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## Study Material

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This document contains study material for the OUPV and Master 100 ton courses offered by Columbia Pacific Maritime LLC. This is not intended to represent all the material covered in the course; it is only intended to provide a preview in a few areas that can be challenging to some students. For a complete study guide you may purchase the workbook online or order it when you schedule the class. The course workbook is provided free with the class; if you purchase it in advance bring it with you to the class and receive full credit off the cost of the class.

The following professional publications are available from new and used bookstores and your local library. They contain information that is relevant to the both the OUPV and Master 100 ton classes.

- Chapman Piloting and Seamanship, 64<sup>th</sup> edition or newer
- Navigation Rules (USCG publication)
- US Coast Pilot (NOAA publication)
- Light List (USCG publication)
- American Practical Navigator (Bowditch)

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## Navigation

This section includes instruction in chart navigation and some general navigation subjects such as marine weather, tides and tidal currents, US system of aids to navigation, electronic navigation equipment, and the use of charts and publications. Having the ability to reference information in the US Coast Pilot and Light List is highly beneficial in the class, along with an understanding of how to determine direction and distance on the chart.

### Chart Basics

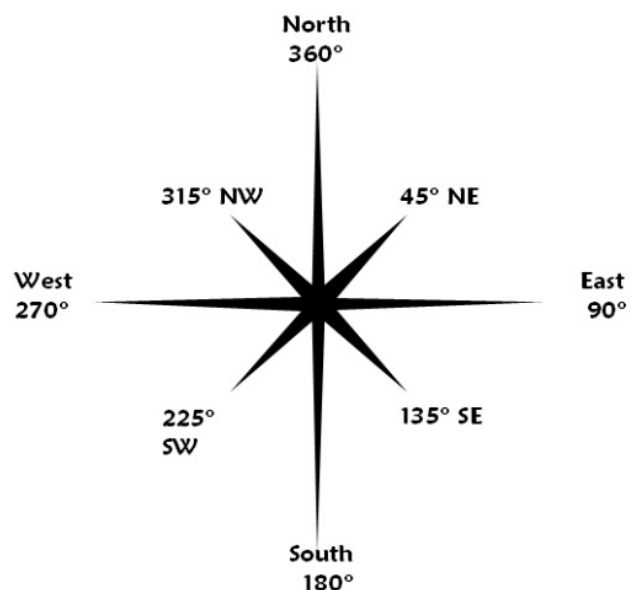
Latitude lines are like the runs on a ladder used to climb between the equator and the North Pole; they are parallel to the equator and equally spaced. Latitude is measured from 0° to 90° north or south of the equator; where 0° latitude is the equator and 90° latitude is the pole. The latitude of 41° 52' N means 41 degrees and 52 minutes north of the equator.

Because latitude lines are parallel and equally spaced, latitude is used to measure distance on a Mercator chart. One minute of latitude is equal to one nautical mile; there are 60 minutes (or miles) in one degree of latitude.

Longitude lines all pass through the North and South Poles and are called Meridians. Since these lines meet at the poles they are not parallel to each other and they are not equally spaced and longitude is not used to measure distance. Longitude is measured from 0° to 180° east or west of the prime Meridian, which is the 0° longitude line that passes through Greenwich, England. The longitude of 121° 35' W means 121 degrees and 35 minutes west of Greenwich.

The combination of latitude and longitude is used as the Earth's geographic coordinate system where any point on the earth can be described as a unique set of latitude and longitude coordinates.

Direction is measured from 000° through 360° using the compass rose on the chart. Having a basic understanding of the compass card makes determining direction on the chart much easier. The compass card is a circle marked off in one degree increments from North (000° or 360°) and increasing in a clockwise direction. The four cardinal points are North, East, South and West; represented by the directions of 000°, 090°, 180° and 270° respectively. The inter-cardinal points are NE, SE, SW and NW; represented by the directions of 045°, 135°, 225° and 315° respectively.



## **Navigation Terminology**

Understanding of the following basic navigation terminology is important to the navigation section of the class.

