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Source of document: Federal Law Enforcement Training Center
Freedom of Information/Privacy Office
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FOIA Online Request Form

Federal Law Enforcement Training Center
U. S. Department of Homeland Security
1131 Chapel Crossing Road
Glynco, Georgia 31524

Homeland Security

November 12, 2013

404-142 (ITD/IBM)

Re: FOIA 13-110

This is the final response to your Freedom of Information Act (FOIA) request to the Federal Law Enforcement Training Centers (FLETC), dated September 14, 2013, and received by this office on said date. You are seeking a digital/electronic copy of the MLETP handbook on maritime operations.

Records responsive to your request are enclosed. However, from the enclosed records I have determined to partially withhold portions of the records pursuant to Title 5 U.S.C. § 552, FOIA Exemptions (b)(5) and (b)(7)(E). Information withheld is marked with the applicable FOIA exemption.

FOIA Exemption 5 protects from disclosure those inter- or intra-agency documents that are normally privileged in the civil discovery context. The three most frequently invoked privileges are the deliberative process privilege, the attorney work-product privilege, and the attorney-client privilege. After carefully reviewing the responsive documents, I determined that portions of the responsive documents qualify for protection under the:

- **Deliberative Process Privilege**
  The deliberative process privilege protects the integrity of the deliberative or decision-making processes within the agency by exempting from mandatory disclosure opinions, conclusions, and recommendations included within inter-agency or intra-agency memoranda or letters. The release of this internal information would discourage the expression of candid opinions and inhibit the free and frank exchange of information among agency personnel.

Exemption 7(E) protects records compiled for law enforcement purposes, the release of which would disclose techniques and/or procedures for law enforcement investigations or prosecutions, or would disclose guidelines for law enforcement investigations or prosecutions if such disclosure could reasonably be expected to risk circumvention of the law. I have determined that disclosure of law enforcement techniques contained in the enclosed training manuals could reasonably be expected to risk circumvention of the law. Additionally, the techniques and procedures at issue are not well known to the public.

This is a partial denial of your request. You may appeal this decision within 60 days of the date of this letter. Your appeal must be in writing, signed by you, and should be addressed to:

Freedom of Information Act Appeal
Federal Law Enforcement Training Center
1131 Chapel Crossing Road, Bldg. 681
Glynco, GA 31524

The cost to process this request did exceed our minimum threshold of $14.00. However, due to the Federal furlough and our subsequent delayed response the fees have been waived in this instance. Therefore, you owe nothing.

If you should have any questions concerning this matter, or if we may be of further assistance, please feel free to contact me at (912) 267-3103 or via email at Leslie.Jensen@fletc.dhs.gov.

Sincerely,

Leslie A. Jensen

Leslie A. Jensen
FOIA/Privacy Officer

Enclosure:
CD containing MLETP training manual

U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

STUDENT TEXT

AIDS TO NAVIGATION

7502 **AUG/11**

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INTRODUCTION

Local knowledge is a great tool for local piloting. Many boat operators keenly develop their local area knowledge, and it often is their only piloting skill. Local knowledge is a great asset within a locale; however, you cannot take it anywhere else.

An MEO, a Marine Enforcement Officer, is a capable pilot, able to dispatch to any assignment through out the U.S. or the world. The MEO can read and understand charts. The MEO recognizes the features of aids to navigation, natural landmarks, or manmade features and knows how to use them for piloting.

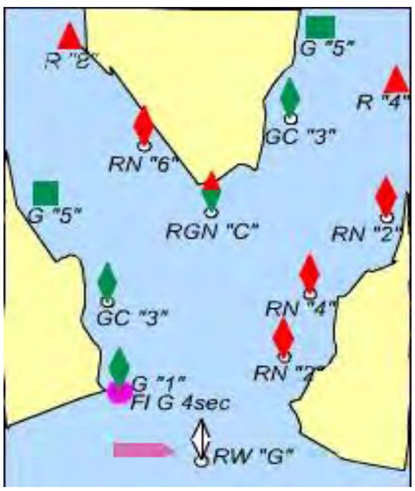
This course is about developing the knowledge to recognize all aids to navigation and the need to relate the symbols on the chart to what the pilot is seeing.

EPO #1: EXPLAIN THE TERM AND THE PURPOSE OF AN AID TO NAVIGATION; AND HOW AIDS TO NAVIGATION DIFFER IN THE TWO REGIONS DESCRIBED BY THE INTERNATIONAL ASSOCIATION OF LIGHTHOUSE AUTHORITY (IALA).

What is an aid to navigation?

An aid to navigation is any device, external of the vessel, *intended to assist a navigator* in determining a position, or a safe course, and warns of dangers or an obstruction.

For the navigator returning from a sea voyage an aid to navigation placed on a prominent headland provides an identifiable landfall. Other aids make it possible to follow natural or improved channels, and provide a continuous system of charted marks for coastal piloting.



