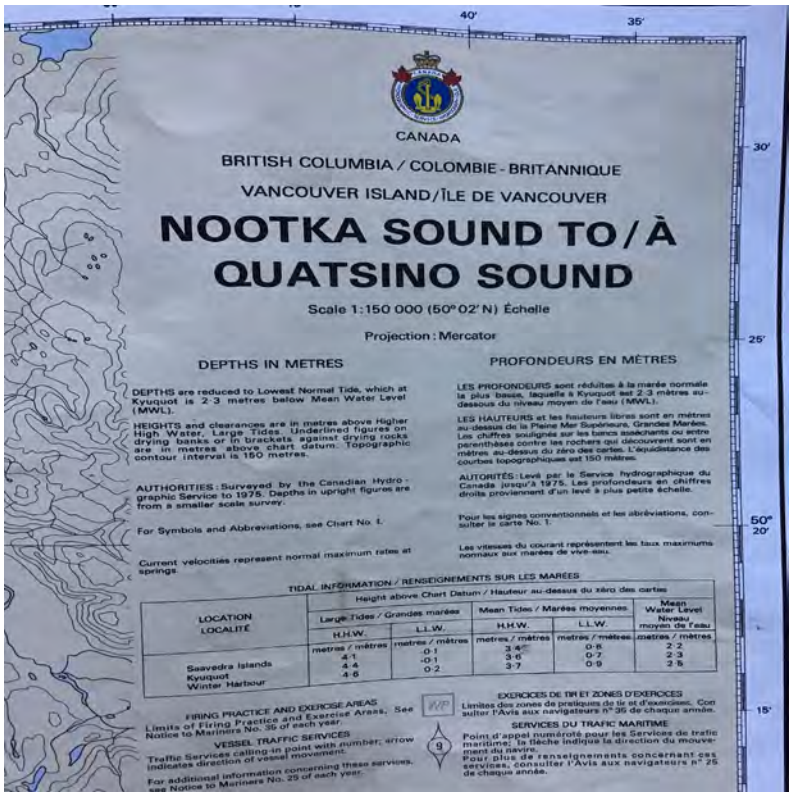
Nautical miles: A nautical mile is a unit of measurement used in the marine and air industry. It was previously measured as 1/60 of a degree of latitude; however, the modern international standard of measurement establishes a nautical mile as 1,852 metres.

Knots: Speed of a vessel is measured in **knots**: one knot = one nautical mile per hour.

Degrees: Lines of latitude and longitude are measured in degrees (°), minutes (‘) and seconds (“) (or decimals). A degree is broken down into minutes and seconds (or tenths of nautical miles). A degree has 60 minutes. A minute of latitude is one nautical mile; therefore, there are 60 nautical miles in one degree.

This calculation allows the navigator to plot a position on a chart. Because the distances between lines of latitude are parallel, they are the only lines that can be used for measuring distance.

Title block



The title block is an important function of a chart. It provides the mariner with the area covered by the chart projection and scale, the country and province, chart projection (Mercator), sounding information, and notes and cautions. The reference for datum (referenced water marker) is also indicated in either metres or fathoms (all recent charts are in metres). Heights above land are measured in

metres and are also referenced. The margin on a chart also includes a reference number specific to the chart area.

Types of charts

Chart scales: In general, there are four classifications of chart scales. The scale of the chart is measured in a ratio of inches. For example: 1:10,000 = one inch on the chart represents 10,000 inches of distance. This would be considered a "**large-scale**" chart, meaning a larger scale of detail. Charts covering a larger area with less detail are referred to as "**small-scale**" charts.

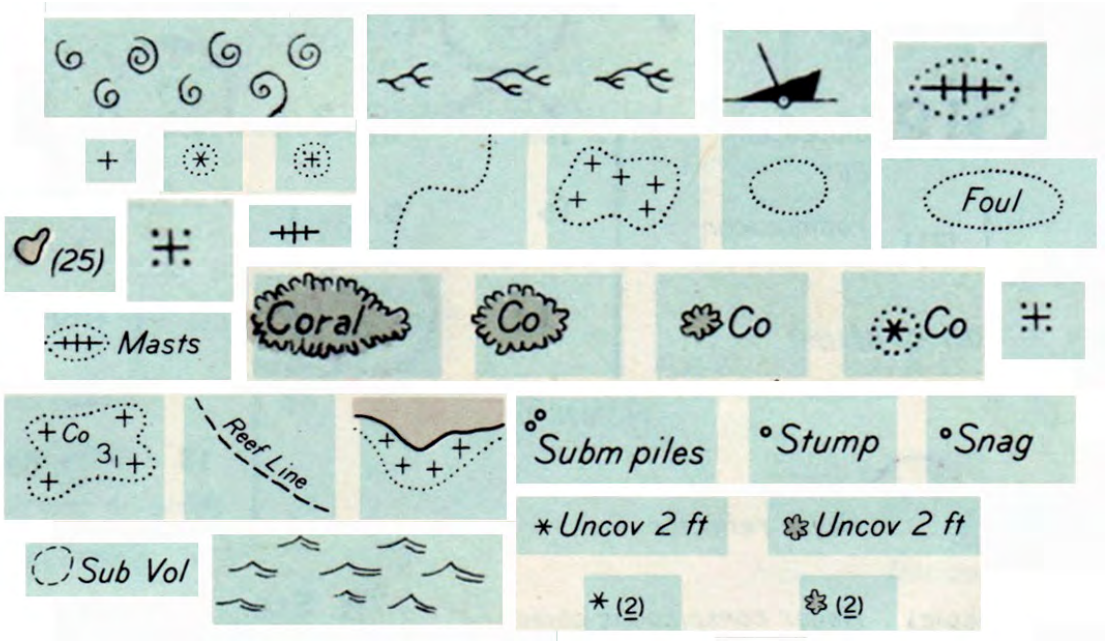
Harbour charts: These charts are large-scale, as they provide necessary detail of the harbour area in the range of the 1:10,000 scale.

Coastal charts: These charts are scaled between 1:50,000 and 1:75,000 and are also considered large-scale charts. They provide detail sufficient for navigational purposes and safety.

General charts: These are charts scaled between 1;100,000 and above. They are considered small-scale charts, and have less detail. They are used for off-shore navigation.

Sailing charts: These are small-scale charts and fall into the category of general charts for offshore use.

Chart symbols



Many chart symbols are found on a hydrographical chart. The Canadian Hydrographic Service's ***CHART 1*** is a publication that provides all symbols found on nautical charts. Charts also provide some consistency in symbols and abbreviations, colours, and other areas recognized internationally. It is of paramount importance that the mariner has a solid understanding of how to read a chart's symbols, markings, and colours. Some of these areas include the following:

Colours: Nearly all charts employ the consistent use of colours for deep water, shoal water, and land areas. Variations of black, blue, green, grey, magenta, gold, and white are generally used.

Lettering style: Lettering style also provides information. Roman numerals describe heights above high water that are dry. Italics describe submerged and floating features. Depth sounds are shown in roman letters.

Symbols and abbreviations: Many symbols and abbreviations are used on charts. The symbols are generally standardized. CHART 1 provides the necessary information to interpret the multitude of information available on a chart.

Features of water areas: Depth is of the greatest concern to the navigator. The title block provides sounding data. Depth will vary with tide height. The chart will have depth contour lines to provide the underwater structure (the closer the lines are together, the steeper the rise or drop off). Colour changes on the chart also reflect depth changes.

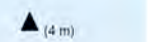
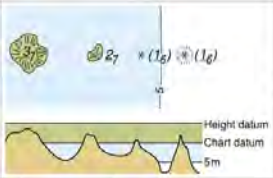
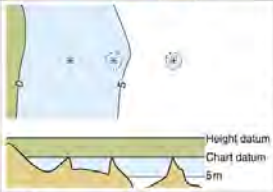
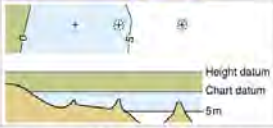
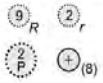
Bottom characteristics: Information on the bottom composition, including sand, mud, gravel rock, and coral, is of great interest to a navigator particularly when anchoring. These abbreviations are included on the chart and referenced in *CHART 1.*

Features of the shoreline: Shoreline features are also included on a chart. Symbols are used to indicate the nature of the shore, including cliffs, marshy areas, and other features.

Aids to navigation: This is of prime importance to the navigator. Both symbols and abbreviations are used, and a mariner must have a full understanding of their meanings.

Example of symbols and meanings found in *CHART 1*

K Rocks, Wrecks, Obstructions, Aquaculture

No.	INT	Description	NOAA	NGA	Other NGA
Rocks					
Plane of Reference for Heights → H		Plane of Reference for Depths → H			
10		Rock (islet) which does not cover, height above height datum			
11		Rock which covers and uncovers, height above chart datum			
12		Rock awash at the level of chart datum			
13		Underwater rock of unknown depth, dangerous to surface navigation			
Supplementary National Symbols					
a		Rock awash (height unknown)			
b		Shoal sounding on isolated rock or rocks			

3. Finding distance and position and plotting the course on a paper chart

Navigational tools

To use a paper chart effectively requires certain aids:

- **Pencils and erasers** (and sharpeners) to mark and remove the lines and position on the chart
- **Parallel rulers** to measure the degrees of course and transfer the course onto the compass rose for measurement
- **Dividers** to measure distances.



Measuring distances

As previously mentioned, the lines of longitude all intersect at the North and South Poles. As the lines of longitude converse at each pole, the only point on the globe where they are parallel to each other is at the Equator. As also noted, the lines of latitude are parallel to each other at all times, which makes measurements between lines of latitude more accurate.

Therefore, all distance measurements MUST be taken from the lines of latitude, which are found on the edges of the chart, and NOT from the top or bottom of the chart. The distances are shown in nautical miles and **cables** (10ths of nautical miles).

Use dividers to measure distances between two points on a chart, as shown below.



Take the measurement and then measure the distance on the chart's latitude scale.



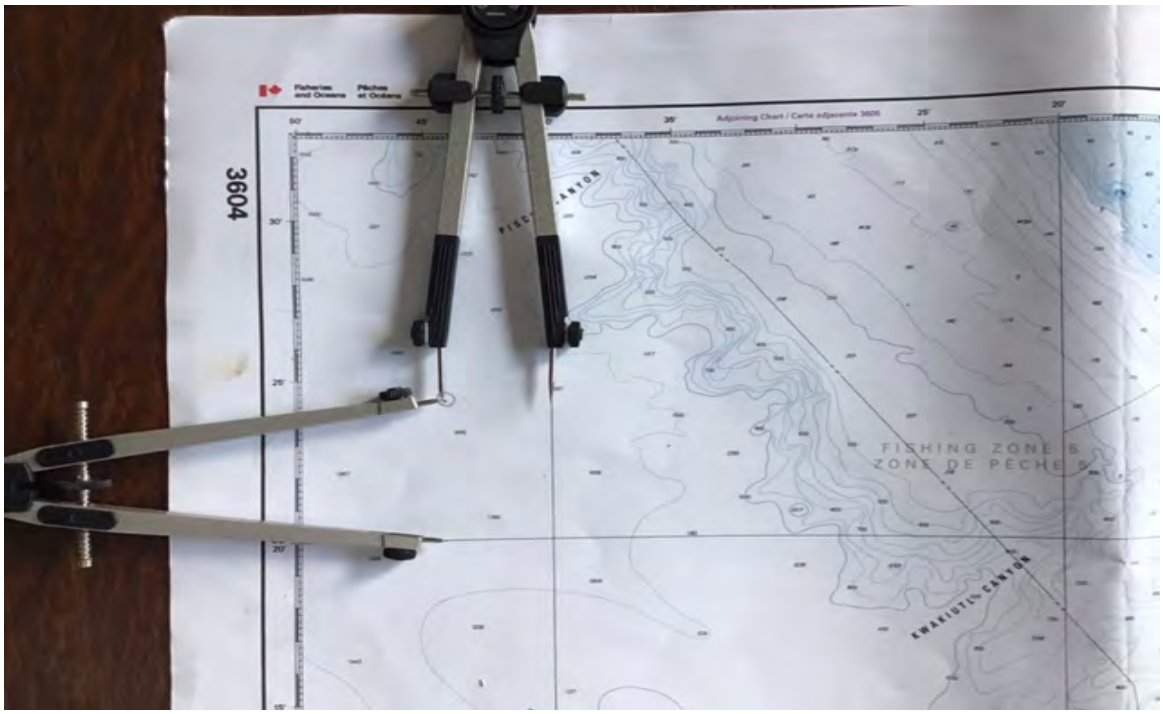
In the above illustration, the dividers measure the distance between two points on the chart. The navigator then measures that same distance on the latitude

scale on the edge of the chart. In this case, the distance is measured at 3.3 nautical miles.

Establishing position

Latitude: The right and left side of the chart reveal the latitude scale that divides the earth into even slices parallel to the equator. These slices are measured in degrees, minutes, and seconds. Because the slices are even, one minute of latitude is equal to one nautical mile, therefore 60 minutes of latitude or 60 nautical miles are equal to one degree of latitude. One minute of latitude can be broken down into 60 seconds or 10ths of a second. (When providing positions, it is most common to reference seconds of position in the decimal form.)

Longitude: The lines of longitude scale are located on the top and bottom of a Mercator chart. They are cut like an apple through the poles dividing the earth in half. These lines are also measured in degrees minutes and seconds. The lines of longitude move closer together as they move closer to the poles. Therefore, only lines of latitude are used for distance measurements.



As illustrated above, the dividers are used to measure a position on the chart with the lines of latitude and longitude as reference points. The dividers are then placed on the latitude and longitude scale markings and measured to determine a position. **Note**: the position of latitude is stated first.

A typical position would be stated in this manner: 48° 42’ 30” N • 123° 27’ 30” W, or expressed in tenths would be 48° 42.5’ N • 123° 27.5’ W.

Note: Always refer to the position as north or south (N or S) for lines of latitude and east or west (E or W) for lines of longitude.

Establishing a course

We have discussed measuring distances and finding a position on a chart but also important is the direction of travel, or **the course** the vessel is following.

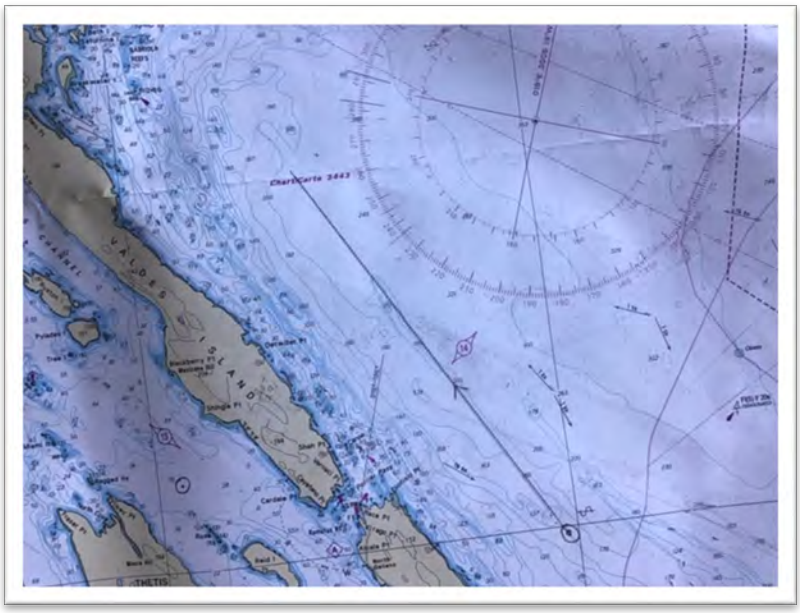
To understand how to plot a course we must first understand how the lines of latitude and longitude are aligned with the chart. The lines of longitude therefore run directly to the North and South Poles, referred to as “True North” or “True South.” However, when using a compass, the earth’s magnetic field does not align with the position of True North, and therefore calculations must be adjusted to address these issues.

The compass rose



The compass rose is fixed in several positions on a chart that provides 360 degrees of the cardinal positions and points in between to allow the mariner to orient positions and set a course in either a True North or magnetic north orientation

Plotting the course



First determine your latitude and longitude position on the chart (as described above). Then determine where you intend to go by scribing a line on the chart with a parallel rule.



Slide the parallel ruler along the same angle as your intended course to the compass rose ensuring the ruler's edge is centred on the middle point of the compass rose. Read the course on the compass rose. The inner ring is for magnetic courses, the outer ring is for True courses.



You can now confirm and mark your course and direction of travel on the chart. This process can be repeated as new courses are required.

4. Nautical publications: *List of Lights, Canadian Tide and Current Tables,* and *Notices to Mariners*

The Canadian Hydrographic Service (CHS) offers a wide range of nautical publications that are used by mariners in support of navigation that affords the mariner with enhanced safety at sea.

As previously mentioned in this chapter, the Charts and Nautical Publications of the ***Canada Shipping Act*** require that you carry the most recent editions of charts and publications for the area of operations that your vessel will be engaged in.

CHS distributes its nautical charts and publications to over 500 dealers across Canada and around the world.

Notices to Mariners (NOTMAR)

The *Notices to Mariners* is a service operated in Canada by the Canadian Coast Guard and includes a website for public access. It provides the mariner with the necessary information to update charts and other publications issued by CHS. It will also advise the mariner of new initiatives, services and announcements concerning the maritime community. NOTMAR provides the following services:

Publication corrections: A list of publications can be downloaded and or provide corrections for specific regions.

Chart corrections: NOTMAR provides chart patches or corrections for all CHS charts

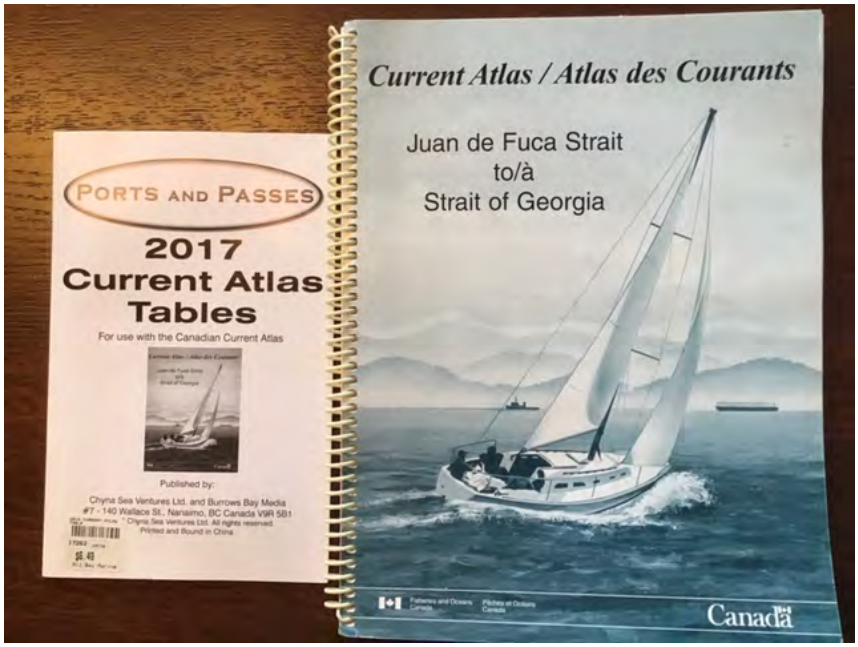
Email notification services: NOTMAR provides mariners with account and subscription services that provide updates and notifications to the mariner regularly.

Publications available through CHS

Current Atlas

The movement of tide and current are one of the most significant factors of the oceanic features of the coastal waters of British Columbia and therefore, extremely important in navigation. Tidal streams are caused by gravitational forces of the moon and the sun that impact on the direction and rate of flow of the water through the ebb and flow of their tidal cycles. This publication can greatly assist the navigator in determining/predicting the movement of water and intensity throughout various area of the coast through channels, islands, and inlets that impact navigation.

This atlas provides the mariner with the direction and intensity of current direction in specific regions of the country. The larger publication provides the intensity and direction of the tidal stream supported by a smaller annual publication, and references the date and times of the current flow for the *Current Atlas*.



Current Atlas

Tides and currents

All coastal areas of Canada that vessels navigate through are significantly impacted by tidal streams and associated currents. Knowing the depth of water under the keel of your vessel in narrow passages or over shoals and reefs, or clearance under bridges and power lines, are critical elements of safe navigation. Equally important is the impact the current can have on the control of a vessel in open water, when docking, or in narrow channels.

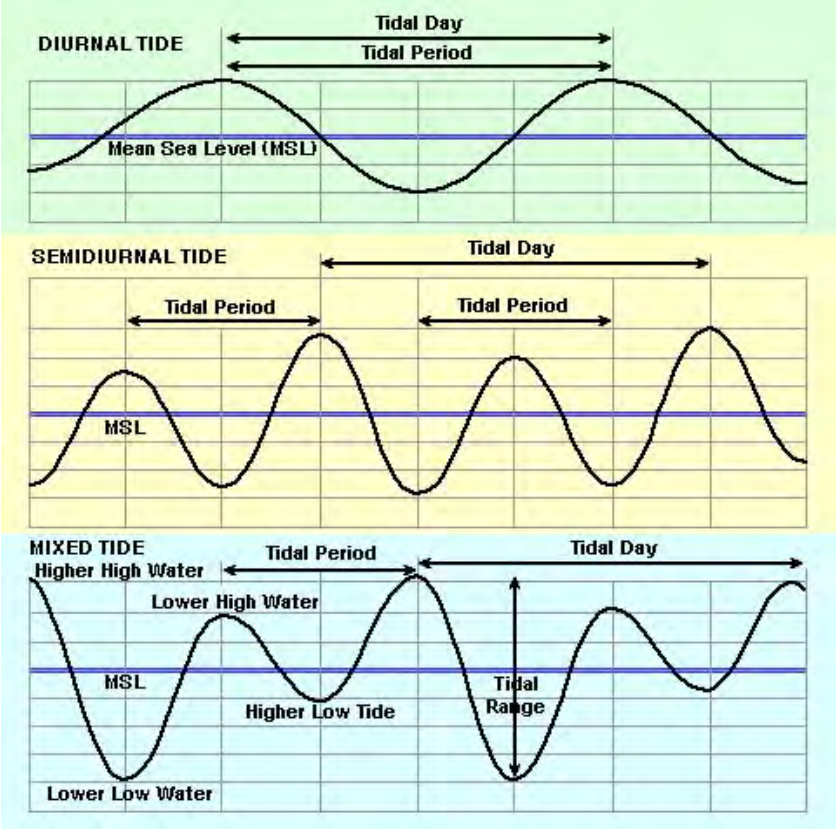
The periodic rise and fall of ocean water is due to the gravitational pull between the ocean, the moon, and the sun. Due to its proximity to Earth, the moon has the most effect.

Though the Earth rotates once per 24 hours, the moon revolves around the Earth once per month and rises 52 minutes later each day, which means that high tides occur 52 minutes later each day.

Spring tides occur at the new and full moon when the moon and the sun are directly in line and have their greatest influence. Tidal highs and lows are at their greatest, and thus have a larger than normal range.