Dead Reckoning (DR) is a navigational process that uses only known information, such as the boats heading, as measured by the steering compass, and speed through the water. A DR plot does not consider any unknown factors, such as current.

The term “current” when used in navigation is a collection of all the unknown factors that affect the vessels position. This includes water movement, leeway caused by wind and any steering errors that may occur. While these unknowns can be measured, they cannot be predicted with any consist accuracy and are considered to be unreliable for the purpose of navigation.

Heading or course is the direction the boat is being steered as read on the steering compass. When the vessels heading is plotted on the chart it becomes an intended track line and the DR position will always fall along the intended track line at a distance based on the speed of the boat.

Bearing is the direction towards an observed object measured in degrees. Bearings can be measured as relative, true or compass. A relative bearing references the bow of the boat and increases clockwise around the boat. The starboard (right) beam is 90° relative to the bow and the port (left) beam is 270° relative to the bow. Compass bearings reference the magnetic steering compass, while true bearings reference true north.

When a bearing is plotted on the chart it is called a “line of position” (LOP). Two or more intersecting lines of position taken at about the same time represent a position fix. Lines of position can be ranges (distance to an observed object) or they can be bearings (direction to an object).

## **Magnetic Compass Error**

True is a direction measured in degrees clockwise from the True North Pole. True is measured on the chart using the outside ring on the compass rose.

Magnetic is a direction measured in degrees clockwise from the magnetic north pole. Since the magnetic north pole is not located in the same place as the True North Pole there is a difference between True and magnetic directions; this difference is called variation.

Variation is the magnetic compass error between True and magnetic heading caused by the magnetic field of the earth. It is measured in degrees east or west of True North; a variation of 18° E means that magnetic north is 18° east of true north. Variation changes with geographic location. The variation for the area will be printed in the center of the compass rose on the chart.

Compass or per steering compass (PSC) is a direction indicated by the vessel's magnetic steering compass. The magnetic compass points to magnetic north, but is affected by the magnetic field of the boat. The difference between magnetic and compass north is called deviation.

Deviation is the magnetic compass error between magnetic and compass heading caused by the magnetic field of the boat. It is measured in degrees east or west of magnetic north and changes with the boats heading. The deviation table contains a list of compass heading from 000° through 360°, generally in 30 degree increments and the corresponding deviation for that heading. Every vessel should have a deviation table posted near the steering compass. The following is an example of a deviation table. To use the deviation table locate the magnetic or compass heading on the left and read the deviation on the right. When the heading falls between two numbers evaluate the deviation accordingly. Example: the deviation for 030°psc is 02°W; the deviation for 015°psc is 03°W.

Heading	Deviation	Heading	Deviation
000°	04°W	180°	04°E
030°	02°W	210°	02°E
060°	00°	240°	00°
090°	02°E	270°	02°W
120°	04°E	300°	04°W
150°	05°E	330°	05°W

Compass correction is the process of changing from True to compass headings or from compass to True headings. The following is an example of applying variation and deviation to change between true and compass headings. The deviation comes from the deviation table above and a variation of 14°W. Use these general rules for making corrections.

- When working from true to compass all WEST errors are added and all EAST errors are subtracted.
- When working from compass to true all WEST errors are subtracted and all EAST errors are added.

True	T	321°	251°	089°	185°
Variation	V	14°W	14°W	14°W	14°W
Magnetic	M	335°	265°	103°	199°
Deviation	D	05°W	02°W	03°E	03°E
Compass	C	340°psc	267°psc	100°psc	196°psc

### Compass Correction Exercise 1

In the following exercise you are applying magnetic errors to change compass headings to true headings. Use the principles illustrated in the previous pages to solve these problems. Your answer should be within one degree of the correct answer. The variation for the area is 14°W and the deviation table is:

Heading	Deviation	Heading	Deviation
000°	04°W	180°	04°E
030°	02°W	210°	02°E
060°	00°	240°	00°
090°	02°E	270°	02°W
120°	04°E	300°	04°W
150°	05°E	330°	05°W