The navigator can accurately interpret the purpose of an aid to navigation by reading the local chart. The proper interpretation of a chart symbol identifies the intent or purpose of an aid to navigation, or better an entire series of aids to navigation.

Viewing the chart, in advance of your present location (i.e. prior planning) allows the operator to recognize what lies ahead. Now, the navigator is able to determine, position, course, and the location of dangers or obstructions.

NOTE: Use the CHART to best Interpret the purpose of aids to navigation.

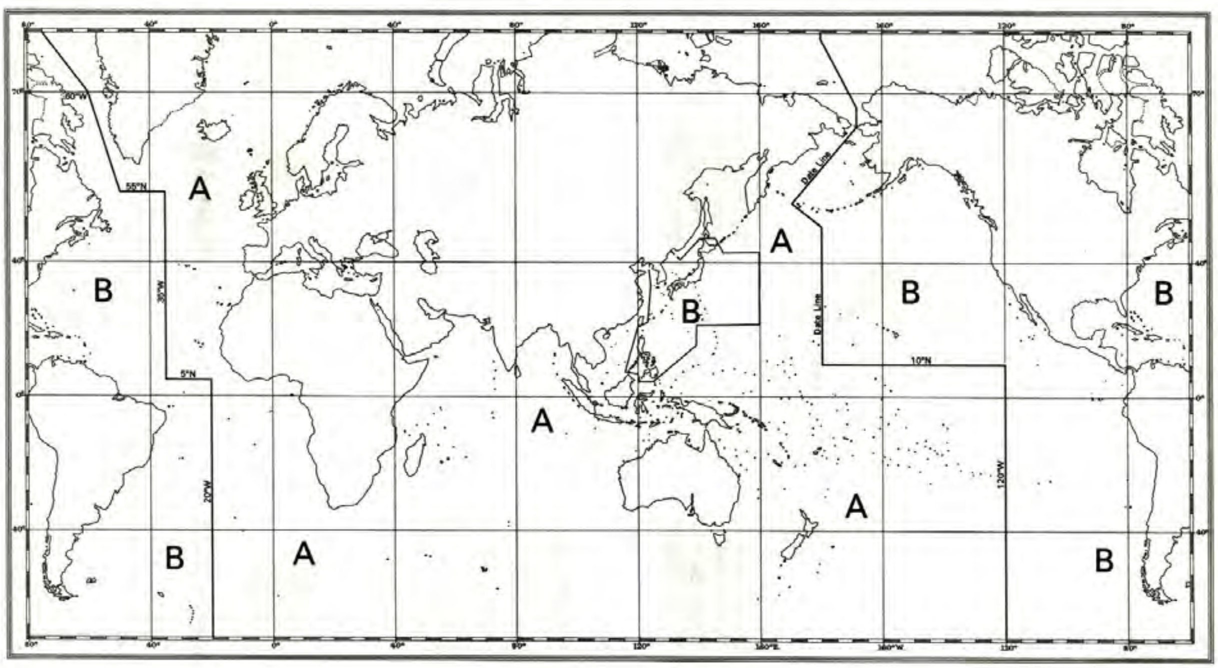
The International Association of Lighthouse Authority (IALA)

The IALA Maritime Buoyage System, adopted in 1980 and fully implemented by 1991, is the results of an international non-governing body representing over 50 Maritime Countries and 9 international organizations. They exchange information and technology to improve aids to navigation.

The IALA Maritime Buoyage System is a worldwide uniform system of buoyage. Its rules define the types of aids to navigation, with their recognition colors, shapes, top-marks, and light color and light characteristics.

The IALA Maritime Buoyage System established two regions to meet the conflicting requirements of its member organizations and countries. Region A uses the color RED to mark the PORT side of a channel and Region B using RED to mark the STARBOARD side of the channel.

The U.S. Navigation System complies with the rules identified in Region B. Lateral marks (aids to navigation that mark the channel limits or side marks) in this region use red to indicate the starboard channel side and green for the port channel side.



The IALA Maritime Buoyage System describes all fixed and floating marks referred as minor aids to navigation. These marks indicate:

The side and centerlines of navigable channels
Natural dangers
Wrecks and other obstructions
Regulated navigation areas
Other important features

The IALA Maritime Buoyage System does not apply to lighthouses, sector lights, leading lights and their daymarks, lightships and large navigational buoys. These types of aid to navigation each have their own unique recognition features. Their unique recognition features will not confuse the navigator when discerning between these lights and other aids to navigation described in this course or the recognition features described by IALA.

EPO #2: IDENTIFY THE PURPOSE OF BEACONS, BUOYS, AND THE APPLIANCES USED ON AIDS TO NAVIGATION.

BEACONS

A beacon is a structure permanently fixed to the surface of the earth. A beacon has a high degree of position integrity. Major lights, and minor lights and minor daybeacons are all categories of beacons.