Neap tides occur when the moon and sun are out of phase with each other, causing lesser impact on tide changes. During this period, tide heights are lower than normal and lows are higher than normal, creating a smaller than normal range.

Tidal cycles



All coastal areas are affected by tidal cycles:

- **Semi-diurinal tides** have two highs and two lows and have small differences between each cycle (US East Coast).
- **Diurinal tides** occur just once a day and usually with smaller changes (much of the US Gulf Coast).
- **Mixed tides** are semi-diurnal with the amplitude of one tide being significantly different than the other cycle. Mixed tides are typical in Coastal British Columbia due to the multitude of irregular coast lines, inlets, islands, and land masses that interrupt the flow.

Tidal currents

Tides, as with currents, can be predicted and are referenced in the tides and current publications listed below.

In the open ocean, tidal currents are rotary. They rotate in a 360° pattern with little intensity and not relevant to navigation.

Periodic currents: (Our local currents) are far more important and evolve around the ebb and flood in constricted waters in the coastal areas of British Columbia.

Flood: is the movement of tidal current into or up an inlet, estuary or river.

Ebb: is the movement of tidal current out of or down an inlet, river or estuary.

Currents **ebb and flow** whereas tides **rise and fall.**

The current cycle can also be predicted and can have significant impact on a vessel's movement, steerage, speed, and routes.

Currents are illustrated on charts by arrows that indicate the direction of flow. Arrows with feathers follow the direction of the flood and arrows without feathers, the ebb.

The term "**slack water**" refers to when a current stops just before the tidal stream reverses in direction; this occurs at each tidal change.

The change in current direction and intensity coincides with the tidal movement; however, this does not mean that at the turn of a tidal cycle the current is at slack water. Due to various islands, channels, passages, and land obstructions, the timing of the current and tidal action may not be at the same time and therefore tidal and current predictions must be measured separately.

Because of the intense speed of current flow through many narrow passages along British Columbia's coastal areas, many vessels must wait for slack water to transit a passage as the vessel may not have sufficient power to negotiate the control of the vessel.

Canadian Tide and Current Tables

The *Canadian Tide and Current Tables* is an indispensable publication that must be on board every commercial vessel. This publication MUST be renewed every year. The publication provides two sets of data:

Tide tables: These provide predicted times and heights of high and low waters associated with the vertical movement of the tide. They are necessary for obtaining depths of water under the vessel for travelling over shoals, anchoring, or beaching a boat.

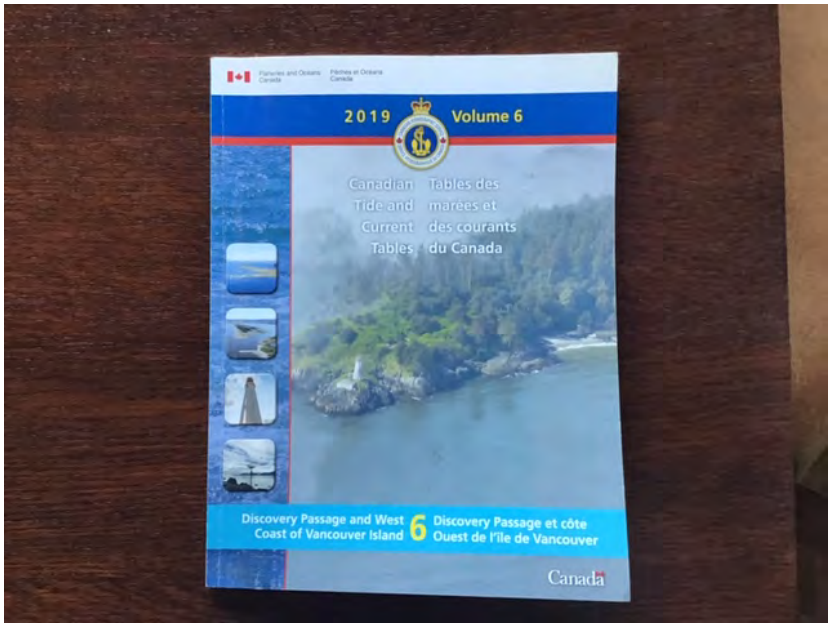
Times and heights for all tidal high and low waters are taken from designated REFERENCE PORTS. Times and heights for SECONDARY PORTS for both high and low water are tabulated related to the reference port.

Note: The height of the tide must be applied to the particular depth of chart data to arrive at the proper depth. For example: If a chart notes the depth of water at

30 feet (per chart data) and the tidal rise is six feet, then the actual depth of water is 36 feet.

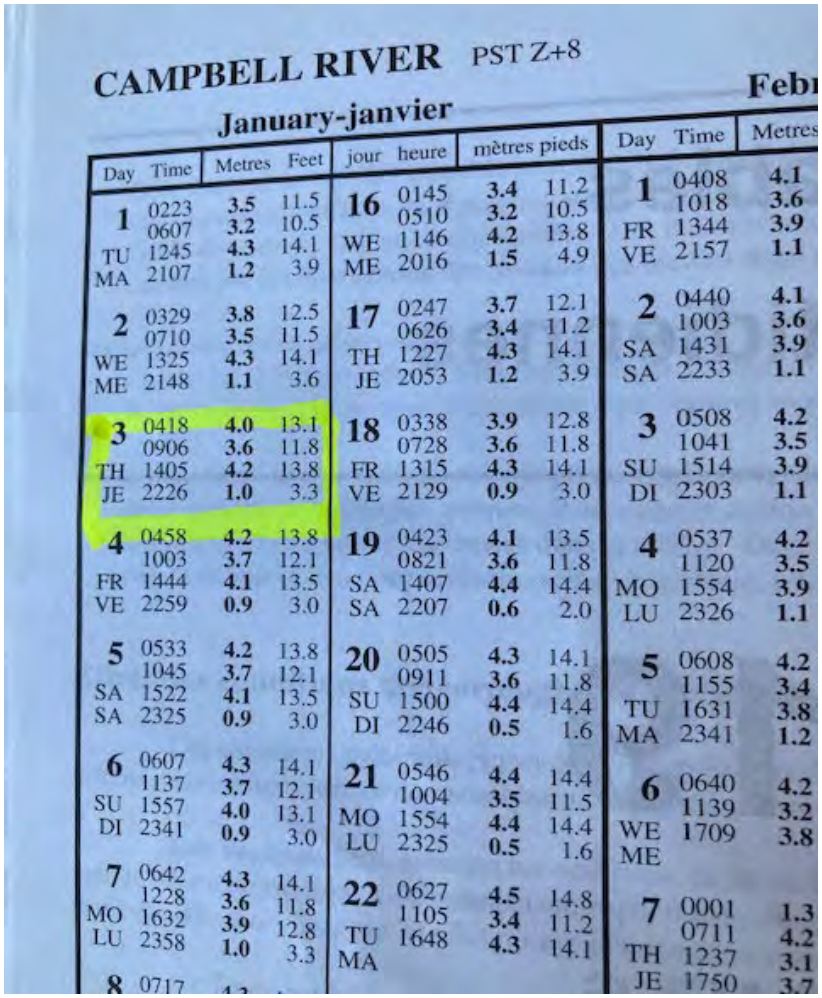
Current tables: These provide predicted times for slack water and maximum current associated with the vertical movement of water. This is necessary information for effective navigation, and the tables are required when navigating tight passes or channels with strong currents.

Current stations are listed that provide the daily current flow directions and speeds. Secondary current stations are tabulated at different times from the reference current tables.



Canadian Tide and Current Tables

Tidal reference ports (example)



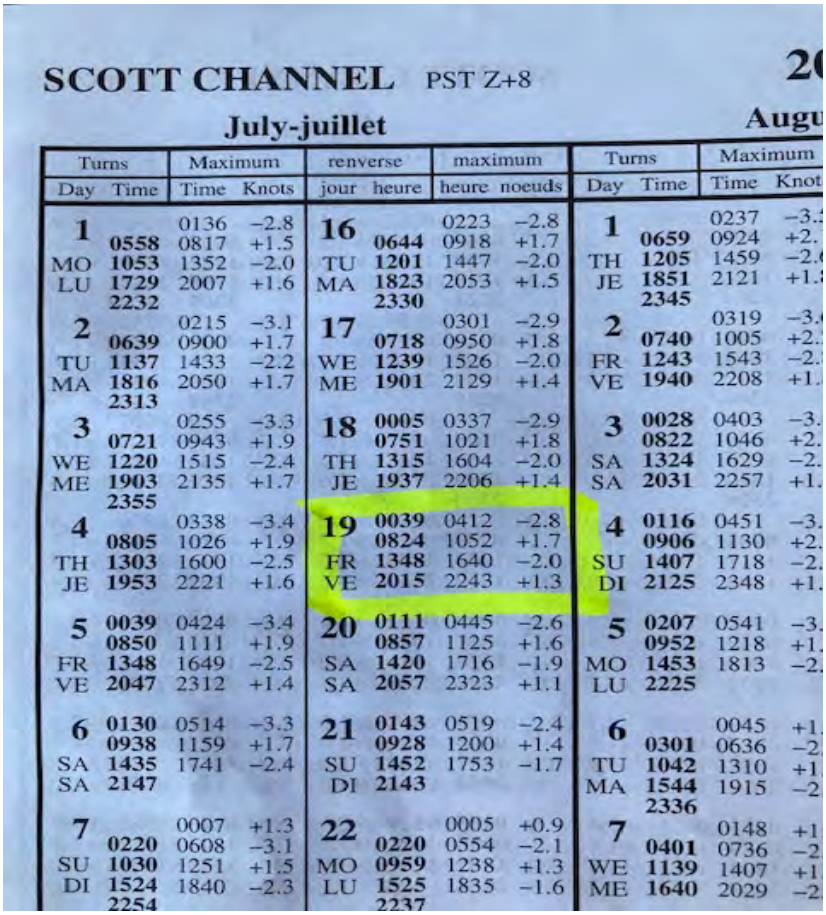
CAMPBELL RIVER PST Z+8

January-janvier

Day	Time	Metres	Feet	jour	heure	mètres	pieds	Day	Time	Metres
1	0223	3.5	11.5	16	0145	3.4	11.2	1	0408	4.1
	0607	3.2	10.5		0510	3.2	10.5		1018	3.6
TU	1245	4.3	14.1	WE	1146	4.2	13.8	FR	1344	3.9
MA	2107	1.2	3.9	ME	2016	1.5	4.9	VE	2157	1.1
2	0329	3.8	12.5	17	0247	3.7	12.1	2	0440	4.1
	0710	3.5	11.5		0626	3.4	11.2		1003	3.6
WE	1325	4.3	14.1	TH	1227	4.3	14.1	SA	1431	3.9
ME	2148	1.1	3.6	JE	2053	1.2	3.9	SA	2233	1.1
3	0418	4.0	13.1	18	0338	3.9	12.8	3	0508	4.2
	0906	3.6	11.8		0728	3.6	11.8		1041	3.5
TH	1405	4.2	13.8	FR	1315	4.3	14.1	SU	1514	3.9
JE	2226	1.0	3.3	VE	2129	0.9	3.0	DI	2303	1.1
4	0458	4.2	13.8	19	0423	4.1	13.5	4	0537	4.2
	1003	3.7	12.1		0821	3.6	11.8		1120	3.5
FR	1444	4.1	13.5	SA	1407	4.4	14.4	MO	1554	3.9
VE	2259	0.9	3.0	SA	2207	0.6	2.0	LU	2326	1.1
5	0533	4.2	13.8	20	0505	4.3	14.1	5	0608	4.2
	1045	3.7	12.1		0911	3.6	11.8		1155	3.4
SA	1522	4.1	13.5	SU	1500	4.4	14.4	TU	1631	3.8
SA	2325	0.9	3.0	DI	2246	0.5	1.6	MA	2341	1.2
6	0607	4.3	14.1	21	0546	4.4	14.4	6	0640	4.2
	1137	3.7	12.1		1004	3.5	11.5		1139	3.2
SU	1557	4.0	13.1	MO	1554	4.4	14.4	WE	1709	3.8
DI	2341	0.9	3.0	LU	2325	0.5	1.6	ME		
7	0642	4.3	14.1	22	0627	4.5	14.8	7	0001	1.3
	1228	3.6	11.8		1105	3.4	11.2		0711	4.2
MO	1632	3.9	12.8	TU	1648	4.3	14.1	TH	1237	3.1
LU	2358	1.0	3.3	MA				JE	1750	3.7
8	0717									

Reference port for Campbell River: January 3: The times and associated heights of water are listed in feet and metres. The reader is also able to establish the mixed range of tidal highs and lows.

Reference current station (example)



SCOTT CHANNEL PST Z+8

July-juillet

Turns Day	Time	Maximum Time	Knots	renverse jour	heure	maximum heure	noeuds	Turns Day	Time	Maximum Time	Knots
		0136	−2.8			0223	−2.8			0237	−3.
1	0558	0817	+1.5	16	0644	0918	+1.7	1	0659	0924	+2.
MO	1053	1352	−2.0	TU	1201	1447	−2.0	TH	1205	1459	−2.
LU	1729	2007	+1.6	MA	1823	2053	+1.5	JE	1851	2121	+1.
	2232				2330				2345		
		0215	−3.1			0301	−2.9			0319	−3.
2	0639	0900	+1.7	17	0718	0950	+1.8	2	0740	1005	+2.
TU	1137	1433	−2.2	WE	1239	1526	−2.0	FR	1243	1543	−2.
MA	1816	2050	+1.7	ME	1901	2129	+1.4	VE	1940	2208	+1.
	2313										
		0255	−3.3		0005	0337	−2.9		0028	0403	−3.
3	0721	0943	+1.9	18	0751	1021	+1.8	3	0822	1046	+2.
WE	1220	1515	−2.4	TH	1315	1604	−2.0	SA	1324	1629	−2.
ME	1903	2135	+1.7	JE	1937	2206	+1.4	SA	2031	2257	+1.
	2355										
		0338	−3.4		0039	0412	−2.8		0116	0451	−3.
4	0805	1026	+1.9	19	0824	1052	+1.7	4	0906	1130	+2.
TH	1303	1600	−2.5	FR	1348	1640	−2.0	SU	1407	1718	−2.
JE	1953	2221	+1.6	VE	2015	2243	+1.3	DI	2125	2348	+1.
		0424	−3.4		0111	0445	−2.6		0207	0541	−3.
5	0039	0850	1111	+1.9	20	0857	1125	+1.6	5	0952	1218	+1.
FR	1348	1649	−2.5	SA	1420	1716	−1.9	MO	1453	1813	−2.
VE	2047	2312	+1.4	SA	2057	2323	+1.1	LU	2225		
	0130	0514	−3.3		0143	0519	−2.4			0045	+1.
6	0938	1159	+1.7	21	0928	1200	+1.4	6	0301	0636	−2.
SA	1435	1741	−2.4	SU	1452	1753	−1.7	TU	1042	1310	+1.
SA	2147			DI	2143			MA	1544	1915	−2.
									2336		
		0007	+1.3			0005	+0.9			0148	+1
7	0220	0608	−3.1	22	0220	0554	−2.1	7	0401	0736	−2.
SU	1030	1251	+1.5	MO	0959	1238	+1.3	WE	1139	1407	+1
DI	1524	1840	−2.3	LU	1525	1835	−1.6	ME	1640	2029	−2.
	2254				2237						

Reference port for Scott Channel July 19: The bold print indicates the current chance or slack. The numbers to the right of slack indicate time and the numbers to the far right indicate current speed: (-) indicates an ebb flow (+) indicates a flood direction. **Note:** the bottom of the page provides the true direction of the ebb and flood current (not illustrated).

Daylight Savings Time: Canadian Tides and Current publications do not account for daylight savings time. Therefore, when calculations are made you must add one hour to the times listed in the publication at the appropriate time of the year. Also note that time is referenced on the 24-hour clock based on standard time zones from Greenwich Mean Time (GMT). Vancouver is (Z)+8 which means we are eight hours ahead of (GMT).

CHART 1

This is another indispensable publication that provides explanation of the symbols, abbreviations, and terms used in CHS nautical charts and consistent with international standards. It can also be referenced and used with electronic charts that use consistent recognized symbols and terms.

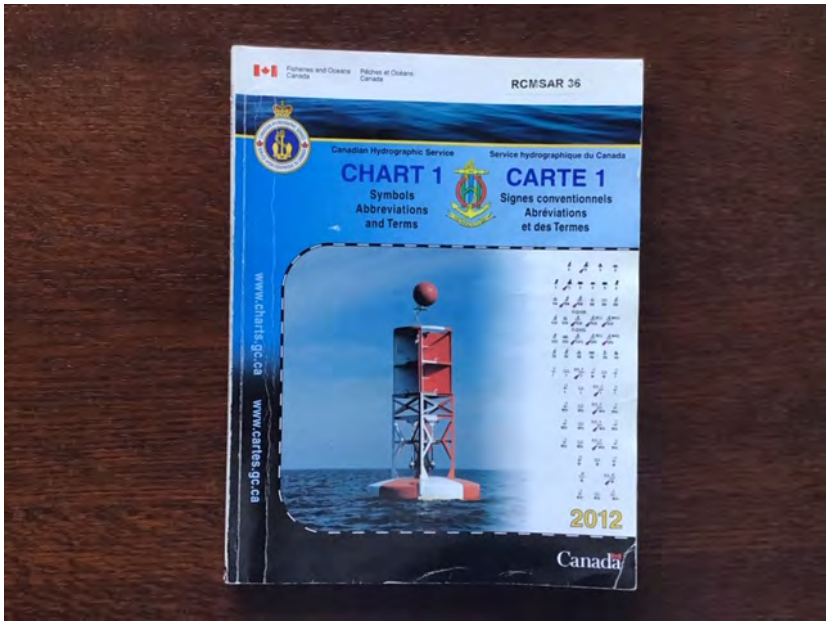
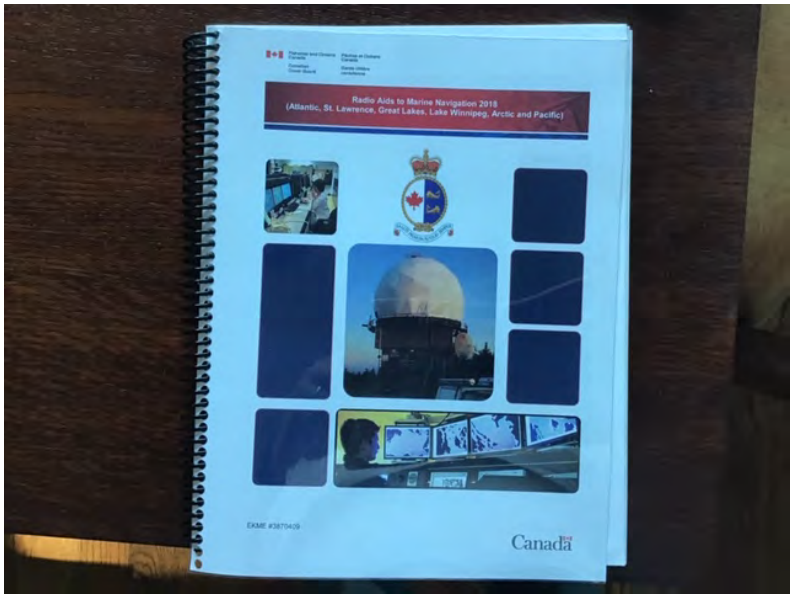


CHART 1

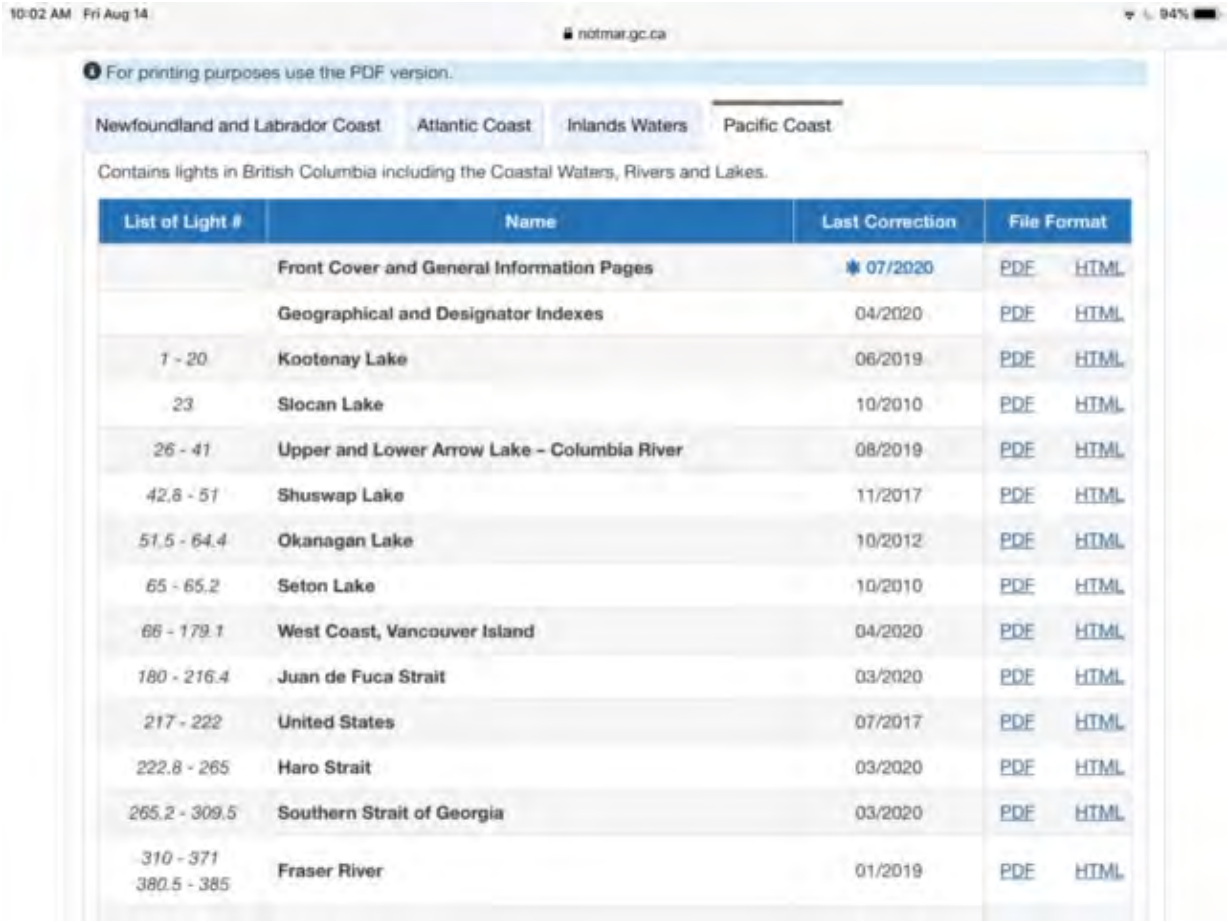
Radio Aids to Marine Navigation

This publication provides information on radio communications and radio navigational aids services in Canada. It includes the Canadian Maritime Mobile Safety and Public Correspondence Communication Frequencies, as well as a directory of Marine Communications and Traffic Services Centres. There is a chapter on Vessel Traffic Services and one on Environment Canada's Marine Weather Forecast Program.