- W	T	<u>083°</u>	T	_____	T	_____	T	_____
+ E	V	<u>14°W</u>	V	_____	V	_____	V	_____
	M	<u>097°</u>	M	_____	M	_____	M	_____
	D	<u>02°E</u>	D	_____	D	_____	D	_____
	C	095°psc	C	301°psc	C	178°psc	C	025°psc

T 083

T 283

T 168

T 009

T	_____	T	_____	T	_____	T	_____
V	_____	V	_____	V	_____	V	_____
M	_____	M	_____	M	_____	M	_____
D	_____	D	_____	D	_____	D	_____
C	240°psc	C	315°psc	C	029°psc	C	241°psc

T 226

T 296.5

T 013

T 227

T	_____	T	_____	T	_____	T	_____
V	_____	V	_____	V	_____	V	_____
M	_____	M	_____	M	_____	M	_____
D	_____	D	_____	D	_____	D	_____
C	058°psc	C	248°psc	C	138°psc	C	069°psc

T 044

T 233


T 128.5

T 056

## Compass Correction Exercise 2

In the following exercise you are applying magnetic errors to change true headings to compass headings. Use the principles illustrated in the previous pages to solve these problems. Your answer should be within one degree of the correct answer. The variation for the area is 14°W and the deviation table is:

Heading	Deviation	Heading	Deviation
000°	04°W	180°	04°E
030°	02°W	210°	02°E
060°	00°	240°	00°
090°	02°E	270°	02°W
120°	04°E	300°	04°W
150°	05°E	330°	05°W

 + W - E	T	173°	T	301°	T	288°	T	006°
	V	<u>14°W</u>	V	_____	V	_____	V	_____
	M	<u>187°</u>	M	_____	M	_____	M	_____
	D	<u>04.5°E</u>	D	_____	D	_____	D	_____
	C	<u>182.5°psc</u>	C	_____	C	_____	C	_____
	C 182.5	C 319.5		C 306		C 023		
	T	197°	T	181°	T	288°	T	190°
	V	_____	V	_____	V	_____	V	_____
	M	_____	M	_____	M	_____	M	_____
	D	_____	D	_____	D	_____	D	_____
	C	_____	C	_____	C	_____	C	_____
	C 209	C 192		C 306		C 201		
	T	236°	T	081°	T	203°	T	218°
	V	_____	V	_____	V	_____	V	_____
	M	_____	M	_____	M	_____	M	_____
	D	_____	D	_____	D	_____	D	_____
	C	_____	C	_____	C	_____	C	_____
	C 251	C 093		C 216		C 230.5		

## Rules of the Road

The Rules of the Road (AKA Navigation Rules) apply to all vessels underway on ocean waters and the federally navigable inland waters of the United States. The demarcation line is the boundary line that divides the International and Inland Rules. The International Rules (AKA COLREGS) apply to all vessels on ocean waters seaward of the demarcation line; the Inland Rules (AKA Unified Rules) apply to all vessel on the federally navigable inland waters of the US shoreward of the demarcation line. The best reference for the Rules of the Road is the “Navigation Rules” published by the US Coast Guard.

The Rules are written in four parts:

- Part A, General Rules contain the general concepts and definitions that the Rules of the Road are built upon.
- Part B, Steering and Sailing Rules contain a common sense approach to avoiding collisions in three sections; conduct of vessels at all times, conduct of vessels in sight of one another and the conduct of vessels operating in or near an area of restricted visibility.
- Part C, Lights and Shapes contain the lights and shapes that vessels must display to indicate their operating condition, as defined in Part A, and how they are approaching another vessel so that they can avoid collision as defined in Part B.
- Part D, Sound and Light Signals contain the sound signals that vessels use to indicate their actions or intentions as defined in Part B; or there location in fog.

The following Rules represent problem areas for some students; for a complete understanding of the Rules please reference the USCG “Navigation Rules” book.

### Rule 3 General Definitions

This Rule contains several definitions that are “for the purpose of applying the Rules”. The following is a selection of those definitions as necessary to understand the fog signals contained in Rule 35.

Underway means that you are not aground, at anchor, or otherwise made fast to shore.

- Underway and Making Way means that you are moving through the water or making a wake.
- Underway and Not Making Way means that you are drifting or otherwise dead-in-the-water.