List of lights, buoys, and fog signals

The HTML and PDF versions of the *List of Lights* publication, are updated up to the latest version of the *Monthly Notices to Mariners*. This online publication provides all dimensions and characteristics for lights and buoys used in Canadian waters



List of Light #	Name	Last Correction	File Format
	Front Cover and General Information Pages	07/2020	PDF HTML
	Geographical and Designator Indexes	04/2020	PDF HTML
1 - 20	Kootenay Lake	06/2019	PDF HTML
23	Slocan Lake	10/2010	PDF HTML
26 - 41	Upper and Lower Arrow Lake – Columbia River	08/2019	PDF HTML
42.8 - 51	Shuswap Lake	11/2017	PDF HTML
51.5 - 64.4	Okanagan Lake	10/2012	PDF HTML
65 - 65.2	Seton Lake	10/2010	PDF HTML
66 - 179.1	West Coast, Vancouver Island	04/2020	PDF HTML
180 - 216.4	Juan de Fuca Strait	03/2020	PDF HTML
217 - 222	United States	07/2017	PDF HTML
222.8 - 265	Haro Strait	03/2020	PDF HTML
265.2 - 309.5	Southern Strait of Georgia	03/2020	PDF HTML
310 - 371 380.5 - 385	Fraser River	01/2019	PDF HTML

Canadian Aids to Navigation system

Defined by the Canadian Coast Guard: *Aids to navigation are devices and systems, external to a vessel, which are provided to assist the mariners in determining position and course, to warn of dangers or obstructions or to advise of the location or preferred route to navigate.*

It is the mandate of the CCG in part, to provide and maintain aids to navigation in most Canadian waterways. The Canadian Aids to Navigation is a system and not a publication that is to be used in conjunction with a variety of CHS publications including the above noted publications.

(The aids to navigation system is discussed in Chapter 15.)

Sailing Directions booklets

The *Sailing Directions* booklets are an indispensable companion to nautical charts. They are a great tool for planning and assisting in navigation because they provide information that cannot be shown on a chart.

All hardcopy print-on-demand (POD) *Sailing Directions* booklets are printed with current NOTMAR updates applied. These POD booklets are available for purchase from authorized chart dealers located across Canada and around the world.

Private cruising guides also provide similar information for mariners.

CHAPTER 13 REVIEW

1. How many nautical miles in one degree of latitude?

2. What is a compass rose and what information does it provide?

3. How do you measure distances on a chart?

4. Name three essential publications to be kept on board a vessel.

5. What information is provided on a title block?

6. What is the difference between a tidal reference port and a secondary port?

7. What is the difference between a large-scale chart and a small-scale chart?

8. What does the term NOTMAR mean, and what service does it provide to mariners?

14. Navigating with the magnetic compass

Goals of this chapter

This chapter provides students with a basic understanding and practical use of the magnetic compass, and describes its application to nautical charts.

Learning outcomes

On completion of this chapter, students will understand:

1. How a magnetic compass works and how to use one at sea
2. How to apply compass readings to the nautical chart of the operational area
3. How to read magnetic compass deviation and make a simple deviation table

1. How to use a magnetic compass

True North and magnetic north

A number or value in any form of measurement has no meaning without some form of reference. In the case of marine navigation, operators seek a present position and direction in the process of travelling from one location to another, and the reference they use is the vessel's position relative to magnetic north and True North:

Geographic north ("True North") is the direction toward the fixed point called the geographic North Pole. Magnetic north is the direction toward the magnetic North Pole, which is a moving point where the Earth's magnetic field goes vertically down into the planet. The geographic North Pole differs from the magnetic North Pole by about 500 kilometres.

The magnetic compass

In the marine world, True North can be established by two separate means: operators can use either a gyrocompass that will automatically line up with True North (used on larger ships), or a **magnetic compass** that aligns with magnetic north, which requires that certain corrections are applied before a course can be established.

The modern compass has evolved over hundreds of years. With the exception of fluxgate compasses, which align with magnetic north, and gyrocompasses, which align with True North, a modern magnetic compass is basically several magnets mounted beneath an imprinted card with markings of one to five degree increments that provide the user with angles of degrees of course. Most compasses also show the cardinal points (north, south, east, and west) and sub-cardinal points. (For the purposes of this course, this chapter is limited to using the magnetic compass.)



The magnets of a compass cause the card to align itself with the earth's magnetic field that exists within the operational area. When a vessel changes course, the compass card continues to align itself with the earth's magnetic field.

A **lubber line,** fixed to the compass and aligned with the vessel's fore and aft direction, rotates with the vessel's direction while the compass card continues to seek magnetic north. The lubber line provides the navigator with a reference point marked in degrees on the compass card and shows the angle the vessel is travelling relative to the magnetic north. The compass allows the navigator to follow a course relative to magnetic north and to take bearings of land in order to plot a position.

Because the most common application for a compass on board a vessel is to steer a course in a desired direction, the compass course should be corrected to a magnetic course by applying the deviation corrections described in Section 3.

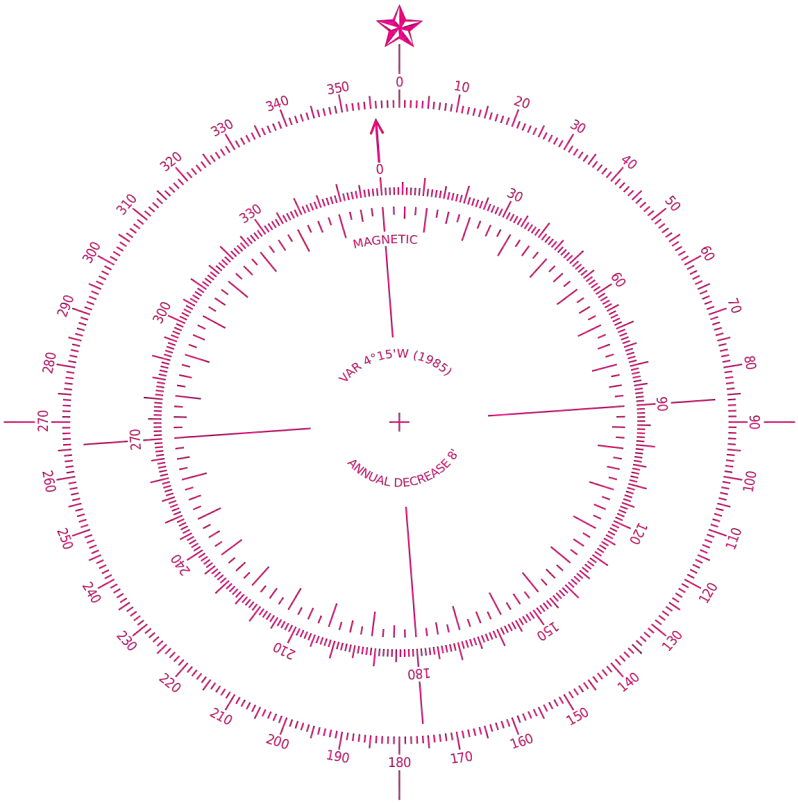
The compass can also be used to take bearings of land points to provide the vessel's present position.

Note: When a position of the vessel is required, it is best to use a hand-held compass.

2. Applying magnetic compass readings to the nautical charts of the operational area

Compass rose: Review

As described in Chapter 13, the compass rose is found on all Mercator marine charts. The compass rose displays two concentric circles marked with various increments depending on the size of the chart. The two circles represent the reference points for True North and magnetic north; True North is the outside circle and magnetic north, the inside circle.



Orientation of True North and magnetic north

The outer circle of the compass rose has True North orientation aligned and parallel to the meridians of longitude displayed on the chart with a star just above True North. The inner circle, which is aligned in the direction of the Earth's magnetic field, shows magnetic north. As depicted in the illustration, the alignment of the compass rose's magnetic north is west of True North. Depending on the area that your chart covers, the orientation can be either west or east of True North. On the West Coast of Canada, the orientation will be easterly.

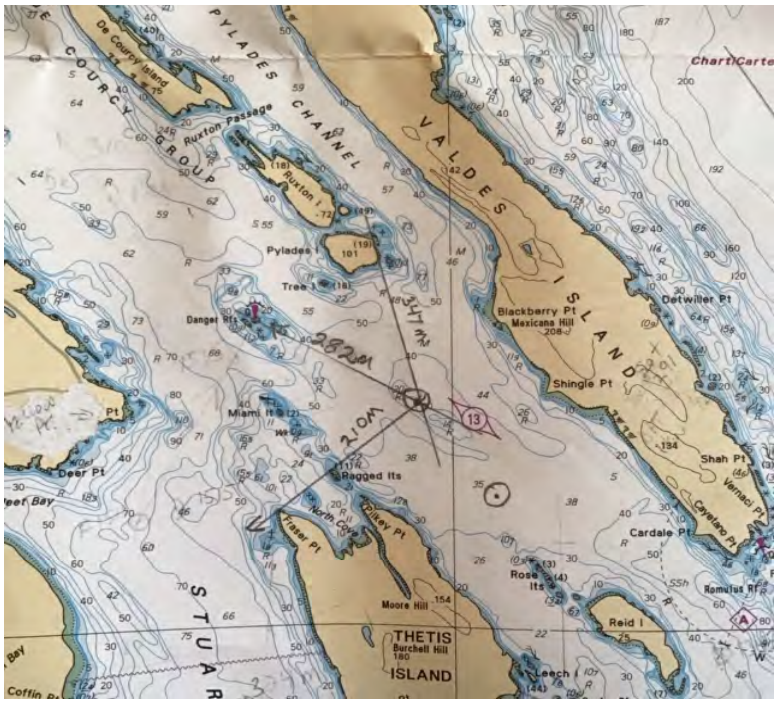
The orientation of magnetic north to True North rests with the amount of magnetic variation that is covered by the chart for your area. The lesser the magnetic variation, the less difference there will be between True North and magnetic north.

The magnetic fields of the Earth change annually. The amount of variation and the amount of annual change in that variation can be found at the centre of the compass rose, and can therefore be calculated to update the chart's variation.

Taking a bearing

To take a bearing, identify three points of land or fixed aids to navigation (i.e., not floating buoys). Point your compass at the points of land you have identified and quickly record their compass bearings. **Note:** Always take the bearings abeam of the vessel last.

Apply the deviation error (see Section 3) and mark the bearings on your chart using a parallel ruler and the compass rose from the land positions you had identified, to establish lines of position. If done correctly, you will have three lines of position crossing on the chart as illustrated below. This identifies your position. Sometimes the intersected lines do not cross exactly and form a small triangle (known as a "**cocked hat**"). This is acceptable, and your position is then considered to be in the centre of the triangle.



Lines of position

3. Reading compass variation and deviation on small vessels and making a simple deviation card

In chart work, it is commonplace for errors to occur when navigators do not apply compass corrections. It is extremely important to remember that there are two types of corrections that need to be made in order to establish an accurate compass reading and to plot the position on a chart — **variation** and **deviation**. Variation is a function of geographic location and your relevant position to the Earth's magnetic field (a correction applied to the chart); deviation is a function of your ship's heading.

Magnetic variation

As noted earlier, the magnetic compass does not point in the direction of True North but to a point somewhere east or west of that position depending on the location of the compass on the Earth's surface. The difference between the magnetic direction of the compass and True North is called the magnetic **variation.**

On Mercator charts used in marine navigation, each section of the world that the chart represents takes into account the variation that exists for that section in order to ensure variation corrections can be made.

Using the compass rose, mariners apply the variation correction to establish a position in True north (the standard all mariners use). As variation changes according to positions on a chart, they use the compass rose closest to their position.

The variation for an area can be found by examining the differences between the compass rose's two concentric circles (magnetic and True) and the direction (east or west) of the variation. Determining variation is a simple process and must only be done once. It is stated as the difference between True North and magnetic north measured in degrees. When mariners are working on a chart or communicating with other mariners, True North positions and bearings are the standard reference used. To talk in the same language, mariners always reference degrees in True North.

For example, when correcting the chart for variation, and the compass rose indicates a variation of 4° 15' West (round the number to 4°), if you are steering a magnetic course of 145° then to provide a True course, you would simply subtract 4° from 145°, arriving at 141° True. This 4° correction applies to every course or position on the chart.

Note: How to apply east or west corrections is discussed below.

Compass deviation

A compass needle turns freely and aligns itself with the earth's magnetic field, which only works if no other magnetic interference is present. Vessels with metal structures, electronics, rigging, engines, and other natural magnetic properties can cause significant deflection on a ship's compass needle away from the earth's magnetic field: **compass deviation.** This divergence also changes as the vessel's alignment changes (e.g., vessel turning).

Depending on the position of the vessel, there will be either minimum deviation or substantial deviation of the compass. Deviation is simple to calculate but must be applied to each change in course as the compass error is unique to each of the vessel's headings and each position of each vessel. In order to establish deviation corrections, a deviation table is created by "swinging the compass," that is, taking the ship's compass readings every 15° and comparing them to known magnetic readings thus creating a deviation table that can be applied to the ships's compass.

Compass error

We have discussed compass variation and deviation; **compass error** is the sum of these two factors. Magnetic compasses aboard small vessels are used in support of position and direction travelled. A magnetic compass can take bearings to establish position and provide a course to steer. However, for any degree of accuracy and to be used in conjunction with a chart, compass error needs to be applied. A compass bearing needs to be corrected to reflect a magnetic bearing (the magnetic pole) and the chart variation needs to be applied to be able to plot a true bearing on the chart (True North).

Applying compass error

To simplify applying compass error and determine when east or west is applied, the following mnemonic is traditionally used:

CAN	**DEAD**	**MEN**	**VOTE**	**TWICE**
Compass	**D**eviation	**M**agnetic	**V**ariation	**T**rue

And applied as follows:

The vessel's **C**ompass **+** or **– D**eviation **= M**agnetic compass **+** or **– V**ariation **= T**rue North

C D M V T

or

True North **+** or **– V**ariation **= M**agnetic compass **+** or **– D**eviation **=** the vessel's **C**ompass

T V M D C

Applying direction

Compass errors can be either east or west. Since it is better to establish one rule than to memorize four rules, the simplest way is to memorize the above mnemonic. Then, when processing from **LEFT** to **RIGHT**, **ADD EAST**. From this, all other rules apply, as follows:

- If EAST is added from LEFT to RIGHT, it is subtracted from RIGHT to LEFT.
- If EAST is added from LEFT to RIGHT, WEST is subtracted from LEFT to RIGHT, but added from RIGHT to LEFT.

From magnetic compass to True:

Compass (**+ EAST D**eviation) **= M**agnetic (**+ EAST V**ariation) **= T**rue

From True to compass:

True (**+ WEST V**ariation) **= M**agnetic (**+ WEST D**eviation) **= C**ompass

Example 1

T	**V**	**M**	**D**	**C**
220°	9°E	?	2°W	?
220°	9°E	211°	2°W	213°

Example 2

C	**D**	**M**	**V**	**T**
128°	15°E	?	4°W	?
128°	15°	143°	4°W	139°W

Note: When making calculations, the variation will always be the same (in this case 4°). However, when making a course change, the deviation correction may change and must be reviewed as set out in the deviation table, as follows.

Deviation tables

A vessel will have certain magnet charateristics that do not change when the ship's heading changes. However, the vessel's magnetism will affect the compass reading with changes of the vessel's direction. In order to determine the deviation for each cardinal and inter-cardinal position, a process of "swinging the compass" is done (see Section 2). This establishes the compass descrepancies from known positions, which can then produce a deviation table that can be applied uniquely to your vessel's compass error. (Swinging a compass for larger vessels is done by professional servces.)

DEVIATION CARD 1 NAVIGATION		
Magnetic Heading	**Deviation**	**Compass Heading**
353°	6°W	000°
014°	6°W	020°
035°	5°W	040°
056°	4°W	060°
078°	2°W	080°
099°	1°W	100°
120°	0°E	120°
142°	2°E	140°
164°	4°E	160°
186°	6°E	180°
208°	8°E	200°
230°	10°E	220°
247°	7°E	240°
266°	6°E	260°
283°	3°E	280°
301°	1°E	300°
317°	3°W	320°
336°	4°W	340°
355°	6°W	360°
This table should not to be used for navigation.		

Note: The deviation is calculated at 15° or 20° intervals.

Reading a deviation table

There are two headings in the deviation table: Magnetic heading (magnetic north) and ship's compass heading (the actual compass on the ship).

For example: If you are trying to establish the ship's compass heading from a magnetic course, then simply use the left-hand column and apply the error. Looking at 045° magnetic, apply 8°W of deviation to arrive at a ship's compass course as follows:

From magnetic compass – EAST = compass course

From magnetic compass + WEST = compass course

Therefore, **045° + 8° WEST = 053° compass**

If you are establishing the ship's magnetic course from its compass reading, then you must use the right-hand column. The ship's compass heading of 210° shows that the deviation is 4° East:

From compass course + EAST = magnetic course

From compass course – WEST = magnetic course

Therefore, **210° compass + 4° EAST = 214° magnetic**

Note: The deviation correction must be applied for every course change. The variation will always remain the same.

Creating a deviation table

Creating a deviation card can determine the effects of a vessel's magnetic influences on the compass and can be done by the operator for smaller vessels.

The objective of the process is to determine and record the ship's heading for each 15° of angle of the ship's compass (all the cardinal and inter-cardinal points) and apply the difference to magnetic north. When completing each position of the swing of the vessel's compass, mariners determine the east or west error of the ship's compass and record this on a deviation chart.

Establish a transit

Where two points of land or navigation aids are lined up to establish an accurate line of position that can be determined in degrees on a chart, this is called a **transit** (similar to using the open sights on a rifle). Using the magnetic circle on the compass rose, establish on the chart the line of position you will use from the transit.

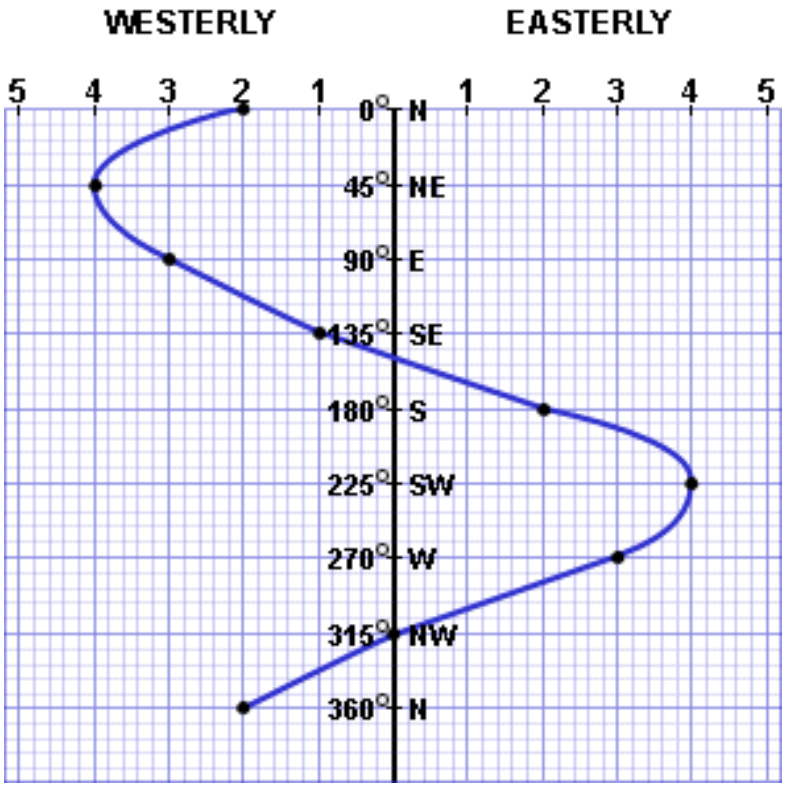
When at sea, line up your vessel to a known line of position on the transit and take compass readings of that known position. If the known magnetic bearing (taken from the chart) is 270° magnetic and your direct approach to the bearing is 265° from your vessel's compass, then you know there is a 5° deviation.

When working from True North to compass, we know that:

"**East is least, and West is best.**"

(Least meaning numerically lesser and best meaning greater.)

When working in the opposite direction, the reverse applies. Therefore, since 265° is less than 270° the deviation is 5°E. Keep your vessel in line with the transit but change angles at 15° intervals until you have completed a full circle. Record the readings and compare the results with the known magnetic reading of 270°.



You will arrive at a graph like this that illustrates the compass deviation at various ship's headings.

CHAPTER 14 REVIEW

1. What is compass error?

2. What is the difference between deviation and variation?

3. What is the rule to establish whether an east or west error needs to be applied?

4. What is the lubber line on a compass?

5. What is the purpose of a compass rose on a chart?

6. If you have a magnetic course, what do you need to do to make it a True course?

7. Fill in the blanks:

T	**V**	**M**	**D**	**C**
?	6°E	?	4°W	16°

8. Fill in the blanks:

C	**D**	**M**	**V**	**T**
?	2°E	16°	?	25°

15. The Canadian Buoyage System

Goals of this chapter

This chapter provides the student with a basic understanding of the Canadian Buoyage System and describes how to use the system to ensure safe navigation.

Learning outcomes

On completion of this chapter, students will:

- Know the Canadian Buoyage System and light-flashing characteristics
- Understand how to navigate a channel marked by lateral buoys and day beacons
- Describe the appearance and purpose of bifurcation and fairway buoys and cautionary, isolated, and special-purpose buoys
- Understand how cardinal buoys indicate the preferred passage
- Understand the significance of SCUBA diving buoys and the “diver’s flag”

1. The Canadian Buoyage System and light-flashing characteristics

Although mariners routinely use mountaintops, points of land, or fixed structures to determine their position on the water, man-made aids to navigation are of vital importance when navigating in coastal waters and entering harbours or inlets.

The Canadian Coast Guard is mandated to provide the Aids to Navigation System in Canadian waters. Aids to navigation can take a variety of forms, some simple and others more complex, all of which serve the same basic concept: the safe navigation of a vessel.

General cautions about buoys!

- Buoy colours often look different from how they appear in publications due to damage by birds or weather. Always consult your chart for detailed characteristics of any buoy.
- Never use a floating buoy as a bearing marker. Buoys are subject to tides and currents and can be out of their stated position.
- It is illegal to attach or moor your vessel to a navigational aid.
- Avoid navigating close to a floating buoy as, without other fixed markers, its position cannot be relied on.

The *Canadian Aids to Navigation System, 2011*

The Canadian Coast Guard (*Canadian Aids to Navigation System,* 2011) defines aids to navigation as: *devices or systems, external to a vessel, which are provided to assist mariners in determining position and course, to warn of dangers or obstructions or to advise of the location of the best or preferred route.*

The Canadian Aids to Navigation System is comprised of a mix of visual, aural, and electronic aids to navigation. For the purposes of this course, we will focus on the three types of buoys: lateral, cardinal, and special-purpose buoys. These buoys can be identified visually, by sound, or through electronic detection.

Visual aids: Visual aids are short-range aids to navigation including buoys, day beacons, day marks, and lights. In Canada, a combined lateral–cardinal system of visual aids is used. Knowledge of the characteristics of each of these aids is prerequisite to the safe use of the system.

Lateral aids: The lateral system of buoyage in use in Canadian waters is the International Association of Marine Aids to Navigation Lighthouse Authorities (IALA) B (explained below). Lateral aids may be in the form of either buoys or fixed aids that indicate the location of hazards, the safest or deepest water, and the safest side on which to pass.

The correct interpretation of lateral aids requires knowledge of the direction of buoyage known as “upstream direction.” Upstream direction is taken by a vessel when proceeding from seaward toward the headwaters of a river into a harbour, or with the flood tide northward (on the West Coast of North America).

When a vessel is proceeding in the upstream direction, starboard-hand aids must be kept to starboard (right) and port-hand aids must be kept to port (left).

Cardinal aids: Cardinal aids take the form of either buoys or fixed aids. However, In the Canadian system, they are predominantly buoys. Cardinal aids indicate the location of hazards and the safest or deepest water by referencing the cardinal points of the compass. The four cardinal marks (North, East, South and West) are positioned so that the safest or deepest water is found to the named side of the mark (e.g. to the north of a North cardinal mark).

Aural aids: Aural aids are sound-producing devices that warn the mariner of danger under low visibility conditions. These aids include buoy-mounted bells and whistles activated by wave action and fog-horn signals on shore. Most aural aids are operated when visibility is reduced to less than two nautical miles.

Electronic aids: The electronic aids used in the Canadian system include radar reflectors, radar beacons, and Differential Global Positioning Systems.

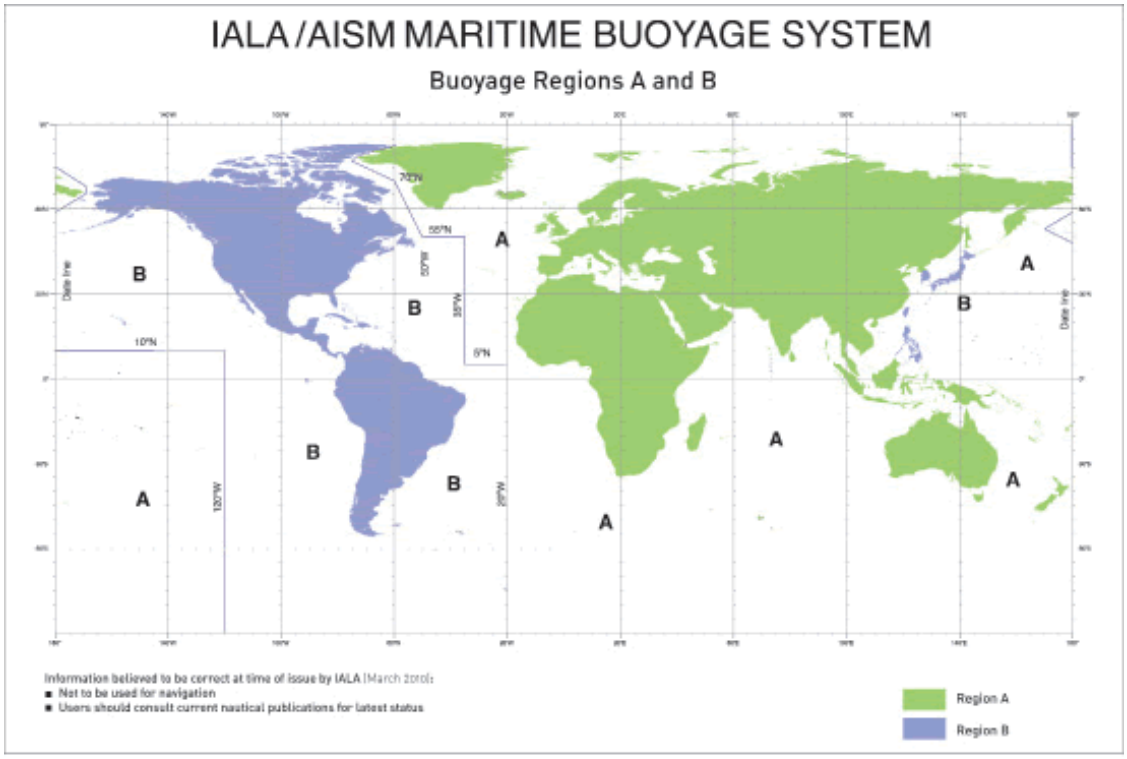
Floating aids to navigation (buoys)

The buoyage system used in Canada (*Canadian Aids to Navigation System*, *2011*) corresponds to the International Association of Marine Aids to Navigation Lighthouse Authorities (IALA) Maritime Buoyage System, which has been adopted by all major maritime nations in the world. This system includes lateral, isolated danger, cardinal, and special-purpose buoys.

Lateral buoys: the IALA System divides the world into two regions, A and B. Within **Region B**, which includes Canada, starboard-hand buoys are **red,** and port-hand buoys are **green**. (Within Region A, the application of these colours is reversed, with red to port and green to starboard.)

Bifurcation buoys are similarly affected in that the predominant colour of starboard bifurcation buoys is red in Region B and green in Region A (and that of port bifurcation buoys is green in Region B and red in Region A).

All other aspects of the IALA Maritime Buoyage System are the same in both Regions A and B.



Since the shape and/or colour of a buoy and the colour and flash of its lights indicate the function of the buoy in this system, it is essential that mariners use up-to-date nautical charts and understand the light-flashing characteristics.

Light-flashing characteristics

Aids to navigation must be identifiable during nighttime marine operations. To assist mariners, lights with distinguishable characteristics are added to identify the navigational aid**.**

To distinguish the lights' phases, it is important to understand their international definitions and meanings. The following chart illustrates the general flash characteristics of lights used on aids to navigation. The abbreviations can be found on your chart, and they should be studied and understood by every mariner.

Illustration	Chart Abbreviation	Type/Description
	F	**Fixed** Shines continuously and steadily; no dark phase.
	Fl	**Flashing** The light goes on at regular intervals; the duration of the light phases are less than the duration of the dark phases.
	Fl (2)	**Group Flashing** Groups of two flashes that are repeated several times a minute.
	Fl (2+1)	**Composite Group Flashing** A group of two flashes followed by a single flash, the entirety repeated several times a minute.
	Iso	**Isophase** All durations of light and dark are equal.
	Mo (A)	**Morse Code** Short ("dots") and long ("dashes") flashes of light are used to represent Morse code; usually flashes the letter "A."
	Oc	**Occulting** The light goes on at regular intervals; the duration of the light phases is greater than the duration of the dark phases.
	Q	**Quick (Flashing)** Very rapid flashing (more than 60 flashes a minute).

Light colour characteristics

Symbols on the chart also include colours of lights as follows: green (G), red (R), yellow (Y), and white (not noted on chart).

2. How to navigate a channel marked by lateral buoys and day beacons

Lateral aids to navigation

Lateral aids to navigation can either be fixed on land or floating. They can also be lighted or day beacons. The concept around lateral buoys and day beacons is that they mark the “sides” of the channel and more specifically which side of your vessel they are to be kept on.

North America uses the IALA System B, which stipulates that the red coloured buoy is kept to our right when returning from sea; as the saying goes:

“Red to **Right** when **Returning.”**

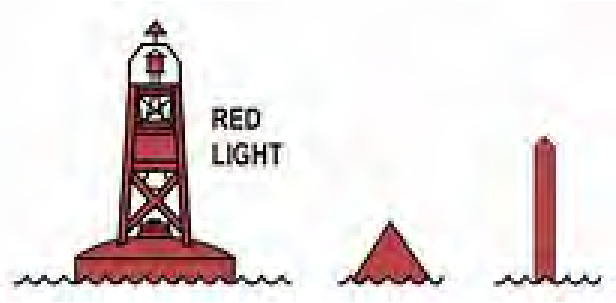
If red is to be kept to the right, which is the starboard side of the vessel, then a red lit buoy is referred to as a **starboard-hand** buoy.

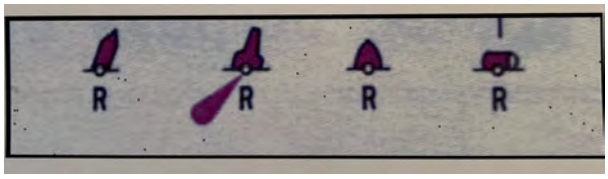
When following IALA System B, keep the starboard-hand markers (red buoys) to the right (starboard) side of the vessel when:

- Returning from sea
- Heading in an upstream direction
- Entering a harbour
- Heading north on the West Coast.

You can also determine the upstream direction by understanding that sailing in a clockwise direction around the continent and following the direction of the flood current arrow on a chart are considered upstream directions. In summary, starboard-hand lateral buoys:

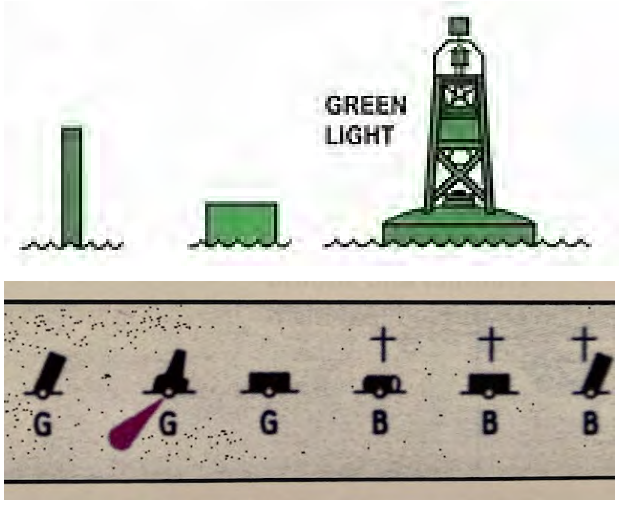
- Mark the right side of channel when proceeding upstream
- Red in colour
- Flash red when lighted
- Even numbers
- Can have a triangular top
- If carrying a light, flash red every four seconds (FL) or quick flash (every second) (Q).





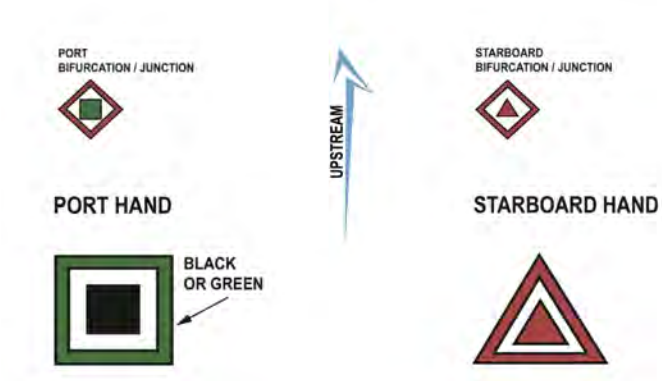
Port-hand lateral buoys

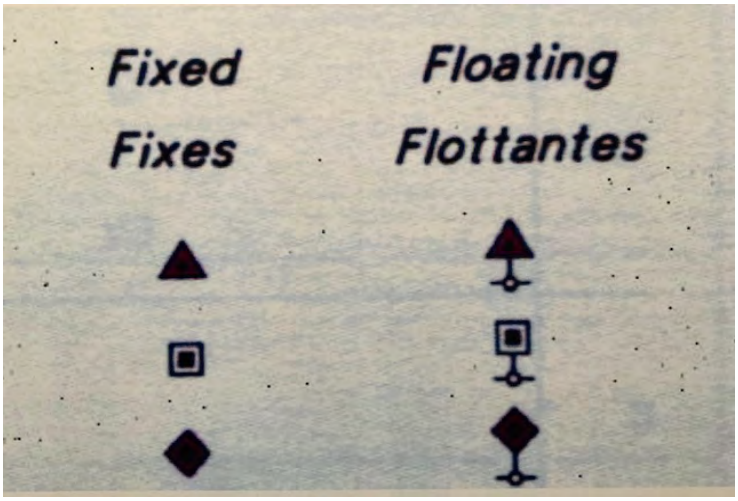
- Mark the left side of a channel
- Flat top
- Green in colour
- Odd numbers
- Flash green when lighted
- If carrying a light, flash green every four seconds (FL) or quick flash (every second) (Q).



Lateral day beacons

Lateral day beacons are used in areas where it is either not practical or not necessary to have lighted lateral markers. They will, however, have reflective tape that can be clearly seen when reflected from a light from a vessel. Day beacons have similar characteristics to lighted lateral buoys.





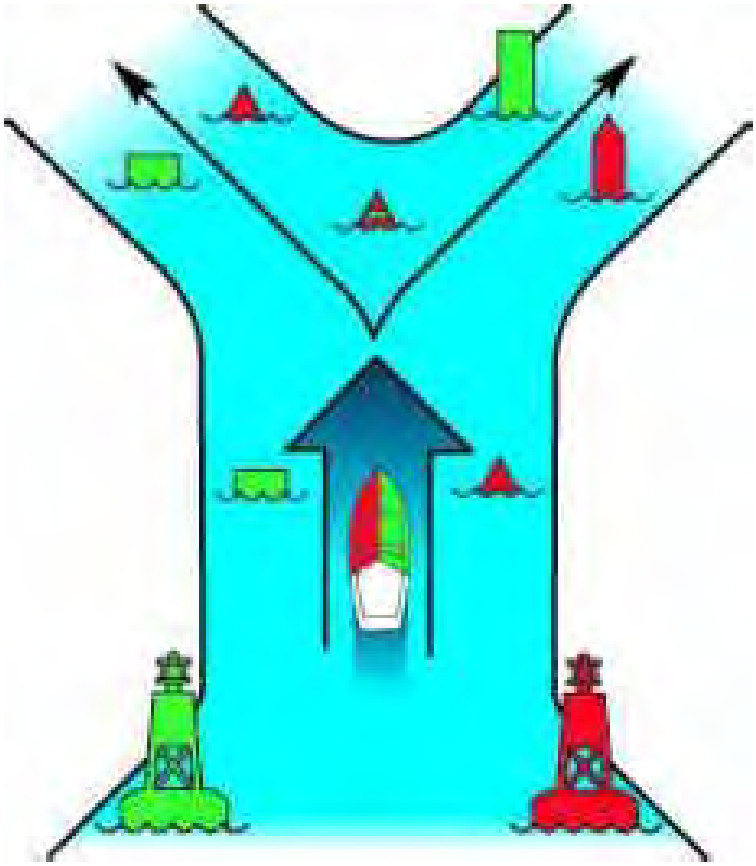
Starboard-hand day beacons

- Keep to starboard when going upstream
- Pointed tops
- Red triangular center on white background
- Red reflective borders
- Even numbers

Port-hand day beacons

- Keep to port when going upstream
- Square shaped tops
- Green reflective border
- Odd numbers

Navigating a channel



The illustration above represents a vessel proceeding in:

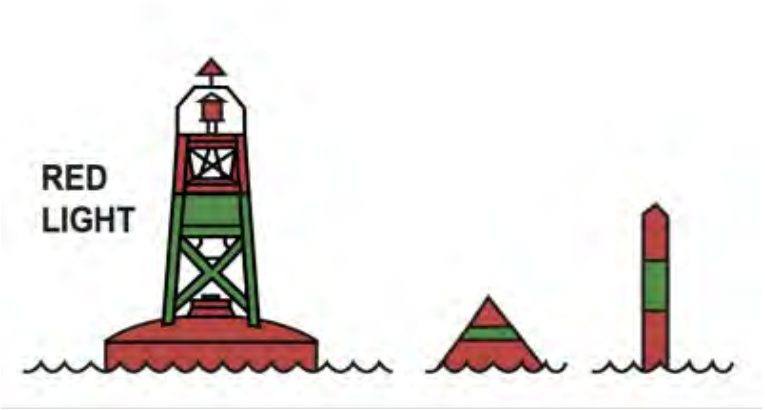
1. An upstream direction (flood)
2. Northerly on the West Coast of North America
3. Entering a harbour.

3. Bifurcation and fairway buoys and cautionary, isolated, and special-purpose buoys

Bifurcation buoys

The term "**bifurcation**" means the division of something into two branches or parts. A bifurcation buoy is similar to a lateral buoy, but also provides the mariner with two options for the preferred channel to take. A bifurcation buoy is also commonly used to direct a vessel around an obstruction.

Starboard bifurcation buoy (Canadian Coast Guard [CCG] definition)

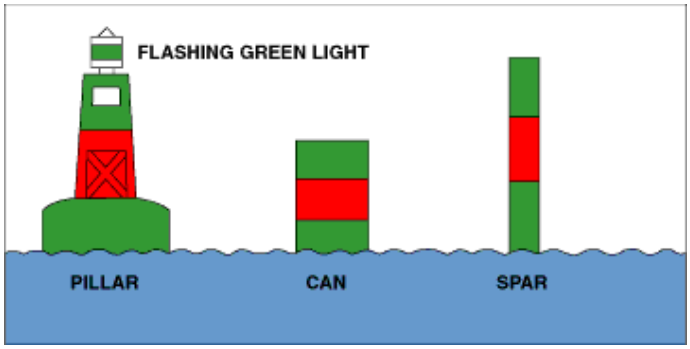


"A starboard bifurcation buoy marks the point where a channel divides when viewed from a vessel proceeding in the upstream direction and indicates the preferred or main channel is on the port (left) side of the buoy.

A starboard bifurcation buoy is coloured red with one broad green horizontal band, displays identification letter(s), and if it carries a light;

I. the light is red and is a composite group flashing Fl (2+1) 6s or Fl (2+1)10s light,
II. if it carries retroreflective material, such material is red,
III. if it does not carry a light, the top of the buoy is conical, and
IV. if it carries a topmark, the topmark is a single red cone pointing upward."

Port bifurcation buoy (CCG definition)



"A port bifurcation buoy marks the point where a channel divides when viewed from a vessel proceeding in the upstream direction and indicates that the preferred or main channel is on the starboard (right) side of the buoy.

A port bifurcation buoy is coloured green with one broad red horizontal band, displays identification letter(s), and

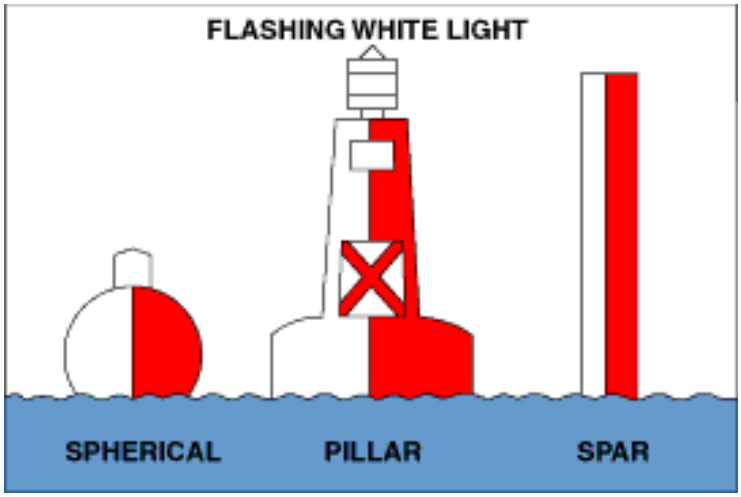
I. if it carries a light, the light is green and is a composite group flashing Fl (2+1) 6s or Fl (2+1) 10s light,
II. if it carries retroreflective material, such material is green,
III. if it does not carry a light, the top of the buoy is flat, and
IV. if it carries a topmark, the topmark is a single green cylinder."



Lateral and Bifurcation Buoy in North America

The illustration above shows direction for vessels using the IALA B (North American) system with lateral and a bifurcation buoy buoyage to proceed in an upstream or downstream direction.

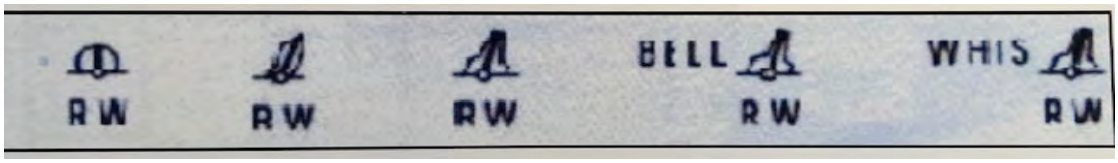
Fairway buoy (CCG definition)



“A fairway buoy indicates safe water. It is used to mark landfalls, channel entrances, or the centre of a channel. It may be passed on either side but should be kept to the port (left) when proceeding in either direction.

A fairway buoy is coloured red and white in wide vertical stripes of equal widths, displays identification letter(s), and

I. if it carries a light, the light is white and is either a Morse ‘‘A’’ Mo (A) 6s light or a long flash (LFl) 10s light,
II. if it carries retroreflective material, such material is white,
III. if it does not carry a light, the top of the buoy is spherical, and
IV. if it carries a topmark, the topmark is a single red sphere. “



Isolated danger buoys (CCG definition)

“An isolated danger buoy is moored on, or above, an isolated danger which has navigable water all around it.

An isolated danger buoy is black with one broad red horizontal band, displays identification letter(s), and

I. if it carries a light, the light is white and is a group flashing Fl (2)5s or Fl (2) 10s light
II. if it carries retroreflective material, such material is white,
III. if it does not carry a light, it is normally spar shaped although other shapes may be used, and

IV. if it carries a topmark, the topmark is two black spheres, one above the other.“



Special-purpose buoys

Special-purpose buoys are used to communicate specific information to the mariner and are not specifically used to assist in navigation. The shapes and colours of these buoys have no specific meaning; however, they flash yellow lights once every four seconds. The exception is ODAS (Ocean Data Acquisition) buoys, which flash five times every 20 seconds.

Where special-purpose buoys display retro-reflective material, it is usually yellow. A buoy displaying an orange symbol indicates a hazard, and it will also display orange reflective tape.