The following are the vessel occupations. A vessels occupation defines the lights and shapes that a vessel must carry, the sound signals it will use in restricted visibility and how it will interact with other vessels to avoid collision. With the exception of two occupations, a vessel must be underway to be defined as one of the following vessels; a vessel at anchor is just an anchored vessel for the purpose of applying the Rules.

- A vessel “Not under Command” (NUC) means a vessel that cannot maneuver because of some exceptional circumstances; the vessel that is broken down, has lost its steering, or is otherwise unable to maneuver as required by the Rules of the Road.
- A vessel “Restricted in Ability to Maneuver” (RAM) means a vessel that cannot maneuver because of the nature of her work. This condition includes survey vessels, vessels servicing an aid to navigation or a submarine cable, vessels dredging, towing

vessels engaged in a towing operation that prevents them from deviating from her course, or any similar operations, but does not include fishing vessels or sailing vessels. RAM is one of the two occupations that can be maintained at anchor.

- A vessel “Constrained by Draft” means a power-driven vessel that cannot maneuver because of her draft in relation to the available the depth and width of the navigable channel. This is an International Only definition.
- A “Fishing Vessel” means a vessel that is fishing with nets, lines, trawls, or other fishing gear which restricts maneuverability, but does not include vessels fishing with trolling lines. Fishing is the second occupation that can be maintained at anchor.
- A “Sailing Vessel” means a vessel propelled by sail only; if she is propelled by sail and power she is considered a power-driven vessel for the purpose of applying the Rules.
- A “Power-Driven Vessel” means any vessel propelled by machinery. This occupation includes pilot vessels and towing vessels.

### **Rule 32 Definitions of sound signals**

A short blast is a blast of the ship’s whistle of about one second. A prolonged blast is a blast of the ship’s whistle of from 4 to 6 seconds.

### **Rule 34 Maneuvering and Warning Signals**

Note the difference between International and Inland signals.

#### International Only

The following signals are given by a power-driven vessel when in sight of another vessel and maneuvering as required by the Rules. These signals are signals of action that are not responded to.

- One Short Blast: Meaning I am turning to starboard.
- Two Short Blasts: Meaning I am turning to port.
- Three Short Blasts: Meaning I am operating astern propulsion.
- Five or more Short Blasts: This is the danger signal meaning that I am in doubt that you are taking sufficient action to prevent a collision; or that I am in doubt as to your intentions; or that I feel it is unsafe for you to overtake me at this time.

#### Inland Only

The following signals are given by power-driven vessels in sight and meeting or crossing at a distance of within a half mile of each other.

- One Short Blast: Meaning I intend to leave you on my port side; if in agreement the other vessel would respond with the same signal.
- Two Short Blasts: Meaning I intend to leave you on my starboard side; if in agreement the other vessel would respond with the same signal.
- Three Short Blasts: Meaning I am operating astern propulsion; this signal is not answered.
- Five or more Short Blasts: This is the danger signal meaning that I am in doubt that you are taking sufficient action to prevent a collision; or that I am in doubt as to your intentions; or that I feel it is unsafe for you to overtake me at this time. The danger signal is not answered.

The following signals are used to indicate a vessel's intention to overtake another vessel. These signals always reference the vessel being overtaken.

#### International Only

These signals are used by any vessel intending to overtake another vessel in a narrow channel, when both vessels are in sight of each other; these signals are not used on open waters.

- Two Prolonged Blasts followed by One Short Blast: Meaning I intend to overtake you on your starboard side.
- Two Prolonged Blasts followed by Two Short Blasts: Meaning I intend to overtake you on your port side.
- One Prolonged Blast; One Short Blast; One Prolonged Blast; One Short Blast: This is a signal of agreement given by the vessel being overtaken.

#### Inland Only

These signals are used by a power-driven vessel intending to overtake another power-driven vessel when both vessels are in sight of each other.

- One Short Blast: Meaning I intend to overtake you on your starboard side; if in agreement the other vessel would respond with the same signal.
- Two Short Blasts: Meaning I intend to overtake you on your port side; if in agreement the other vessel would respond with the same signal.