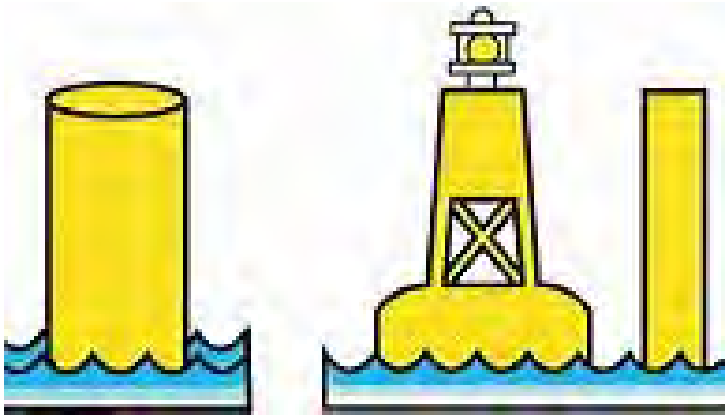


ODAS Buoy

An **ocean data acquisition system** (**ODAS**) is a buoy with a set of instruments deployed at sea to collect meteorological and oceanographic data

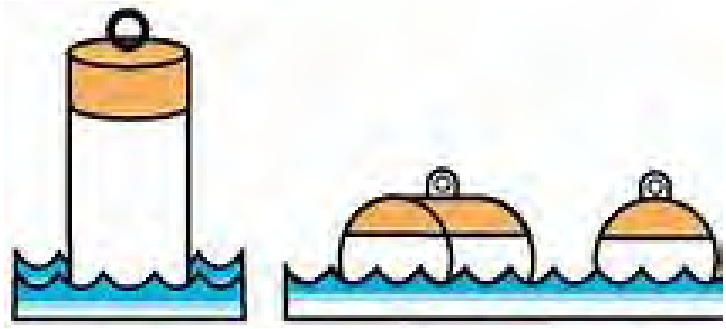
Cautionary buoys

A cautionary buoy warns the mariner of danger or precautions to be taken relative to a specific area.



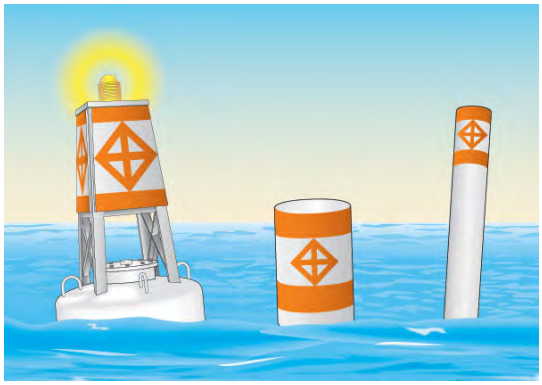
Mooring buoys

These indicate an area designated for vessels to secure.



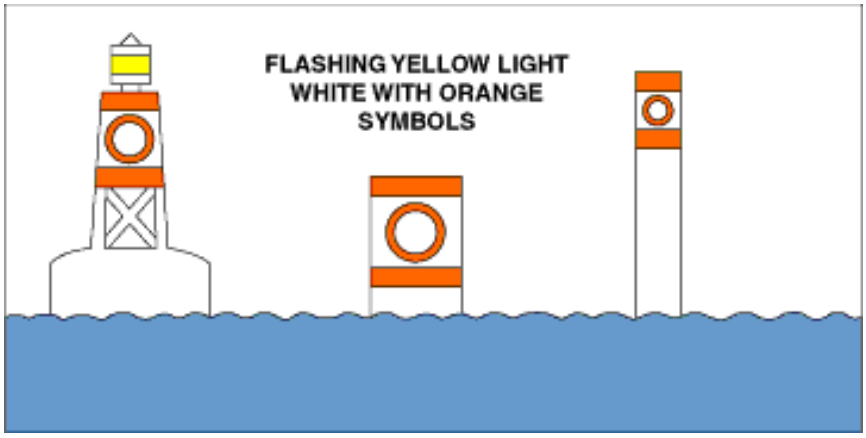
Control buoys

A control buoy marks and boundaries where vessels are restricted.



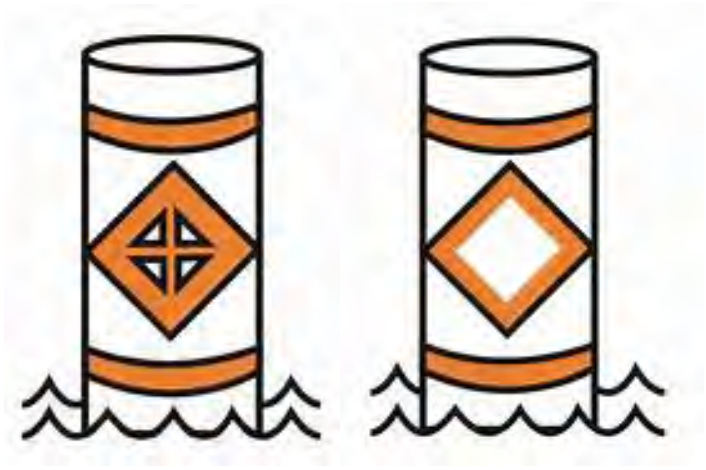
Information/hazard buoys

An information buoy provides information to the mariner regarding the specifics of an area.



Hazard buoys

A hazard buoy identifies hazards such as shoals and/or reefs specific to an area.



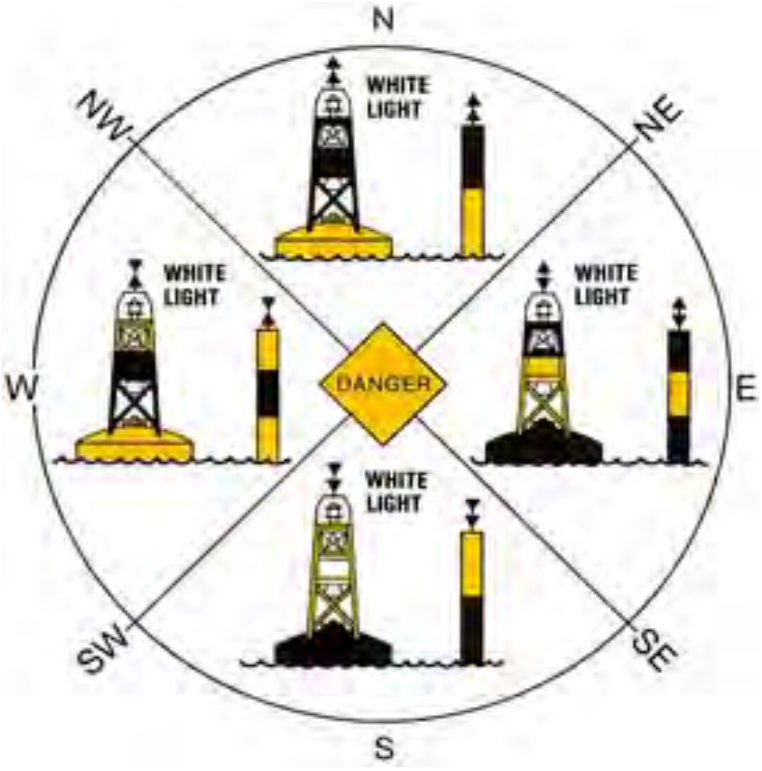
“Keep out” buoys

Vessels are not permitted in this area.

4. Cardinal buoys indicating preferred passage

Cardinal buoys are designed to identify the direction of safe water by pointing out the relative position of danger. This is accomplished by referring to the four cardinal points of North, South, East, and West.

For example, a South cardinal buoy will indicate to a mariner that the safe water is to the south of the buoy and therefore the danger lies to the north. Cardinal buoys are coloured black and yellow and fixed with a white flashing light on top. How the strips of colour are placed on the buoy and the flashing characteristics of the light indicate the cardinal position and direction of safe water.



North cardinal buoys

- Indicate safest water is to the north of the buoy.
- Coloured evenly between black (top) and yellow (bottom).
- The light is white and displays a quick flash (Q) or very quick flash (VQ).
- Topmark: two black cones above each other pointing upwards.

East cardinal buoys

- Indicate safest water is to the east.
- Coloured black with a yellow band in the middle.
- If lighted, a group flashing of three very quick flashes VQ (3).
- Topmark: two black cones on top of each other with base to base.

South cardinal buoys

- Indicate safest water is to the south.
- Coloured equally between black and yellow with the bottom half being black.
- If lighted, the light flashes white with a quick group of six flashes with one long flash QF (6) = LF (1) or very quick flashing of six flashes with one long flash VQ (6) + LF (1).
- Topmark: two black cones one above the other pointing downwards.

West cardinal buoys

- Indicate safest water is to the west.
- Coloured yellow with a black band in the middle.
- If lighted, a group flashing of 9 quick flashes Q (9) or very quick flashes VQ (9).
- Topmark: two black cones on top of each other with point to point.

Helpful tips

To remember the markings and flashing sequences:

Flashes: The flashing sequence of a cardinal buoy closely matches the time markings on a clock. The only difference is north, which flashes continuously. The remaining positions are the same:

- 3 o'clock = 3 flashes (east cardinal)
- 6 o'clock = 6 flashes (south cardinal)
- 9 o'clock = 9 flashes (west cardinal)

Topmarks: This is another memory aid to identify the cardinal direction of the buoy. North and south are fairly easy—they point either up or down, which readily identifies the buoy. As illustrated below, placing an "E" or "W" in the remaining topmarks will help distinguish the cardinal position.



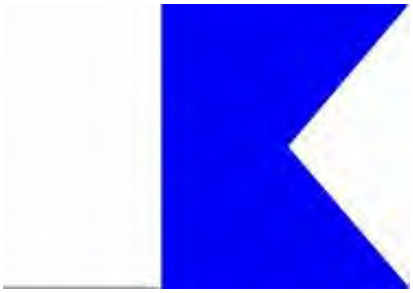
5. The significance of SCUBA diving buoys and the "diver's flag"

Diving buoys and flags

The Collision Regulations under rule 27 and the Canadian Safe Boating Course, consistent with the *Canada shipping Act,* specify that the International diving flag "Alpha" (usually blue-and-white) must be displayed by any vessel conducting diving operations in Canadian waters, whether the diving is done for pleasure or commercial purposes.

The *Canadian Aids to Navigation* also recognizes the use of the more common red-and-white flag on a buoy. (You will also see the red-and-white flag displayed on vessels.) It is more likely that mariners will see the red-and-white flag used for sports divers and the Alpha flag for commercial operations. **Note:** The red-and-white flag is common only in North America and nowhere else.

The are no specific regulations that indicate how far a vessel must keep away from diving operations, nor does the regulation state how far a diver must be from the diving buoy or flag. Transport Canada recommends that the vessel stay at least **100 metres** from any diving operation. Practicing good seamanship is always the best way to proceed.



Alpha



Pleasure diving

Meaning for both flags:

"I have a diver in the water, keep well clear and at low speed."

CHAPTER 15 REVIEW

1. What does FL (2+1) G mean, and what aid to navigation does it represent?

2. How are the top markings of a west cardinal buoy presented, and what is the flashing sequence?

3. Name three types of special-purpose buoys and describe their purpose.

4. Explain how the lateral buoyage system works in Canada.

5. How does a cardinal buoy protect the mariner from danger?

6. Describe a fairway buoy and the purpose it serves.

7. What light colours are used for special-purpose buoys?

8. Define “upstream direction.”

9. What is a bifurcation buoy?

16. Dealing with emergency situations

Goals of this chapter

This chapter provides students with a basic understanding of measures to be taken in emergency situations on a small vessel.

Learning outcomes

After completing this chapter, students will be able to identify:

1. Measures to be taken in emergency situations such as: collision, grounding, flooding, fire, man overboard, and release of a polluting substance or liquid
2. Measures to be taken to ensure protection and safety of crew members and passengers in emergency situations
3. The master's obligation regarding initial and subsequent reports to be made in case of a marine emergency event

1. Measures to be taken in emergency situations

General measures

An **emergency** can be defined as an incident that has occurred that presents serious and dangerous consequences to both the safety of the ship and its crew and passengers. Emergencies at sea can be more devastating than on land because ships are isolated from other resources. Apart from identifying an emergency (which is equally important), the most important factor in resolving an emergency situation is to have an action plan; however, an action plan that is not clearly understood and practiced repeatedly by the ship crew has little value.

The vessel: Emergencies can happen in calm weather with great visibility, and nevertheless have dire consequences for the safety of the ship in a matter of seconds. The only thing separating the crew and the ocean is the vessel. Therefore, ensuring the vessel and her equipment (both operational and safety) are maintained, repaired, and inspected routinely is critical to the vessel and crew's overall safety.

The Master and crew: are responsible for maintaining the vessel and practicing the skills necessary for the overall safety of the vessel. As mentioned in previous chapters, it is critical for the Master and crew to ensure that a pre-departure check is completed. The idea behind the checks is to make sure there are no surprises and that the critical systems on board the vessel are functioning properly, that the lifesaving equipment is ready and available for use, and that the vessel is secure for sea.

Protocols and procedures: Emergencies can include a variety of situations but generally include: collisions, grounding, flooding, fire, and man overboard. Depending on the vessel's function, operational area, design, and personnel on board, the protocol and procedures used to address each emergency situation will vary; however, the common theme and philosophy will not change: address the emergency expediently, aggressively, orderly, and under the protocols established for your vessel.

Below are some basic procedures used in the various emergencies that a vessel may encounter. You should have protocols specific to your vessel.

Note: Common to all emergencies will be to sound the alarm, verbally or by other means. **Life jackets should also be donned in all emergencies unless in situations where the lifejacket interferes with the ability to respond to the emergency.**

Collisions

- Sound the alarm and advise.
- Ensure the Master and all crew advised (it is the Master's job to lead).
- Close all watertight hatches, doors, and other openings to minimize flooding.
- Gather crew and passengers and assess injuries.
- Transmit radio broadcast with clear and concise information on position, damages/injuries, and what assistance is required.
- Control the vessel and assess what movements are required, if any.
- Assess damage and repair or minimize flooding if able. If the vessel is sinking, the master will prepare and order the abandon ship directive.
- Distribute life jackets and dispatch life raft.

Groundings

- When a grounding has occurred, immediately stop all engines.
- Sound the alarm to notify all crew and proceed to emergency stations.
- Assess damage including structural integrity of the vessel's hull, fuel tanks, ballast, and other critical systems.
- Dispatch radio broadcast if warranted with position, damage assessment, and what aid, if any, is required.
- Exhibit "aground vessel" shapes and lights.
- Once damage is assessed, consider an action plan for vessel refloating considering tide, current, weather, and if the vessel will require floatation or towing.

Flooding



- When detected, sound the alarm.
- Ensure the Master is notified (he/she will lead the emergency response).
- All watertight doors and hatches should be closed.
- Engines should be slowed down or stopped.
- Crew should muster to damage-control stations.
- Damage should be assessed, and an action plan formulated.
- Consider dispatching radio broadcast re: position, situation, damage, and what assistance is required.
- If there is the possibility of the vessel sinking, life raft and other live-saving equipment should be at the ready.

Fire



- Sound the alarm and inform the Master.
- Attempt to extinguish the fire immediately, if possible.
- Crew to muster to emergency stations.
- Close all ventilation hatches, doors.
- Position the vessel so that the smoke does not impede firefighting.
- Dispatch radio broadcast with position, situation, and what help is required.
- Fight the fire aggressively.

Man overboard



- The crew member that identifies the man overboard must immediately sound the alarm and point to the position of the man overboard and must not lose contact with the victim.
- The spotting crew member should launch a lifebuoy with its light or smoke activated to assist in marking the general position of the victim.
- The Master will direct the maneuvering of the vessel to retrieve the victim while the lookout continues to report the relative position of the victim.
- Dispatch radio broadcast with position, situation, and assistance required, if any.
- Treat the victim once recovered to the vessel.

Release of pollutant substances or liquids



- It is illegal to accidentally or willfully discharge oil, garbage, sewage, or other pollutants into Canadian waters without reporting the incident. Even if reported, you may be held responsible for the cost of cleanup.
- The law requires polluters to report a spill to the Canadian Coast Guard. Failure to report a spill may result in heavy fines.
- If you are responsible for a spill or view another vessel polluting, you must provide the following information:
    - Your name and contact information
    - When and where the pollution occurred
    - The type of discharge or description of the product
    - The extend of pollution or area covered
    - The name of the vessel or other source
- The CCG will contact the owner and take steps to remove the pollution.

2. Protection and safety of crewmembers and passengers in emergency situations

Crew proficiency

Pursuant to Transport Canada regulations, every vessel in Canada must have enough crewmembers to perform the tasks necessary for the safety of the vessel and the passengers on board during its voyage. The crew must be trained and competent to perform the tasks necessary to respond and mitigate an emergency.

The safety of the vessel, crew, and passengers also depends on all persons aboard knowing the safety procedures and having the ability to locate and use the safety equipment quickly and properly when needed.

Life-saving equipment

Since the purpose of life-saving equipment is in support of an emergency to mitigate the situation for both crew and passengers, all life-saving equipment must be at the ready and fitted on the vessel where it can be quickly dispatched. Some of this equipment includes:

- Lifejackets available for all passengers including children
- Life rafts in the event of the Master's order to abandon ship
- Lifebuoys and heaving lines used for man overboard situations
- Distress alerting equipment: flares, strobes, smoke
- VHF radio: all crew should be trained in radio signaling a distress
- Locating devices: EPIRB (electronic position indicator radio beacon)
- Fire extinguishers and other firefighting equipment

Establishing emergency evacuation procedures

Transport Canada's *Life Saving Equipment Regulations* require that within 30 minutes of when the abandon ship alarm is sounded, all passengers and crew must be able to disembark a vessel. The regulation mandates that all passenger vessels have an evacuation plan that provides direction on how passengers and crewmembers will be evacuated from the vessel. However, Transport Canada does not provide a process to confirm that the evacuation plan meets the requirements listed.

It is recommended that owners/operators of vessels establish their own evacuation plans and discuss their plan with a TC inspector who can provide guidance, direction, and approval.

Briefings and passenger list

From a practical standpoint, all passengers prior to embarking on a vessel should be given a safety briefing. The briefing should include the location of the life jackets, the exits, and muster stations in the event of the ship's evacuation alarm procedures being implemented.

Passengers are required to know their onboard responsibilities and procedures that will help them to adapt to the emergency in a controlled way and avoid panic, and which allows the trained crew to deal more effectively with the situation.

A complete list of passengers and children should be recorded as they board the vessel.

Crew training for passenger management

In an emergency situation, crewmembers follow their training specific to the emergency at hand, but this changes when passengers are involved. Drills and training associated with specific emergencies do not deal with crowd control or crowd management. *Passenger Safety Management Certificates* are issued for larger vessels. Smaller vessel training is provided through Domestic Vessel Safety Training.

3. Master's obligation regarding initial and subsequent reports of a marine occurrence

The *Transport Safety Board Regulations* state:

"3 (1) The operator of the ship, other than a pleasure craft, whether or not they are the owner, the master, the ship's pilot, any crew member of the ship and the harbour master, that have direct knowledge of a marine occurrence must report the following marine occurrences to the Board:

- (a) a person is killed or sustains a serious injury as a result of

  (i) boarding, being on board or falling overboard from the ship, or
  (ii) coming into direct contact with any part of the ship or its contents;
- (b) a person falls overboard from the ship;
- (c) a crew member whose duties are directly related to the safe operation of the ship is unable to perform their duties as a result of a physical incapacitation which poses a threat to the safety of persons, property or the environment;
- (d) the ship

  (i) sinks, founders or capsizes,
  (ii) is involved in a collision or a risk of a collision,
  (iii) sustains a fire or an explosion,
  (iv) goes aground,
  (v) makes unforeseen contact with the bottom without going aground,
  (vi) sustains damage that affects its seaworthiness or renders it unfit for its purpose,
  (vii) is anchored, grounded or beached to avoid an occurrence,
  (viii) is missing or abandoned,
  (ix) fouls a utility cable or pipe, or an underwater pipeline,
  (x) sustains a total failure of
    - (A) the navigation equipment if the failure poses a threat to the safety of any person, property or the environment,
    - (B) the main or auxiliary machinery, or
    - (C) the propulsion, steering, or deck machinery if the failure poses a threat to the safety of any person, property or the environment;
- (e) all or part of the ship's cargo shifts or falls overboard; or

- (f) there is an accidental release on board or from the ship which results in any of the events listed in subsection 8.4(2) Transportation of Dangerous Goods Regulations."

Summary: Though this information applies more specifically for larger ships it is still incumbent upon you to report the above-noted incidents. The *Transport Safety Board Regulations* require that the above-noted incidents are reported in a timely fashion and as soon as possible with all relevant details of the incident. To best understand the reporting requirements, visit the *Transportation Safety Board Act*.

CHAPTER 16 REVIEW

1. How many life jackets are required to be kept onboard a 30-foot vessel?

2. What training do new crew members require before being considered prepared for their duties?

3. Who is responsible for ensuring the above noted training requirements are met?

4. What is the maximum time that Transport Canada requires all passengers and crew take to abandon ship once the order is given by the Master?

5. Name five items of life-saving equipment that can be used during an emergency at sea.

6. If you are the Master of your vessel and responsible for an oil spill, what are your responsibilities, what must you report, and to whom?

7 Name five common emergencies that can occur at sea.

17. Search and rescue resources

Goals of this chapter

This chapter provides the student with a basic understanding of the search and rescue resources (SAR) available to the Master and crew in the event of an emergency where SAR assistance is needed.

Learning outcomes

On completion of this chapter, students will:

1. Know the search and rescue resources available in the area of operation
2. Know the marine SAR coordination system in the operational area
3. Understand what happens after a distress call is initiated
4. Recognize distress, urgency, and routine prefixes on VHF radio
5. Understand mariners' responsibilities when hearing or responding to a distress call

1. Search and rescue resources available in the area of operation

In previous chapters, we have discussed the need to prioritize safety protocols, emergency drills, navigation, pre-departure checks and a myriad of other skills required to keep the safety of the vessel, crew, and passengers intact.

As Master of the vessel, you may encounter a situation in which the skills and experience you have acquired will not be sufficient to mitigate an emergency and require you to reach out for additional assistance. Knowing which resources are in your area and when and how to ask for assistance are critical skills that you need to master.

Maritime search and rescue (SAR) has a deeply rooted history in Canada, beginning at the local community level. When a fishing vessel did not return home from sea, the entire community would immediately mobilize their own search and rescue efforts to locate the missing. The internationally famous West Coast Trail between the towns of Port Renfrew and Bamfield on the West Coast of Vancouver Island was created as a rescue route for shipwrecked sailors.

There are now many search and rescue organizations, both ground-based and at sea, that comprise thousands of volunteers and government services that respond to SAR related matters. These organizations include: the Canadian Coast Guard (CCG), Royal Canadian Marine Search and Rescue (RCMSAR), the Canadian Armed Forces, RCMP, the Federal Parks Service, municipal and provincial police services, fire departments, and many other volunteer organizations.

BC inland marine SAR resources

Ground SAR: The BC Search and Rescue Association (BCSARA) represents approximately 80 ground SAR groups in BC. Ground SAR is an important asset for mariners to consider, as a marine rescue can also require ground SAR support. There are over 2,500 ground SAR volunteers in BC responding to over 1,600 incidents a year. Ground SAR members are deployed to assist government agencies mandated for Ground SAR operations. These groups are often equipped with small vessels that service inland waterways, lakes, rivers, and marine shorelines.

Inshore Rescue Boat Service Program: As part of a summer student program, CCG and the Canadian Navy Reservists are trained and assigned to the Inshore Rescue Boat Service across Canada. Participants provide help to mariners in need of assistance or in distress on inland waters.

RCMP, DND, and other police services: Police services are mandated to provide SAR services and have personnel trained to deal with SAR operations

requiring specific skill sets such as dive teams and white water and ice rescue teams. Military aircraft through the Department of National Defense (DND) have a mandate to support inland searches. Volunteers through flying clubs also provide air SAR support in inland communities.

BC Emergency Management Services (BCEMS): BCEMS is the framework within BC that coordinates ground SAR operations and organizes resources to tackle other emergencies. This can include search and rescue operations that require additional resources from outside a local region.

BC coastal marine SAR resources

Marine SAR operations in Canada is a mandate of the Federal government and involves several agencies including: the Canadian Coast Guard, Canadian Coast Guard Auxiliary (volunteers), BC Royal Canadian Marine Search and Rescue (BCRCM-SAR) (volunteers), the Department of National Defense, and the RCMP. Local municipal police and fire services will also respond to SAR related emergencies when requested from BCEMS.

Under the national SAR program, the CCG and DND coordinate all marine and air SAR operations through the Joint Rescue and Coordination Centres (JRCC). These rescue centres can be found at three locations across the country to support Canada's response to SAR emergencies (more on this further in this chapter). The CCG provides oversight to the Coast Guard Auxiliary units and BCRCM–SAR.

The CCG has the primary mandate of maritime SAR operations in Canada and have primary and secondary vessels for response in SAR operations. CCG lifeboat stations are located along areas of the coast deemed high-risk for SAR operations. These stations are equipped with specialized vessels designed for emergency response and are manned on a continuous state of readiness. Other vessels within the CCG fleet have SAR responsibilities as a secondary mandate.



CCG lifeboat

BCRCM–SAR and CCG Auxiliary

The CCG Auxiliary provides volunteer and seasonal marine rescue operations in all other parts of Canada except BC. The BCRCM–SAR falls under the CCG and provides year-round voluntary marine SAR support for coastal and inland waters for BC. BCRCM–SAR operates 33 stations along the coast supported by over 1,000 members. BCRCM–SAR members provide continuous coverage throughout the year as marine activities along the BC coastline operate yearlong.



BCRCM–SAR vessel (Sidney)

DND, Parks Canada, and the RCMP

DND's ships and Royal Canadian Air Force, RCMP, and Parks Canada participate in Canada's shared responsibility for national search and rescue operations.









Vessels of opportunity

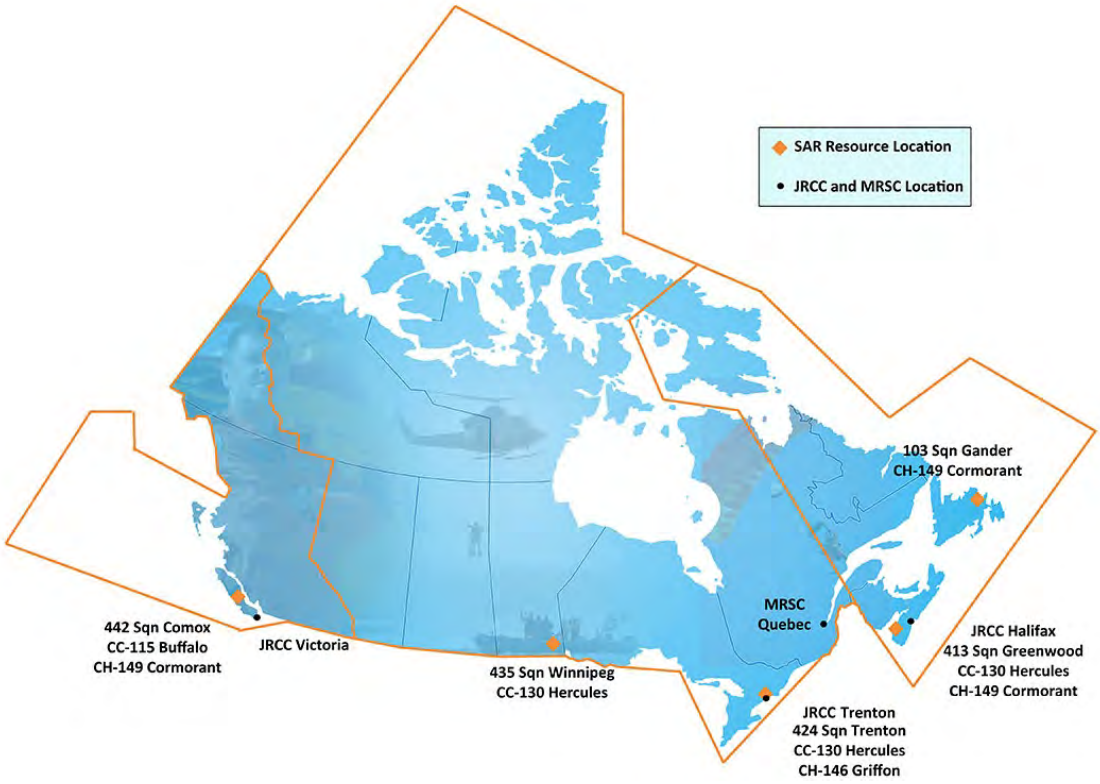
Under the Canada Shipping Act and international law, every vessel at sea is required to assist (if capable) in a distress situation. A vessel of opportunity is considered any other vessel, pleasure craft or otherwise, that is not mentioned above.

2. Marine SAR coordination systems in the operational area

The primary goal of the SAR coordination system across Canada is to save lives that may be at risk. As already discussed, Canada's response to SAR activities both on the ground and at sea is through an integrated approach supported by federal, provincial, local, and volunteer assets.

Joint Rescue Coordination Centres (JRCC)

Canada's Minister of National Defense is the lead Minister responsible for coordinating air and marine SAR operations. The DND coordinates SAR through three distinct centres across Canada: Halifax, Nova Scotia, Trenton, Ontario and Victoria, BC. Each centre is staffed by DND and CCG personnel responsible for coordinating air and sea SAR incidents throughout all regions of Canada. The JRCC staff evaluate information and activate the SAR response utilizing both government and non-government resources as required.



Marine Communications and Traffic Centres (MCTS)

The Canadian Coast Guard operates 12 marine communication and traffic services (MCTS) across the country. The objective of the program focuses primarily on distress, urgency, and safety and also includes safety of life at sea, contributing to the efficiency and safety of navigation and the protection of the marine environment.

The services provided include:

- Safety radio communications services
- Vessel traffic services and regulation
- Screening of vessels entering Canadian waters
- A 24/7 commercial marine telephone call service

The safety radio-communications service provides a comprehensive system of terrestrial VHF radio facilities to allow the mariner to have radio communications with MCTS centres.

VHF radio channel 16 is the distress channel monitored by MCTC. It is for EMERGENCY and CALLING purposes only. Never use this channel for a conversation with another vessel**.**

Cellular phones are not considered a reliable substitute for a VHF radio. Cellular coverage may not exist in your area of operations. It is not an approved method of sending a distress and does not alert other vessels to your situation.

3. After a distress call is initiated

Distress communications

Mariners can signal distress by using visual, electronic, and/or audible distress signals. The International Collision Regulations have established recognized distress signals including messaging, flares, flags, lights, and sounds.

Included in the list is the use of electronic signaling including VHF radio, DSC (Digital Select Calling), and EPIRB (Electronic Positioning Indicator Radio Beacon). These electronic devices are integrated with SAR satellites and terrestrial stations to allow mariners to alert others of their distress, identity, and position.

False distress signals

Initiating a distress signal is a serious matter. Upon the activation of the signal a myriad of SAR resources will be dispatched for a rescue. It is an offense to knowingly send or cause to be sent any false or fraudulent signal.

Mariners must be tested and licensed to operate a VHF radio in the proper manner and pursuant to established protocols.

GMDSS (Global Maritime Distress and Safety System)

The GMDSS is a system of integrating satellite, shipboard radio systems and ground stations set up to capture an electronic distress signal emitted by a vessel in distress. The integrated system increases the means of locating survivors by a quick alert and deployment system of resources in the area. The SOLAS (Safety of Lives at Sea) requires all vessels over 300 gross tons and all passenger ships on international voyage to be fitted with GMDSS equipment. Many pleasure and smaller commercial vessels also fit their vessels with GMDSS equipment. Components of the GMDSS system include:

- EPIRB (emergency position-indicating radio beacon)
- NAVTEX (automated International marine safety messaging, distress, and weather warning system)
- Satellites
- High frequency radio
- SAR location devices
- DSC

Distress detection: COSPAS–SARSAT

This distress detection system uses orbiting search and rescue satellites that pick up distress signals emitted from beacons such as EPIRBs (marine), ELT (emergency location transmitters) (aviation) and PLB (personal locator beacons). The beacons transmit radio signals on 406 MHz that are detected by the

COSPAS–SARSAT satellites and transmitted to the appropriate rescue coordination centres for SAR deployment. These satellites are supported by Canada, the US, Russia, and France.



Electronic positioning indicator beacon (EPIRB)

The EPIRB is a vessel distress beacon that should be on every vessel. The COSPAS–SARSAT detects emergency radio beacons on signals 121.5MHz and 406 MHz. Each EPIRB is registered with its own unique identification number (MMSI), providing information on the owner, type of vessel, and country of origin.

When activated, the ERPIB sends a one-way distress signal to the SAR satellites identifying its position, vessel, and identification. EPIRBs can be water activated or manually activated. Depending on the model, an EPIRB will emit a signal for up to 48 hours. An EPIRB is detachable from the vessel and would be taken in a life raft if the vessel is abandoned.



EP indicator beacon

Search and rescue transponder (SART)

A search and rescue transponders are typically fitted on survival crafts. It emits a frequency designed to be detected by ship and aircraft radar. This device operates in close range and creates a series of dots on a radar screen.



SAR transponder

Beyond VHF radio distress

A marine VHF radio is mandatory communication device in areas that are covered by VHF. When operating outside a VHF area you must employ other means of two-way communications. A radio distress may be accomplished by two methods:

Digital Selective Calling (DSC): DSC has become the standard for distress calling by providing pre-defined digital messages via marine radio frequencies. It has a longer range than analog and includes your identity, a description of your vessel, and its position. The DSC is an alerting device and automatically alerts

vessels in VHF range of your distress. Once the signal is received and acknowledged, other vessels can activate voice communications.

DSC–VHS radios must be registered with a nine-digit number (Marine Mobile Service Identity Number- MMSI) that acts as a digital radio call sign.

Most VHS radios are now equipped with the red-capped DSC button.

Pushing a button on your VHF radio for five seconds sends a mayday distress signal. When connected to a GPS, the signal also sends the vessel position and identity. Once this DSC signal is sent, it will continue until it is acknowledged by another DSC radio.



4. Distress, urgency, and routine prefixes on VHF radio

General Radio Operating Procedures, Canada

This section refers to the *General Radio Operating Procedures* for the use and proper protocols of a VHF radio and the priority of communications from a distress message to all other VHF communications. (This section is *not* a substitute for instruction and certification for *Restricted Operators Certification* and will focus on established protocols for distress messages.)

The order of priority for the transmission of messages is:

1. Distress communications
2. Urgency communications
3. Safety communications
4. All other communications

Emergency conditions

Emergency conditions are classified in accordance with the degree of danger or hazard as follows:

Distress: A condition of being threatened by grave and/or imminent danger and requiring immediate assistance.

Urgency: A condition concerning the safety of an aircraft or other vehicle, or of someone on board or within sight, but which does not require immediate assistance.

Safety: An indication that the station calling is about to transmit a message concerning the safety of navigation or important meteorological warnings.

Distress, urgency, and safety procedures are outlined in regulations and are designed primarily for the aeronautical and maritime services. Use of these types of communications in the land mobile service are very rare.

Distress signals

In radiotelephony, the spoken word for distress is "mayday," and it should be used at the commencement of the first distress communication.

The distress signal indicates that a person or station sending the signal is:

1. threatened by grave and imminent danger and requires immediate assistance, or
2. aware that an aircraft, ship, other station or person is threatened by grave and imminent danger and requires immediate assistance.

The distress call has priority over all other communications

The distress call identifies the station in distress, and such calls shall only be sent on the authority of the person in command of the station. The distress call should comprise:

1. The distress signal "MAYDAY" spoken three times
2. The words "THIS IS"
3. Call sign of the station in distress spoken three times.

Distress message

The distress message shall follow the distress call as soon as possible.

The distress message should include as many as possible of the following elements spoken distinctly and, if possible, in the following order:

1. The distress signal "MAYDAY"
2. Call sign of the station in distress (once)
3. Nature of the distress condition and the kind of assistance required (i.e. what has happened)
4. Intentions of the person in command
5. Particulars of its position (location, airspeed, altitude, heading)
6. Number of persons on board and injuries (if applicable)
7. Any other information that might facilitate the rescue
8. Call sign of the station in distress.

Example:

MAYDAY - X 3
THIS IS - MV FATHOM X 3
RAN AGROUND
VESSEL SINKING

ABANDONING SHIP
POSITION: NORTH COD REEF (LAT AND LONG)
FOUR PERSONS ON BOARD - NO INJURIES
MV FATHOM

Repeat the message at intervals until an answer is received or it is no longer feasible to continue.

Action by station in distress

When a station is threatened by grave and imminent danger, and requires immediate assistance, the person in command should direct appropriate action as follows:

1. Transmit the distress call.
2. Transmit the distress message.

3. Listen for acknowledgement of receipt.
4. Exchange further distress traffic as applicable.
5. Activate automatic emergency equipment (emergency locator transmitter EPIPB) if available and when appropriate.

5. Mariners' responsibilities when hearing or responding to a distress call

Action by stations other than the station in distress

A station that is not in distress should transmit the distress message when:

1. the station in distress is not in a position to transmit the message, or
2. the person in command of the station that intervenes believes that further help is necessary.

When a distress message is received and it is known that the affected station is not in the immediate vicinity, sufficient time should be allowed before the distress message is acknowledged. This will permit stations nearer to the station in distress to reply.

Action by other stations hearing a distress message

1. Continue to monitor the frequency on which the distress message was received and, if possible, establish a continuous watch on appropriate distress and emergency frequencies.
2. Notify any station with direction-finding or radar facilities and request assistance unless it is known that this action has been, or will be, taken by the station acknowledging receipt of the distress message.
3. Cease all transmissions that may interfere with the distress traffic.

Relay of a distress message

A distress message repeated by a station other than the station in distress shall transmit a signal comprised of:

1. The signal, "MAYDAY RELAY" (spoken three times)
2. The words "THIS IS"
3. Call sign of the station relaying the message (spoken three times)
4. Distress signal "MAYDAY" (once)
5. Particulars of the station in distress such as its location, the nature of distress, the number of persons on board, etc.

Distress traffic (stay off the radio if you are not involved)

Distress traffic consists of all transmissions relative to the immediate assistance required by the station in distress. Essentially, all transmissions made after the initial distress call are considered as distress traffic. In distress traffic, the distress signal "MAYDAY" spoken once, shall precede all transmissions. This procedure is intended to alert stations not aware of the initial distress call and now monitoring the distress channel that traffic heard relates to a distress situation.

Any station in the land mobile, aeronautical, or maritime mobile service that has knowledge of distress traffic and cannot itself assist the station in distress shall

follow such traffic until it is evident that assistance is being provided. All stations that are aware of distress traffic, and that are not taking part in it, are forbidden to transmit on the frequencies being used for distress traffic until a message is received indicating that normal working traffic may be resumed (cancellation of distress).

SEELONCE MAYDAY: If too much radio chatter continues, the vessel in distress may impose silence to all other stations by using the expression SEELONCE MAYDAY. All unrelated transmission shall cease during this time.

Acknowledgement of receipt of a distress message

The acknowledgement of receipt of a distress message shall be given in the following form:

1. The distress signal, "MAYDAY"
2. Call sign of the station in distress (spoken three times)
3. The words "THIS IS"
4. Call sign of the station acknowledging receipt (spoken three times)
5. The words "RECEIVED MAYDAY."

Urgency communications (PAN PAN X 3)

Urgency signal

The urgency signal indicates that the station calling has a very urgent message to transmit concerning the safety of a station or a person, but does not require immediate assistance and shall only be sent on the authority of the person in charge of the station.

The urgency signal is "PAN PAN" spoken three times. It should be used at the beginning of the first communication.

The urgency signal and the urgency message may be addressed to all stations or to a specific station.

6.2 priority: **This urgency signal has priority over all other communications except distress.**

Stations that hear the urgency signal shall continue to listen for at least three minutes on the frequency which the signal was heard. After that, if no urgency message has been heard, stations may resume normal service. All stations that hear the urgency signal must take care not to interfere with the urgency message which follows. Stations that are in communication on frequencies other than those used for the transmission of the urgency message, may continue normal work without interruption, provided that the urgency message is not addressed to all stations.

Urgency message

The urgency signal shall be followed by a message giving further information of the incident that necessitated the use of the urgency signal.

The urgency message should contain as many as required of the following elements spoken distinctly and, if possible, in the following order:

1. Urgency signal "PAN PAN" (three times)
2. Name of the station addressed or the words "ALL STATIONS" (three times)
3. The words "THIS IS"
4. Identification of the station sending the urgency message
5. Nature of the urgency condition
6. Intentions of the person in command
7. Present position, flight level or altitude, and heading
8. Any other useful information.

Safety communications (SECURITE X 3)

Safety signal

The safety signal is used mainly in the maritime mobile service. It indicates that the station calling is about to transmit a message concerning the safety of navigation or important meteorological warnings.

The safety signal is the word "SECURITE" (pronounced as French) spoken three times and pronounced as in French. It should be used at the beginning of the first communication.

The safety signal and the safety message may be addressed to "ALL STATIONS" or to a specific station.

Priority

The safety signal has priority over all other communications except distress and urgency.

Stations that hear the safety signal shall continue to listen on the frequency on which the message was transmitted until they are satisfied that the message is of no interest to them.

All stations that hear the safety signal must take care not to interfere with the safety message that follows it.

Safety message

The safety message should contain as many of the following elements and, if possible, in the following order:

1. Safety signal "SECURITE" (three times)
2. Name of the station addressed or "ALL STATIONS" (repeated three times)

3. The words "THIS IS"
4. Name or call sign of the station sending the message
5. Nature of the condition
6. Name or call sign of the station sending the message.

The following is a chart of distress procedural words and phrases and their meanings.

Procedural words and phrases

Word or phrase	Meaning
ACKNOWLEDGE	Let me know that you have received and understood this message.
AFFIRMATIVE	Yes, or permission granted.
BREAK	Indicates the separation between portions of the message. (To be used where there is no clear distinction between the text and other portions of the message.)
CHANNEL	Change to channel ... before proceeding.
CLEARED	Authorized to proceed under the conditions specified.
CONFIRM	Have I received the following ... or Did you receive the message?
CORRECTION	An error has been made in this transmission (message indicated). The correct version is....
DISREGARD	Consider this transmission as not sent.
GO AHEAD	Proceed with your message.
HOW DO YOU READ?	What is the readability of my transmission?
I SAY AGAIN	Self-explanatory (use instead of "I REPEAT").
MAYDAY	The spoken word for distress communications.
MAYDAY RELAY	The spoken word for the distress relay signal.
MONITOR	Listen on (frequency).
NEGATIVE	No, or that is not correct, or I do not agree.
OUT	Conversation is ended and no response is expected.
OVER	My transmission is ended, and I expect a response from you.
PAN PAN	The spoken word for urgency communications.

READ BACK	Repeat all, or the specified part of this message back to me exactly as received (do not use the word "REPEAT").
ROGER	I have received all of your last transmission.
ROGER NUMBER	I have received your message Number __.
SAY AGAIN	Self-explanatory. (Do not use the word "REPEAT".)
STAND BY	I must pause for a few seconds or minutes, please wait and I will call you.
SEELONCE	An international expression to indicate that silence has been imposed on the frequency due to a distress situation.
SEELONCE FEENEE	An international expression to indicate that the distress situation has ended.
SEELONCE MAYDAY	An international expression to advise that a distress situation is in progress. The command comes from the station in control of the distress traffic.
THAT IS CORRECT	Self-explanatory.
VERIFY	Check coding, check text with originator and send correct version.
WILCO	Your instructions received, understood and will be complied with.
WORDS TWICE	(a) As a request: Communication is difficult, please send each word, or group of words, twice. (b) As information: Since communication is difficult, I will send each word or group of words, twice.

CHAPTER 17 REVIEW

1. What is an EPIRB?

2. What does SEELONCE MAYDAY mean?

3. What is a DSC, and how does it work?

4. What does GMDSS stand for, and what purpose does it serve?

5. What is the JRCC, and what purpose does it serve?

6. Which federal agencies have the search and rescue mandate for Canada?

7. What are “vessels of opportunity” and what role do they play in SAR operations in Canada?

8. What is the difference between a distress message and an urgency message?

18. Marine pollution prevention

Goals of this chapter

This chapter gives students a basic understanding and awareness of marine pollution and the regulations surrounding marine pollution control and prevention.

Learning outcomes

After competing this chapter, students will understand:

1. The precautions to be taken during fueling
2. The statutory requirements to report pollution incidents
3. “Division 4 – Sewage” and “Division 5 – Garbage” from the *Regulations for Prevention of Pollution from Ships and for Dangerous Chemicals*

1. Precautions before, during, and after fueling

Early chapters discussed the need for safe fuelling protocols to avoid a vessel catching fire, as the fueling process is the most likely scenario in which a vessel will ignite.

Precautions taken during the fueling process also serve a secondary purpose of preventing pollution of hazardous chemicals in the marine environment. As such, mariners should approach safety protocols for fueling a vessel, taking into account both fire and pollution prevention.

Safe steps to fueling a vessel

Special attention should be given to inboard gas engines: Gasoline is highly flammable and is heavier than air, forcing flammable vapours to collect in the bilge area of the vessel. It is important to schedule periodic checks of hoses and fuel tanks to ensure there are no leaks.

Prior to fueling

In general, follow these safety steps before fueling:

- First, know the capacity of your fuel tanks and how much fuel is required to fill them in order to avoid spillage. Be aware of the location and use of the marina's firefighting and spill response equipment.
- Have absorbent cloths, spill material, and fire-fighting equipment at the ready prior to fueling.
- Make sure all ventilation to the engine area is opened.
- Turn off any sources of flames on your vessel such as pilot lights, electronics, cell phones, and main batteries.
- Ensure no smoking on the vessel or fuel dock, and that all non-essential crew and passengers are away from the vessel (that is, no one is on board the vessel who is not required for fueling).
- Check that all doors and hatches are closed.
- Ground the hose nozzle to the vessel to avoid a static spark. It should remain in contact for the entire fueling process (that is, touching the fuel tank port). Secure the nozzle in the tank opening before fueling commences.

During fueling

Follow these rules during fueling to prevent spillage:

- All fuelling should be done by hand, and not through automatic locking

systems, to allow the operator to monitor the flow and to immediately stop the fueling when necessary.

- Fuel will expand with heat; therefore, ensure you do not overfill the tank.