#### Summary of Maneuvering and Warning Signals

Signal	Inland	International
	Signals of Intent given when within one half mile meeting or crossing; these signals are always matched	Signals of Action given when in sight; these signals are never answered
One short	I intend to leave you on my port side (maneuvering right)	I am altering course to starboard
Two short	I intend to leave you on my starboard side (maneuvering left)	I am altering course to port
Overtaking (Signals of intent given when in sight)		
One short	I intend to overtake you on your starboard side (maneuvering right)	
Two short	I intend to overtake you on your port side (maneuvering left)	
Two prolonged & One short		I intend to overtake you on your starboard side (maneuvering right)
Two prolonged & Two short		I intend to overtake you on your port side (maneuvering left)
Answer when in agreement	Answered with the same signal	Prolonged – Short – Prolonged – Short
The following signals are the same for both International and Inland		
Three short	I am operating astern propulsion	
Five short	Danger signal (This signal can be given by any vessel)	

## **Rule 35 Sound Signals in Restricted Visibility**

The following signals are required for vessels operating in or near an area of restricted visibility.

Power-driven Vessels when underway and making way shall sound One Prolonged Blast every two minutes; when underway and not making way she shall sound Two Prolonged Blasts every two minutes.

All of the following vessels sound a fog signal of One Prolonged and Two short blasts every two minutes. This signal is commonly called the "Handicapped Signal" because it is used by all vessels that are not power-driven and by vessels working at anchor.

- Not Under Command
- Restricted in Ability to Maneuver (underway or at anchor)
- Constrained by Draft
- Fishing Vessel (underway or at anchor)
- Sailing Vessel
- Towing Vessel

Manned Vessels being towed, if the last vessel in the tow, shall sound One Prolonged Blast followed by Three Short Blasts every two minutes

Vessels at anchor, except for Restricted in Ability to Maneuver and Fishing Vessels, sound a five second rapid ringing of the bell every minute. If the vessel is greater than 100 meters in length this would be followed by a five second sounding of a gong in the after part of the vessel.

A vessel aground will sound three distinct strokes of the bell; followed by a five second rapid ringing of the bell; followed by three distinct strokes of the bell ever minute. If the vessel is greater than 100 meters in length this would be followed by a five second sounding of a gong in the after part of the vessel.

### **Optional Fog Signals**

Four Short Blasts is the optional identity signal for a Pilot Vessel. This signal does not replace the required fog signals, but may be used in addition to the required fog signals by a Pilot Vessel while engaged in pilotage duty.

One Short Blast; One Prolonged Blast; One Short Blast is a warning signal that may be used by a vessel at anchor or aground to warn an approaching vessel of her position. This signal does not replace the required fog signals for a vessel at anchor or aground.

## Summary of fog signals

Signal	Vessel
<b>Underway Signals (Two minutes intervals)</b>	
One Prolonged	Power-driven vessel making way
Two Prolonged	Power-driven vessel NOT making way
One Prolonged – Two short	Handicapped Signal given by NUC, RAM, CBD, Fishing Vessels, and Sailing Vessels (RAM and FV give this signal while underway or at anchor)
One Prolonged – Three short	Manned vessel being towing if the last vessel in the tow
<b>Anchor Signals (One minute intervals)</b>	
5-sec bell	Anchored vessel less than 100 meters
5-sec bell / 5-sec gong	Anchored vessel 100 meters or more
3-strokes bell / 5-sec bell / 3-strokes bell	Vessel aground (if over 100 meters would give a 5-sec gong sound aft)
<b>Optional Whistle Signals</b>	
Four short	Identity signal for a Pilot vessel given in addition to the required fog signals for a power-driven vessel or a vessel at anchor.
Short – Prolonged – Short	Given by vessel aground or at anchor to warn an approaching vessel of their position

## Deck General, Safety and Environmental Protection

This section is about seamanship, safety and the federal regulations governing the safe operation of small passenger vessels. For the purpose of the federal regulations a small passenger is any vessel less than 100 gross registered tons (GRT) carrying at least one passenger for hire.