After fueling

These steps will help prevent further fuel spillage and pollution:

- Be aware of the smell of fuel and if odour is present, investigate.
- Check that no fuel has spilled into the bilges or into the water.
- If fuel is found in the bilges, remove with a manual pump.
- If any spillage is found in the water, report immediately to the marina operator.
- Allow your bilge fan to run for at least four minutes to remove any vapours from the bilge. Confirm visually and with your sense of smell.
- For adequate ventilation, ensure a complete change of air in the relevant area.

2. Statutory requirements to report pollution incidents

General requirements

Transport Canada has established guidelines for reporting incidents involving dangerous goods, harmful substances, and marine pollutants (*TP 9834 E*).

The intent of these Guidelines is to enable the proper authorities to be informed without delay so that appropriate action may be taken when:

1. "any incident occurs involving the loss, or likely loss, overboard of packaged dangerous goods in the sea; or
2. any incident occurs giving rise to pollution, or threat of pollution to the marine environment, as well as of assistance and salvage measures; or
3. any oil pollution incident occurs involving the loading or unloading of oil to or from a vessel at an oil handling facility."

The *Pollutant Discharge Reporting Regulations*, 1995, stipulate that "a vessel's master or owner must make reports required under the Regulations in the manner described in these Guidelines."

How to make a report (summary of reporting protocols)

The report should be transmitted in the following manner:

1. When an incident occurs involving a vessel in waters under Canadian jurisdiction, the report shall be made with the highest possible priority and using the quickest means available to a marine safety inspector, or for incidents occurring in a shipping safety control zone, to a pollution prevention officer.
2. When the vessel is in a radio telecommunications area that is covered by Canadian Coast Guard Marine Communications and Traffic Services, the report should, where expedient, be routed through that system to a marine communications and traffic services officer.
3. When an incident occurs involving a Canadian vessel outside waters under Canadian jurisdiction, the report should be made to the nearest coastal State through an appropriate coast station, preceded by the safety signal (if the incident affects the safety of navigation), or by the urgency signal (if the incident affects the safety of the vessel or persons).

Detailed reporting requirements of dangerous goods spill report

There are multiple reporting forms that can be used to report a spill. From the perspective of a small vessel a basic understanding of what is required to report

is listed below. What is important to know is if you observe or are responsible for a spill of a dangerous or harmful substance then you must report it as follows:

1. Identify your vessel, and provide Master and contact information for the owner of the vessel.
2. Provide position, and time and date of the spill along with weather conditions.
3. Provide best description of the dangerous/hazardous substance and the correct technical name of the substance, if known.
4. Describe disposition of the substance—floating, sinking, contained, or spreading out—and the amount or quantity of contamination.
5. Establish whether the contamination is growing.
6. Describe the cause of the contamination, if known.
7. Estimate the movement of the discharge or loss, giving current conditions if known.
8. Estimate of the surface area of the spill, if possible.

3. “Division 4 – Sewage” and “Division 5 – Garbage” of the *Regulations for Prevention of Pollution from Ships and for Dangerous Chemicals*

“Division 4 – Sewage” (Transport Canada)

“International requirements for the prevention of pollution from sewage are contained in Annex IV of the International Maritime Organization's *Pollution Convention, Regulations for the Prevention of Pollution by Sewage from Ships*

Canada has adopted its own regulations concerning sewage pollution prevention in “Division 4 – Sewage” of the *Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals*. The *Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals* are a consolidation of the former regulatory requirements, the recommendations of a stakeholder working group established by Transport Canada Marine Safety, and the requirements of “Annex IV” of the Pollution Convention that have not been fully addressed by regulation in Canada.

The application has been expanded in the regulations to include **all ships in all Canadian waters and to all Canadian ships everywhere**. Previous regulations concerning sewage applied to ships, other than pleasure craft, only on the Great Lakes and to all ships in a few areas designated for zero discharge.

Section 119 of the regulations requires a ship that has a toilet on board to have a holding tank or an approved marine sanitation device. With some exceptions, the discharge of untreated sewage into all Canadian inland waters and Canadian coastal waters within 3 nautical miles of land (ships less than 400 tons) and 12 miles of land (ships larger than 400 tons) is now banned. Treated sewage will only be allowed to be discharged into Canadian waters subject to specified limits of fecal coliforms per 100 ml of water. Adoption of these requirements will permit Canada to accede to Annex IV of the Pollution Convention.”

What does this mean?

The new regulations prohibit raw sewage discharge in most situations with a few exceptions.

- Sewage discharge is prohibited in any waters within one mile of any shore.
- Use a sanitation device or discharge three miles from any shoreline in salt water.
- Use a pump-out station or holding tank.
- In restricted waters where there three mile distance cannot be achieved, and where there is no pump-out alternative, overboard discharge can be

done, provided it is on an ebb tide and the vessel is in the deepest possible water and proceeding in excess of four knots.

"Division 5 – Garbage" (Transport Canada)

"International requirements for the prevention of pollution from garbage are contained in Annex V of MARPOL, *Regulations for the Prevention of Pollution by Garbage from Ships*. Annex V contains requirements for placards, garbage management plans, garbage record keeping, disposal of garbage, and reception facilities. Annex V came into force on December 31, 1988.

The *Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals,* "Division 5 – Garbage" provides a consolidation of the requirements contained in Annex V of the Pollution Convention that have not been fully addressed by regulation in Canada under the former Garbage Pollution Prevention Regulations.

Division 5 applies to all ships in Canadian waters and to all Canadian ships everywhere. The regulations ban the discharge of garbage into internal waters and specify requirements for discharge of garbage into the oceans. Provisions for the discharge of cargo residues in the Great Lakes and St. Lawrence River have been included, consistent with established voluntary practices and United States Coast Guard requirements. The regulations specify record-keeping requirements for commercial carriers. Smaller craft operators and short run ships are excluded from the record-keeping requirements. Adoption of these requirements will permit Canada to accede to Annex V of the Pollution Convention."

What does this mean?

Garbage from ships can be just as dangerous as oil and chemicals with plastic causing the greatest danger (it can float for years). Garbage from the ocean can be attributed to persons on shore and from vessels at sea. MARPOL (stands for the International Convention of Pollution from Ships) seeks to eliminate and reduce the amount of garbage being discharged into the sea from ships.

Unless expressly provided otherwise, Annex V applies to all ships, which means all ships of any type whatsoever, operating in the marine environment, from merchant ships to fixed or floating platforms to non-commercial ships like pleasure crafts and yachts. Although MARPOL Annex V is voluntary, more than 150 countries have signed on.

MARPOL generally prohibits the following:

- Food waste must be grounded and discarded at least three nautical miles (NM) from land (non-grounded at least 12 NM).
- Cleaning agents, solvents, additives discharge prohibited.

- Animal carcasses: as par as possible from the nearest land (should be at least 100 NM).
- All other garbage, including plastics, synthetic ropes, fishing gear, cooking oil, packing material, glass, metal, foam, crockery, and similar refuse are **all prohibited** from being discarded into the ocean.

Note: The above noted items are general and provide the mariner with the concept that supports the disposal of garbage. For more information, please consult Annex V.

CHAPTER 18 REVIEW

1. What should you do if you spill fuel into the water when refueling your vessel?

2. What is a master's responsibility when a vessel is leaking significant oil at sea? List four items that need to be covered.

3. How far offshore can a mariner dispose of plastic?

4. How far off share can a mariner dispose of raw sewage?

5. What is a mariner's responsibility when spotting another vessel that is leaking significant amounts of oil?

6. To whom do you report pollution observed by you or created by your vessel?

7. How soon must you report an incident of pollution?

8. What size vessel do pollution regulations apply to?

19. *The Canada Shipping Act* (2001) and Canadian small-vessel regulations

Goals of this chapter

This chapter provides a basic understanding of the *Canada Shipping Act* and other Canadian maritime legislation relevant to small vessel operations.

Learning outcomes

After completing this chapter, student will know and understand:

1. Basics of the *Canada Shipping Act*, 2001
2. Small vessel regulations and fishing vessel safety regulations
3. Parks and Marine Mammals Protection Legislations
4. *Regulations for Prevention of Pollution from Ships and for Dangerous Chemicals*

1. The *Canada Shipping Act*, 2001

Canadian seafarers are subject to standard and regulatory oversight in Canadian waters through the *Canada Shipping Act*, 2001 (CSA). The principle purpose of the *Act* is to provide standards for safe marine transportation and recreational boating as well as guidance for the protection of the marine environment.

The CSA was recently modernized, making it clearer and easier to understand, and new regulations came into force in July 2007. The CSA is an extensive consolidation of government regulations and orders that apply to all shipping. It is not necessary to read the entire document but it is important to know which reference materials are relevant to your needs.

The many regulations and standards that govern small commercial vessel operations can be found on the Transport Canada website at www.tc.gc.ca.

Below are regulations of the CSA prepared for quick reference. (For detailed information, users are advised to consult the official CSA publications.)

Regulations and orders pursuant to the *Act*

- *Administrative Monetary Penalties and Notices (CSA 2001) Regulations (SOR /2008-97)*
- *Anchorage Regulations (SOR /88-101)*
- *Regulations Amending the Ballast Water Control and Management Regulations (SOR /2006-129) (Repealed by SOR /2011-237)*
- *Ballast Water Control and Management Regulations (SOR /2011-237)*
- *Board of Steamship Inspection Scale of Fees (C.R.C., c.1405)*
- *Boat and Fire Drill and Means of Exit Regulations (SOR /2005-280) (Repealed by SOR /2010-83)*
- *Burlington Canal Regulations (SOR /89-222)*
- *Regulations Amending the Cargo, Fumigation and Tackle Regulations (Proposed) (SOR /2007-128)*
- *Certain Areas Covered with Water Proclaimed Public Harbours Effective January 1, 1980 (SI /80-8)*
- *Charts and Nautical Publications Regulations, 1995 (SOR /95-149)*
- *Classed Ships Inspection Regulations, 1988 (SOR /89-225)*
- *Collision Regulations (C.R.C., c.1416)*
- *Competency of Operators of Pleasure Craft Regulations (SOR /99-53)*
- *Towboat Crew Accommodation Regulations (C.R.C., c.1418)*

- *Eastern Canada Vessel Traffic Services Zone Regulations (SOR /89-99)*
- *Environmental Response Arrangements Regulation (SOR /2008-275)*
- *Fire and Boat Drills Regulations (SOR /2010-83)*
- *Fire Detection and Extinguishing Equipment Regulations (C.R.C., c.1422)*
- *Fishing Vessel Safety Regulations (C.R.C., c.1486)*
- *Home-Trade, Inland and Minor Waters Voyages Regulations (C.R.C., c.1430)*
- *Hull Construction Regulations (C.R.C., c.1431)*
- *Hull Inspection Regulations (C.R.C., c.1432)*
- *Large Fishing Vessel Inspection Regulations (C.R.C., c.1435)*
- *Life Saving Equipment Regulations (C.R.C., c.1436)*
- *Load Line Regulations (SOR /2007-99)*
- *Long-Range Identification and Tracking of Vessels Regulations (SOR /2010-277)*
- *Marine Machinery Regulations (SOR /90-264)*
- *Marine Personnel Regulations (SOR /2007-115)*
- *Minor Waters Order (C.R.C., c.1448)*
- *St. Clair and Detroit River Navigation Safety Regulations (SOR /2005-134)*
    - *Also pursuant to the* Arctic Waters Pollution Prevention Act
- *Northern Canada Vessel Traffic Services Zone Regulations (SOR /2010-127)*
- *Pollutant Discharge Reporting Regulations, 1995 (SOR /95-351) (Repealed by SOR /2012-69)*
- *Port Wardens Tariff (SOR /79-154)*
- *Private Buoy Regulations (SOR /99-335)*
- *Regulations Excluding Certain Government Ships from the Application of the* Canada Shipping Act *(SOR /2000-71)*
- *Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals (SOR /2007-86) (Repealed by SOR /2012-69)*
- *Response Organizations and Oil Handling Facilities Regulations (SOR /95-405)*
- *Sable Island Regulations (C.R.C., c.1465)*
- *Safe Working Practices Regulations (C.R.C., c.1467)*
- *Safety Management Regulations (SOR /98-348)*

- *Ship Radio Inspection Fees Regulations (C.R.C., c.1472)*
- *Ship Station (Radio) Regulations, 1999 (SOR /2000-260)*
    - *Also pursuant to the* Arctic Waters Pollution Prevention Act
- *Ship Station (Radio) Technical Regulations, 1999 (SOR /2000-265)*
- *Shipping Casualties Reporting Regulations (SOR /85-514)*
- *Ships' Elevator Regulations (C.R.C., c.1482)*
- *Regulations Amending the Small Vessel Regulations (Proposed) (C.R.C., c.1487) (Repealed by SOR /2010-91)*
- *Small Vessel Regulations (SOR /2010-91)*
- *Special-purpose Vessels Regulations (SOR /2008-121)*
- *St. Clair and Detroit River Navigation Safety Regulations (SOR /84-335)*
- *Cargo, Fumigation and Tackle Regulations (C.R.C., c.1494)*
- *Tariff of Fees of Shipping Masters (C.R.C., c.1495)*
- *Towboat Crew Accommodation Regulations (C.R.C., c.1498)*
- *Vessel Certificates Regulations (SOR /2007-31)*
- *Vessel Clearance Regulations (SOR /2007-125)*
- *Vessel Detention Orders Review Regulations (SOR /2007-127)*
- *Regulations Amending the Vessel Operation Restriction Regulations (SOR /2008-120)*
- *Vessel Pollution and Dangerous Chemicals Regulations (SOR /2012-69)*
- *Vessel Registration and Tonnage Regulations (SOR /2007-126)*
- *Vessels Registry Fees Tariff (SOR /2002-172)*
- *Vessel Traffic Services Zones Regulations (SOR /89-98)*
- *VHF Radiotelephone Practices and Procedures Regulations (SOR /81-364)*
- *Voyage Data Recorder Regulations (SOR /2011-203)*

2. Small vessel regulations and fishing vessel safety regulations

"Small Vessel Regulations" July 1, 2007, *Canadian Shipping Act* (CSA)

The regulations address safety equipment and construction standards of small vessels. It also includes licensing, limits to the vessel's operation capacity, and certification for new vessels. It is an appropriate read for mariners to familiarize themselves with the requirements for their vessel and knowledge on the vessel expected by Transport Canada inspectors.

1) "These Regulations apply in respect of

    (a) a pleasure craft;
    (b) a passenger-carrying vessel of not more than 15 gross tonnage that carries not more than 12 passengers and is not a human-powered vessel;
    (c) a workboat of not more than 15 gross tonnage; and
    (d) a human-powered vessel other than a pleasure craft.

2) These Regulations do not apply in respect of

    (a) a fishing vessel;
    (b) a rescue boat or lifeboat that is carried on board a vessel exclusively to meet a requirement for life-saving appliances set out in other regulations made under the *Act;*
    (c) a vessel in respect of which the Special-purpose Vessels Regulations apply; or
    (d) an air cushion vehicle of more than 4 500 kg all up weight."

Prohibitions: "No person shall operate or permit another person to operate a vessel unless the safety equipment required by these Regulations is carried on board the vessel and the equipment meets the requirements of these Regulations."

Safety equipment summary

- "Certain safety equipment must be fitted to the vessel. If that equipment is substituted it must be assessed by Transport Canada to meet the safety criteria.
- The safety equipment designated for the vessel must be in good working order, accessible for immediate use and replaced at the manufacturers' recommendations.

- A personal flotation device, lifejacket, lifebuoy, self-igniting light, pyrotechnic distress signal or life raft required by these Regulations shall meet the applicable standards and tests set out in the schedule.
- All safety equipment used on the vessel must be approved by Transport Canada and bear the markings of the equipment.
- A first aid kit required by these Regulations shall be packed in a waterproof case capable of being tightly closed after use and contain certain equipment as described in the regulations. (Marine Occupational Health and safety Regulations)."

Summary: Understand all safety equipment and operational limits for your vessel, the maintenance schedule and use of your equipment. You can/may be tested on it at any time by a TC inspector!

"Fishing Vessel Safety Regulations" (CSA)

Most commercial fishing deaths happen because of vessel instability, where a vessel capsizes, founders, or sinks, or because of crew falling overboard. Transport Canada's priority is to help reduce deaths and injuries as well as loss or damage to commercial fishing vessels. Transport Canada regularly engages with fishing vessel owners, safety groups and fishing safety associations across the country to develop new safety standards that reflect industry best practices and new technology. So, what is new?

- There must be written safety procedures for your crew to help increase and reduce accidents. TC inspectors need not approve these procedures, but they must be on board the vessel.
- The crew and master must hold and record safety drills on board the vessel on a regular basis.
- You must carry approved lifesaving equipment that meets the requirements and regulations for the size and operating area of your vessel. This includes life-saving appliances, signaling flares and firefighting equipment.
- Your vessel must pass stability assessments if the hull length is over 9 meter (after July 2018) or has undergone a major modification that can potentially affect its stability.
- A new Small Vessel Compliance Program is being developed to assist commercial mariners to meet regulatory requirements.

Summary: Prioritize your personal safety (wear a life jacket) and the vessel's safety (all life-saving gear available and in good repair) and ensure your vessel can meet stability issues if major modifications have been made**.**

3. Parks and marine mammal protection legislations

Marine Mammal Protection Legislation

The protection of marine mammals on our coast has become a rising concern and high-profile issue with the public. Depleted salmon stocks and questionable survival rates for local killer whales coupled with large commercial vessels and potential pollution has elevated the interest and enforcement of protection of the maritime environment. Below are some highlights of the regulations that you should be aware of.

Application (from the regulations)

"These Regulations apply in respect of

(a) the management and control of fishing for marine mammals and related activities in Canada and in Canadian fisheries waters;

(b) the management and control of fishing for marine mammals from Canadian fishing vessels in the Antarctic; and

(c) the conservation and protection of marine mammals in Canada and in Canadian fisheries waters."

Prohibitions

"7 (1) No person shall disturb a marine mammal except when fishing for marine mammals under the authority of these Regulations."

"For the purposes of the *Act*, *disturb* includes to approach the marine mammal to, or to attempt to:

(a) feed it;

(b) swim with it or interact with it;

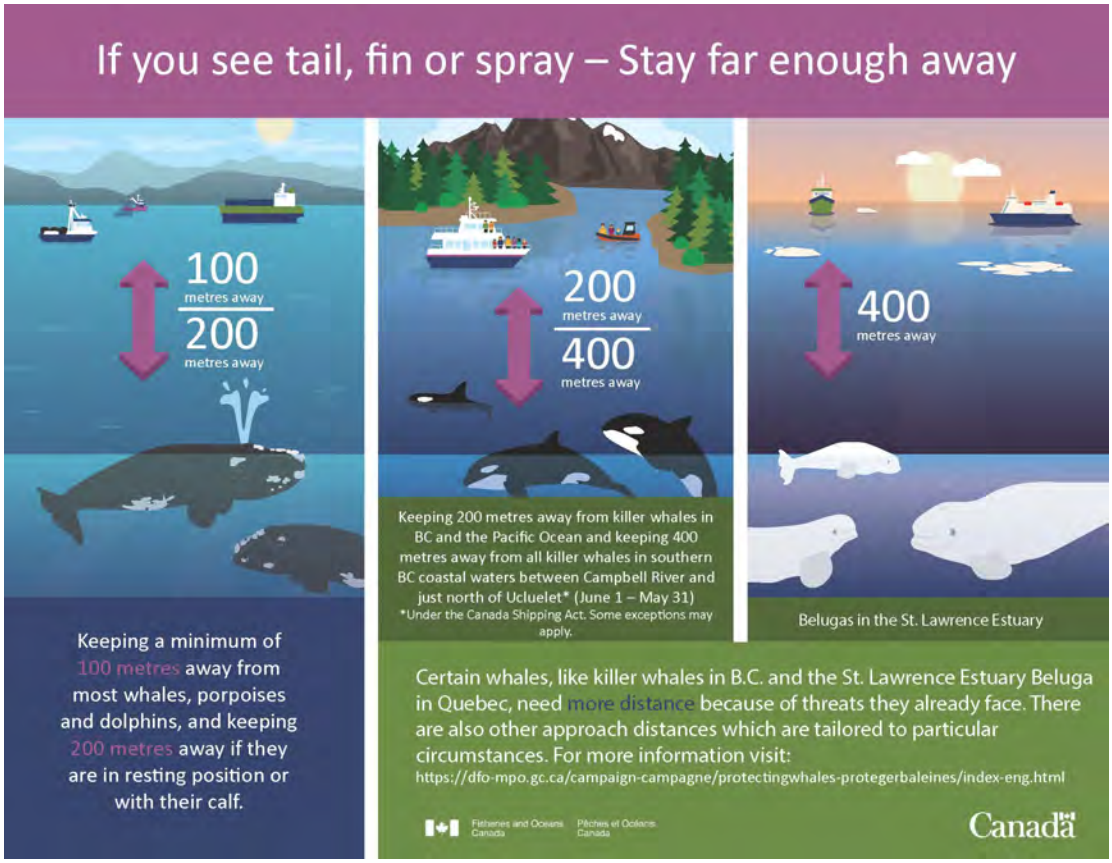
(c) move it or entice or cause it to move from the immediate vicinity in which it is found;

(d) separate it from members of its group or go between it and a calf;

(e) trap it or its group between a vessel and the shore or between a vessel and one or more other vessels; or

(f) tag or mark it."

For the purposes of the *Act* in the case of a whale, dolphin, or porpoise in resting position or with its calf, *disturb* also includes to approach the whale, dolphin, or porpoise with a vehicle at an approach distance of less than 200 M in all Canadian fisheries waters from January 1 to December 31.



Summary: The protection of marine mammals and their environment has become a serious public issue. Under the CSA, Canada has adopted strict regulations regarding pollution and vessel restrictions when near marine mammals.

Exceptions: There are certain exceptions for First Nations, authorized researchers, and federal officers in the legal execution of their duties for approaching marine mammals in certain situations. For the rest of us, it is best to stay as far away as possible. Distance requirements for specific mammals are listed in the regulations. The *Act* is extensive and should be reviewed.

Another good read is the *Species at Risk Act* (SARA). This *Act* is part of the Government's commitment to keep Canadian wildlife species from becoming extinct and secures the necessary actions for their recovery. It also provides for the legal protection of wildlife species and the conservation of their biological diversity.

Canada's marine parks and protected areas

The *National Framework for Canada's Network of Marine Protected Areas* provides strategic direction for establishment of a national network of marine protected areas that conforms to international best practices and helps to

achieve broader conservation and sustainable development objectives identified through Integrated Oceans Management and other marine spatial planning processes.

Parks Canada guiding principles for mariners

- Parks Canada implements appropriate regulations under the *National Parks Act* or other statutes in accordance with management and zoning decisions set out in the approved conservation area management plan.
- Parks Canada, in cooperation with other law enforcement agencies, monitors compliance with the marine conservation area regulations that have been implemented to protect marine ecosystems, maintain the public peace, and protect life and property. Strict enforcement action will be taken to detect and stop illegal activities such as poaching.

Fishing and aquaculture

Fishing can be an appropriate activity in certain areas within the protected marine area of a national park. Fisheries in national marine conservation areas are regulated under the provisions of the *Fisheries Act*. Other statutes may also be used to provide additional protection to marine ecosystems.

Parks Canada works cooperatively with the Department of Fisheries and Oceans (DFO) and the fishing industry to minimize indiscriminate methods of fishing and the use of gear that is destructive to the seabed within a conservation area.

Marine transportation

Transportation, navigation and aids to navigation, and the operation of pleasure craft in marine conservation areas is regulated under the *Canada Shipping Act* and other applicable legislation and regulations.

Summary: Pleasure craft and commercial and fishing vessels can use federal marine parks but may have some restrictions as legislated.

4. *Regulations for Pollution from Ships and for Dangerous Chemicals*

Vessel Pollution and Dangerous Chemicals Regulations, 2001 (CSA)

The International Convention for the Prevention of Pollution form Ships (MARPOL) provides international governments with agreed upon conventions for preventing pollution from ships into the marine environment. Under the *Canada Shipping Act*, 2001, most aspects of the MARPOL Convention have been adopted. In Artic waters, Canada has exceeded pollution regulations beyond MARPOL

The Convention and protocols include regulations aimed at preventing and minimizing pollution from ships—both accidental pollution and that from routine operations—and currently includes six technical Annexes that lay out with strict controls on operational discharges. (Also covered in Chapter 18: Marine Pollution Prevention.)

As stated in the regulations: "Pollution of the marine environment from ships may originate from a variety of sources, including accidental and operational pollution. Accidental pollution may result from the loss of cargo or fuel after a grounding or collision and from minor accidents on board such as a hose breaking or a tank overflowing. Operational pollution results from the discharge of shipboard generated wastes such as garbage, sewage, dirty ballast water and tank washings, and engine exhaust and tank venting emissions."

In Canada, regulatory action has focuses on:

- Air pollution
- Anti-fouling systems
- Ballast water
- Garbage
- Marine pollutants in package form
- Noxious liquid substances and dangerous chemicals
- Oil
- Sewage

Liability: The *Marine liability Act* is the principal legislation dealing with the liability of ship owners and ship operators in relation to passengers, cargo, pollution, and property damage. It sets limits of liability and establishes uniformity by balancing the interests of ship owners and other parties.

Summary: Most of this *Act* applies to larger seagoing ships and oil tankers, as the potential for catastrophic damage from their pollutant discharge is significant. However, the regulations apply equally to smaller coastal vessels.

For small commercial vessels operating in inshore waters the discharge or contamination of the above-mentioned substances is prohibited and subject to liability claim and clean-up costs.

Provisions in the regulations for disposal of certain substances and conditions are specific and beyond the practical scope of this course; however if a spill occurs, it is your responsibility to report it as soon as is practical.

CHAPTER 19 REVIEW

1. What is the guiding legislation on which all maritime regulations and standards are based?

2. What does MARPOL stand for, what does it mean, and why does it exist?

3. Name four activities that are prohibited regarding marine mammals.

4. Name four safety protocols that are mandatory on a fishing vessel.

5. Name five areas that the *Vessel Pollution and Dangerous Chemicals Regulations* focus on.

6. How far away must you keep your vessel from killer whales in the southern waters of Vancouver Island?

7. What is the cause of most commercial fishing deaths?

8. What is the principle purpose of the *Canada Shipping Act*?

20. Pre-departure preparations

Goals of this chapter

This chapter provides students with a basic understanding of developing protocols for pre-departure checks and preparations as part of routine safety prior to departure.

Learning outcomes

After completing this chapter, students will understand:

1. Safe fueling and the importance of running the bilge blower
2. Planning for fuel consumption
3. Using a “departure checklist”
4. How to create and file a “sail plan” or “trip plan”
5. How to prepare for local hazards within the operational area

1. Safe fueling and running the bilge blower

General safety review

- Much of what is discussed in this chapter has been covered in previous chapters; it is an important review of procedures and, though somewhat simple, they are critical for a mariner to establish as “standard operating procedures” (SOP).
- Pre-departure preparations are so important because most emergencies at sea can be traced back to a flawed or incomplete pre-departure check.
- Each section of this chapter acts as a reminder of potential danger, and explains how to mitigate risk for the safety of the vessel and its crew.

Fueling safety protocols

Most fires on board a vessel occur during the process of fueling. This should not come as a surprise, considering the process involves transferring a highly flammable and gaseous substance (particularly gasoline) from a relatively secure area to a vessel’s fuel tanks. Many things can go wrong during the process, considering that flammable gases from the fuel transfer can leak out into the bilge, the engine compartment, and the area where the fuel tanks are located.

A number of protocols mitigate some of the risk when fueling, including removing all non-essential crew and passengers from the vessel, enforcing no smoking, turning off batteries and pilot lights, and other safety procedures (see Chapter --).

Running the bilge blower

A bilge blower is an essential item required on any non-open type vessel that runs on gasoline. The blower is a mechanical ventilation system that removes potentially flammable gas fumes from the closed areas of your vessel. The bilge blower is designed for this specific task—do not jury rig a blower!!

The electrical components are sealed to prevent sparking, and the unit is built to withstand overheating and corrosion. Bilge blowers are not designed to run for long periods of time but rather for short periods to remove gas fumes from confined spaces.

Blowers are to be operated upon completion of the fueling process. The minimum recommended time you should run a blower is four minutes. Prior to turning on your blower, use your “best odour detector” to determine if there are any leaks… your NOSE!

Below is an example of the fueling checklist for the Royal Canadian Marine Search and Rescue (RCMSAR):

Fueling checklist

- ✓ Secure vessel to mooring.
- ✓ Shut down engines.
- ✓ Set bilge pumps to “OFF.”
- ✓ Move portable tanks ashore.
- ✓ Ensure all non-fueling crew are ashore.
- ✓ Person fueling, hand-held radio off.
- ✓ Shore crew monitors VHF 04A & 16.
- ✓ Extinguish all open flames prior to arrival.
- ✓ Shut off main power.
- ✓ Place fire extinguisher on standby.
- ✓ Close all hatches and doors.
- ✓ Ground nozzle against fill pipe before fueling.
- ✓ Fuel slowly to prevent spillage.
- ✓ Wipe up any spillage.
- ✓ Check below deck for vapours or odours.
- ✓ Blower on for 4 minutes before starting engine.
- ✓ Set bilge pumps to “AUTO.”

2. Planning for fuel consumption

In populated areas of the West Coast of British Columbia there are multiple small marine towing companies that provide service to recreational and commercial vessels operating in local waters. The main thrust of their business is towing vessels that have either broken down or have run out of fuel. There are not many good reasons why a vessel should run out of fuel considering a sail plan and navigation briefing should have already been established before the vessel has left the dock. In fact, vessel having to be rescued because they risk running their boats aground after running out of fuel can be quite embarrassing and dangerous.

Knowing fuel capacity and burn rate

Every vessel has a known size and capacity of its fuel tanks along with the fuel burn rate for a particular load and engine size under normal operating conditions.

EVERY OPERATOR OF THE VESSEL SHOULD KNOW THIS!

The vessel will also have a maximum range of travel for its capacity of fuel and a calculation of hours of operation can be determined and used to cross-referencing fuel consumption.

Variances to established fuel consumption and range

The fuel capacity of a vessel will not change, however the burn rate and therefore distance and time a vessel can operate its engines change when conditions change. Environmental conditions and cargo load can significantly alter the burn rate of the vessel. Consideration should be given to:

- **Weather:** As a vessel proceeds into strong winds and larger seas, the engines will require significantly more power to make way thereby burning more fuel. This can be significant.
- **Current:** Currents tend to slow the speed made good of the vessel. If meeting a tight schedule, the operator will consume more fuel to maintain speed. Current is a lesser factor than wind and sea state.
- **Cargo:** The distribution and total weight of cargo on a vessel can have significant effects on the fuel consumption of a vessel. Improperly placed cargo too forward or aft will put the vessel out of trim and cause inefficiencies and thus a much higher fuel consumption rate.
- **Bent or chipped propeller:** This will cause inefficiencies in the propulsion system and burn more fuel.

- **Water in the bilge:** Carry excess water in the bilge area will add significant weight to the vessel, increase free surface effect and increase the fuel consumption of the vessel.
- **Improperly maintained vessel engine:** An engine requires regular services to maintain peak performance and fuel efficiencies.

Consumption rate

Knowing the fuel consumption of your vessel and the range your vessel can travel is a critical component to operating a safe vessel. Consumption rate coupled with the capacity of your fuel tanks will give you a good idea of how far you can go without fueling. **Sea conditions can and will significantly alter your calculations, and must be taken into account.**

Check your fuel tanks regularly and apply this method:

- **1/3 to go, 1/3 to return, and 1/3 reserve.**

3. Using a pre-departure checklist and other pre-departure requirements

If you've ever been in the cockpit of an aircraft prior to take off, you would have noticed the pilot performing a series of detailed checks of all systems. This is known as the "pre-departure check" and is standard in the aviation business and equally applies in maritime operations.

The principle behind the pre-departure check is to ensure that the critical systems onboard a vessel are inspected and operating properly. Maintaining the fitness and integrity of the vessel does not need to take a lot of time if conducted regularly but is a critical step to verify that the vessel is ready for safe operations.

"Best practices" suggest that each vessel has a pre-established list, customized for the specific vessel's operational requirements that can be used in support of a pre-departure check. Pre-departure checks can also be augmented by monthly inspections of the vessel that provide a more thorough examination. For example, below is an abbreviated pre-departure checklist for a Canadian Coast Guard fast-response craft.

- ✓ Check fuel, water, oil, and coolant levels and keep them full.
- ✓ Check water filters and ensure they are clean.
- ✓ Ensure anchor is secure.
- ✓ Close and secure hatches.
- ✓ Secure ropes, fenders, and other loose items.
- ✓ Ensure life raft is secure.
- ✓ Ensure bilges are dry and bilge pump is functioning.
- ✓ Secure all lockers, drawers, and galley.
- ✓ Replenish provisions as necessary.
- ✓ Ensure all lifesaving equipment is functional and in its proper place.
- ✓ Check that radios are working.
- ✓ Ensure electronic navigation equipment is working.

Other pre-departure requirements

The previous paragraph addresses the need for a pre-departure check of the vessel. However, you are not done yet. Here are other areas that need to be examined and considered before departure.

Passenger briefing

All passengers must be provided with a basic orientation to the vessel and a safety briefing. The briefing will include location and donning of life jackets, emergency station locations, and individual responsibilities.

Weather and tidal information

No vessel should leave port without this information on hand. Marine weather forecasts provide specific wind direction and strength, visibility, and precipitation. Environment Canada provides weather information 24 hours a day

Local hazards

There are always local hazards and danger spots that exist in our inland and coastal waters. Islands, inlets, and irregular coastlines can create unique tidal and current responses particularly when affected by inflow or outflow winds. A professional mariner should be aware of these conditions as they can be extremely hazardous to navigation.

4. Creating and using a “sail plan” or “trip plan”

A sail plan (or trip plan) is simply a document that details your travel itinerary while you are on your vessel. The document provides relevant information that should be given to someone onshore you trust, and who can call emergency services in the event you do not return home from your trip on time. In that case, the sail plan provides search-and-rescue resources with detailed information on your intended route.

Sail plans for small commercial vessels

Small commercial vessels tend to operate on known routes and schedules that are well documented and within the company’s operational structure. This does not alleviate those responsible for the vessel and crew safety to know where the vessel is and an action plan in place to assist SAR resources in responding, if necessary. The information that should be included in any formal or informal sail plan will depend on factors including environmental conditions, protected/ unprotected waters, distances travelled, traffic and radio communications.

Below is a list of items that should be considered as part of a routine sail plan:

- Type of vessel (size and colour) and registration number
- Company name and contact information, operators name
- Number of persons on board
- Details of trip including route and departure and return times
- VHF channels monitored

Where to file a plan

A sail plan on a small commercial vessel is likely to be filed with a shore-based company official. This can be very routine and in most cases with the above noted information at the ready in case of an emergency. Any change in the sail plan should be reported to your shore-based company official.

5. Local hazards within the operational area

Having a healthy respect for the marine environment is a critical factor in providing a safe voyage for the vessel and its crew. The ocean's response to the various environmental factor will change along coastal areas and inland waters, revealing unique risks and hazards to mariners. Weather patterns, tide and current flow, fog, wind, sea state coupled with irregular coastlines and inlets are all factors that produce unique hazards. Mariners must be briefed and understand the local marine characteristics in their area of operation to best anticipate and mitigate the risk and hazards that exist.

Besides local knowledge, there are numerous resources and information available to the mariner that can identify and greatly assist in risk managing the local dangers. As in all cases, preparation is key to a safe voyage.

Here are some hazards a mariner should consider while planning your voyage.

Submerged rocks and shoals, Inlets: Tidal flows can expose or hide dangers that a mariner can face when navigating in new waters. Referring to your chart in advance of entering an area will provide you the necessary information needed to navigate the waters safely. Many inlets are subject to high winds at certain times of the day and can be a significant danger to mariners.

Traffic hazards: New waters can expose a mariner to busy traffic areas including ferry lanes, float planes runways, multiple vessel traffic entering and exiting harbours and restricted waters with specified traffic lanes to be used.

Tidal and rip currents: It is a good idea to familiarize yourself with the local currents and tidal action in new waters that can be significantly influence by; inflow and outflow winds from inlets, tidal shelves or current flows from irregular land fall and islands.

Inclement weather: Weather patterns unique to a new marine area can present a multitude of challenges to the mariner. Inlets, high mountain land fall, tidal shelves can create sea states that can be difficult or nearly impossible for a small vessel to navigate through. Some areas have significant fog or strong wind patterns that need to be recognized by the mariner.

Marine wildlife: Healthy marine life populations are is extremely important to Canadians. Certain areas of our marine coastline support these populations. It is a mariner's responsibility to abide by the establish rules when in these marine habitats. (See Chapter --- for detailed information from Parks Canada.)

Environmental resources to assist mariners

Previous chapter have provided detailed instructions on the following marine resources.

Local charts: Charts contain a substantial amount of information available to the mariner that include surface and subsurface hazards, current directions, aids to navigation, harbor information, restricted areas, and much more. (Chapter ---)

Canadian tide and current tables: These tables provide the official tidal and current prediction for the area in which you are travelling. (Chapter ---)

Sailing/cruising guides: These books contain the most valuable information available to mariners on various coastal areas: ports, hazards, fueling, facilities, weather conditions, best times and conditions to travel, etc. Your vessel should not leave port without the appropriate volume for the area. (Chapter ---)

***CHART 1*:** Charts have many symbols, not all of which a mariner may be familiar with. *CHART 1*, produced by the Canadian Hydrographic Services, provides all symbols, abbreviations, and terms used in standard charts. (Chapter ---)

Current Atlas: In areas where significant and irregular current exists, the current patterns can vary significantly. The current atlas provides the predicted current flow direction and intensity that will aid navigators in the planning of their voyage. (Chapter ---)

Weather: Knowing the weather forecast, weather warnings, and synopses is a must for a mariner travelling in any waters. There are numerous apps available for predicting weather models; however, there is no substitute for monitoring the continuous VHF marine weather information provided on a 24-hour basis by Environment Canada. (Chapter ---)

CHAPTER 20 REVIEW

1. What is a pre-departure check?

2. What is the minimum time you should run a bilge blower?

3. What general protocol should be established regarding fuel when planning a trip?

4. What three factors can alter the fuel consumption of a vessel?

5. How does a sailing/cruising guide assist a mariner when travelling in unknown waters?

6. How does the placement of cargo affect fuel consumption?

7. What does the grounding of a fuel nozzle do during the process of refueling?

21. Sample departure and safety checklists

Goals of this chapter

This chapter provides students with templates for various checklists that form the basis of safety and maintenance protocols of a small commercial vessel.

Learning outcomes

After completing this chapter, students will know how and when to use the following checklists to improve operational safety:

1. Daily maintenance and pre-departure
2. Weekly maintenance and vessel safety gear
3. Engine start-up, pre-voyage, post-voyage
4. Fueling process
5. Heavy weather preparation

1. Daily maintenance checklist

Maintenance checks of a vessel are an ongoing process that forms part of proper seamanship and the safety of the vessel, crew, and passengers. It is a never-ending process that cannot be overlooked or minimized.

Checklists should be considered daily, weekly, monthly, pre- and post-departure, and as required by equipment manufacturers recommendations and Transport Canada regulations. Checklists will vary from vessel to vessel and based on areas and purpose of operations.

Following is an example of a pre-departure and daily inspection checklist commonly used in Canadian Coast Guard vessels:

CCGA Vessel (20-50 feet) Pre-Departure Checklist

✓ Check fuel levels. Consider free-surface effect – keep tanks full.

✓ Check water tanks. Consider free-surface effect – keep levels full.

✓ Check oil levels. Keep levels full.

✓ Check filters and ensure they are clean.

✓ Ensure anchor secured.

✓ Ensure all hatches are closed and secured.

✓ Store all ropes and fenders in bow lockers and ensure they are locked.

✓ Ensure life raft is secured and in good condition.

✓ Check bilges to ensure they are dry.

✓ Ensure bilge pumps are in good working order.

✓ Secure all internal lockers and drawers.

✓ Ensure galley secured.

✓ Check provisions and replenish as necessary.

✓ Secure all loose items, include main salon and aft cockpit.

✓ Check safety equipment and ensure it is in good working order.

✓ Check all personal safety equipment – strobe, knife, flares, radio.

✓ Check radios to ensure they are in good order.

✓ Ensure electronic navigation equipment is in good working order.

✓ Check there are adequate spares onboard.

✓ Check fuel filters, oil filters, impellers.

✓ Check belts and clips.

✓ Check tool kit.

A daily maintenance check should also include the following steps:

- ✓ Conduct an engine systems check for your specific power system.
- ✓ Verify and examine all safety gear is onboard, in good condition, and accessible.
- ✓ All systems are working and batteries charging.
- ✓ Fuel is topped up or sufficient for the trip with spare fuel remaining.
- ✓ All navigational and communication equipment tested.
- ✓ Ensure all previous deficiencies have been repaired.
- ✓ Vessel is properly sitting in the water and bilges are empty.
- ✓ Maintenance logs are up to date.

2. Weekly inspections: Vessel and safety gear

Below is an example of a Canadian Coast Guard weekly inspection for larger vessels. The example provides a complete list of items that should be reviewed weekly. All vessels have different requirements and manufacturers recommended servicing requirements. Adjust according to the size and purpose of your vessel.

General

✓ Hull and superstructure
✓ Lines/fittings/rails
✓ Mast and equipment
✓ Mountings
✓ Anchor and windlass
✓ Moorings
✓ Anchor locker
✓ Lazarette
✓ Void spaces

Lights

✓ Running lights
✓ Search lights fixed
✓ Search lights portable
✓ Navigation lights
✓ Instrument lights
✓ SAR horn
✓ Loud hailer

Safety

✓ Life jackets
✓ Fire extinguishers
✓ Flares
✓ Anchor and line
✓ Flashlights
✓ EPIRB
✓ Life rafts/life rings
✓ Fire pump
✓ Sea anchor
✓ Heaving line
✓ First aid bag/stretcher

Electronics

✓ Shore power
✓ GPS
✓ Radar/direction finder
✓ Radios/cell phone
✓ Depth sounder
✓ Single side band
✓ Engine hours

Engines

✓ Water level
✓ External leaks
✓ Transmission oil
✓ Fuel level sound/gauge
✓ Oil level
✓ Bilges, through hulls
✓ Generator levels
✓ Spare fluids
✓ Belt tension
✓ Run up/in gear
✓ Running gear and steering
✓ Pumps and lines
✓ Rudders

3. Engine startup and shut-down procedures

Engine startup checklist (pre-voyage)

Depending on the type and size of a power system, each engine will have a manufacturer's recommended startup and shut-down procedure. The startup check is completed by a cursory visual inspection of the engine and systems and is not a full examination. Here is a list of common checks that are consistent with most engine types.

- ✓ Fuel is topped up.
- ✓ Batteries are charged up.
- ✓ Belts are properly tensioned and not damaged.
- ✓ No water in the bilge.
- ✓ Steering system functional.
- ✓ Upon start up – tell-tail signs show impeller working.
- ✓ All gauges are operating correctly.
- ✓ Cooling system checked.

Engine shut-down checklist (post-voyage)

Make sure the vessel is ready for the next trip and that any irregularities or malfunctions are noted, logged, and reported or immediately repaired.

A shut-down check does not have to commence when the vessel is secured in port. A trained and experienced crew will run through a properly formulated shut-down checklist while the vessel is returning to port and make the necessary adjustments or repairs in transit. Here are some considerations:

- ✓ Vessel is properly secured to its mooring.
- ✓ Vessel is re-fueled.
- ✓ Visual inspection of the engine shows no abnormalities and everything in the appropriate place.
- ✓ Visual inspection and placement of all safety equipment.
- ✓ No water in the bilge.
- ✓ All systems remain functional.
- ✓ All logs are up to date.
- ✓ Batteries are charging.

4. Fueling process

Steps to fuel safely

As mentioned in previous chapters, fueling presents certain safety issues that need to be addressed through proper protocols. Below are some best practices that should form part of your fueling process:

1. Vessel must be secured to the dock.
2. All engines shut down.
3. Portable tanks removed from vessel.
4. All non-essential crew/passengers disembark vessel.
5. Extinguish all flames and pilot lights.
6. Shut off all batteries.
7. Have a fire extinguisher at the ready.
8. Close all hatches and door compartments to prevent the spread of fumes.
9. Ground nozzles to fill pipe to avoid static spark.
10. Have a spill cloth at the ready for spillage.
11. Avoid overfill and fuel expansion.
12. Upon completion, check for vapour, odours.
13. Run bilge blower for four minutes.

5. Heavy weather preparation

A “good captain” can often be defined as one who knows when to leave port – or not! Good seamanship requires a throughout knowledge of weather, seas, and the impact this environment will have on your vessel. It also requires a good understanding of how a vessel will react on various angles of seas. This includes: head seas, following seas, at angles to seas, and the unique characteristics and dangers presented.

The size of a vessel, the route the vessel will take, and the weather and wind conditions for that day are all calculations that should determine how the vessel will proceed.

Weather checklist

This checklist can be viewed as a risk-management tool to assist the Master on the elements that need to be assessed before proceeding. When presented with heavy weather, a vessel should follow a checklist to establish protocols. Here are some steps to considered before departure:

- ✓ Obtain the latest weather forecast and conditions available.
- ✓ Advise crew and passengers of the vessel’s heavy weather and safety protocols.
- ✓ The vessel should have a policy that dictates when the sea state is too severe to depart.
- ✓ Weather routing should be used to avoid adverse weather conditions.
- ✓ Establish a checklist for placement and securing of cargo and all items above and below decks: anchors, lifeboats, galley, bridge, and lashings.
- ✓ Implement a checklist to ensure hatches, doorways, and ventilation openings are closed.
- ✓ Fuel and water tanks should be full to avoid stability issues by free-surface effect.