- The term “Gross Registered Tons” is not a measurement of the vessel’s weight, but a measurement of her interior space, where every 100 cubic feet is considered to be one ton of carrying capacity. While the GRT of a vessel cannot be determined entirely by referencing its length, in general most vessels of less than 65 feet in length are less than 100 GRT.
- The term “Passenger for hire” means any passenger that pays or contributes anything of value as a condition for riding on the vessel. If you operate a power driven vessel on the federally navigable waters of the US or on any ocean waters and carry even one passenger for hire you are required to hold a USCG issued Merchant Mariner Credential (MMC) officers endorsement.

The Code of Federal Regulations (CFR) contains the federal laws of the United States in 50 titles. Title 46, Shipping, contains the federal laws governing the operation of all US flagged vessels engaged in the transportation of cargo and passengers for hire. Three subchapters in Title 46 contain the federal regulations that apply to small passenger vessels.

- Subchapter B Merchant Marine Officers and Seaman; this subchapter contains the manning and watch-standing requirements for commercial vessels, along with the sea service and exam requirements for the different MMC endorsements.
- Subchapter C Uninspected Vessels; this subchapter contains uninspected vessel regulations, including the federal regulations governing small uninspected passenger vessel. For the purpose of this regulation a small uninspected passenger vessel is a vessel of less than 100 GRT carrying from one to six passengers for hire, not counting the operator or crew. The operator must hold an endorsement as Operator of Uninspected Vessel (OUPV) or higher to legally operate a small uninspected passenger vessel.
- Subchapter T Small Passenger Vessels; this subchapter contains the federal regulations governing small inspected passenger vessels. An inspected vessel is issued a Certificate of Inspection (COI) by the local US Coast Guard Marine Safety Office. Small inspected passenger vessels, or T-Boats, are power-driven vessels of less than 100 GRT carrying more than six and fewer than 150 passengers for hire. The COI will state the total number of passengers allowed as well as the route the vessel may operate on the all the safety equipment that must be onboard. The operator of a T-Boat must hold an endorsement as Master with an appropriate tonnage limitation for the vessel.

In addition to having knowledge of federal regulations, this section requires knowledge of seamanship as well. Both the OUPV and the Master are required to have knowledge of basic seamanship skills; including an understanding small vessel handling and maneuvering characteristics, anchor gear and anchoring procedures, and marlinespike seamanship. The master must also have knowledge of ship construction terminology, helm and line handling commands, station bills and emergency drills, sea survival skills, and stability theory.

Most mariners are somewhat familiar with anchors and anchoring procedures, and small vessel handling characteristics; but many mariners with experience limited to small vessels are much less familiar with marlinespike seamanship.

Marlinespike seamanship includes construction and use of all types of lines found on boats, including wire rope. While the OUPV and Master are not required to be able to splice line or tie any knots, they are required to have knowledge of basic knots and splices used in the maritime industry. The following knots reference the diagram on the next page; all mariners should have knowledge of these basic knots.

E. Timber Hitch or a timber hitch and a half hitch; this knot is used to secure a line to a timber or a spar.

F. Round Turn and two half hitches; this knot is used to secure a line to a spar or pole when the pull is perpendicular to that spar or pole.

G. Fisherman's Bend; this knot is used to secure a line to a ring, anchor or anchor chain.

H. Becket Bend; this knot is used to attach two lines of different sizes together or attach a line to an eye; it is also known as a sheet bend.

I. Bowline on a Bight; this knot is used to make a temporary eye in the middle of a line.

O. Barrel Hitch; this knot is used for lifting or loading barrels or similarly shaped cargo when they need to be lifted vertically.

P. Rolling Hitch; this knot is used for securing a line to a railing or a spar.

Q. Bowline; this is a knot used to make a temporary eye in the end of a line.

R. Double Becket Bend; see becket bend above.

T. French Bowline; this is a knot that can be used for lifting a man over the side while allowing his hands to be free.

W. Square Knot; this knot is used to secure two small lines together; it is also known as a reef knot or sailor's knot.

X. Clove Hitch; this knot is used to secure a line to a railing or spar when the pull is perpendicular to that railing or spar.