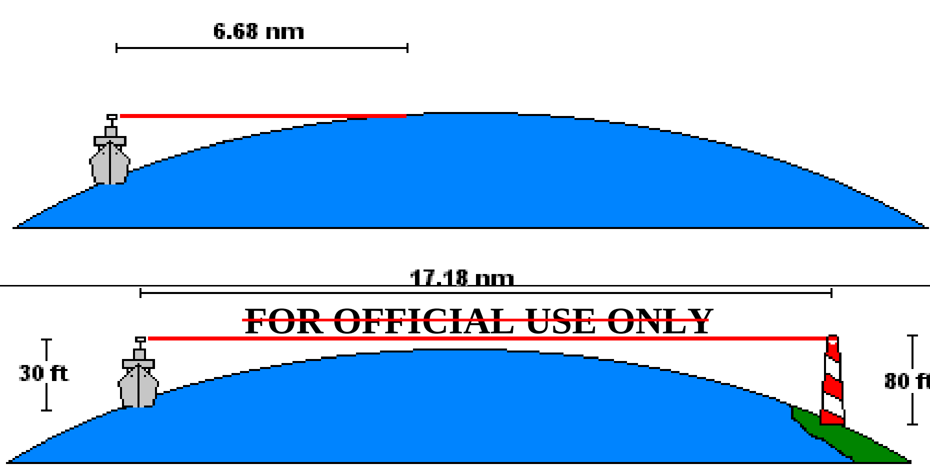
Primary seacoast lights and secondary lights are major lights. Major lights have a high intensity light exhibited from their fixed structure.

Lighthouses and light towers are primary and secondary seacoast lights. Primary seacoast lights assist in making landfall from sea and for coastwise travel from headlands to headlands. Secondary lights are at harbor entrances and other locations where a reliable high intensity light is required.

The primary purpose of a lighthouse is to hold a light, high, above the water increasing the geographic range of the light. Every lighthouse is a unique structure, for identification by day. It displays a unique flashing light phase, which identifies the light by night. The chart indicates the light color and frequency, height of light, and the NOMINAL RANGE (NM). (ST.SIMONS Light, FFL 60s, 104 ft., 18NM.)

Nominal range is the maximum distance a light is seen. The intensity or brilliance of the light fixes its nominal range, when viewed under clear meteorological conditions. Nominal range is generally greater than the observed distance.

Geographic range is a limiting factor for observing a light. Geographic range varies with the height of the object and the height of eye. Geographic range is the greatest distance the curvature of the earth permits viewing an object of a given height, from a given height of eye.



GEOGRAPHIC RANGE TABLE

The following table gives the approximate geographic range of visibility for an object which may be seen by an observer at sea level. It is necessary to add to the distance for the height of any object the distance corresponding to the height of the observer's eye above sea level.

Height Feet / Meters	Distance Nautical Miles (NM)	Height Feet / Meters	Distance Nautical Miles (NM)	Height Feet / Meters	Distance Nautical Miles (NM)
5/1.5	2.6	70/21.3	9.8	250/76.2	18.5
10/3.1	3.7	75/22.9	10.1	300/91.4	20.3
15/4.6	4.5	80/24.4	10.5	350/106.7	21.9
20/6.1	5.2	85/25.9	10.8	400/121.9	23.4
25/7.6	5.9	90/27.4	11.1	450/137.2	24.8
30/9.1	6.4	95/29.0	11.4	500/152.4	26.2
35/10.7	6.9	100/30.5	11.7	550/167.6	27.4
40/12.2	7.4	110/33.5	12.3	600/182.9	28.7
45/13.7	7.8	120/36.6	12.8	650/198.1	29.8
50/15.2	8.3	130/39.6	13.3	700/213.4	31.0
55/16.8	8.7	140/42.7	13.8	800/243.8	33.1
60/18.3	9.1	150/45.7	14.3	900/274.3	35.1
65/19.8	9.4	200/61.0	16.5	1000/304.8	37.0

Located in offshore waters is the Light tower. It provides a landfall for busy ports, providing a high accuracy of positioning, such as the Ambrose Light or Chesapeake Light. The primary purpose of a light tower, like a lighthouse, is to support the light a considerable height above the water.

The light tower is a four-pile structure, with a superstructure atop the pilings and a light tower. The light has a unique flashing phase. It is frequently equipped with a foghorn. The light tower displays its name on each side of the superstructure. It normally has a RACON.

A Minor Light displays a light of low to moderate intensity. A minor light follows the IALA rules for determining recognition and purpose. It marks features in a harbor, defines the limit of a channel, and placed in isolated locations. Their construction is a single piling, a dolphin or cluster of pilings, or a skeletal tower, located in shallow water. They have geometrically shaped daymarks, pertinent for recognition and determining purpose. They have lights for nighttime recognition. The light color and light phase or light characteristics identify the purpose of the light.

The chart symbol for any lighted beacon is a **black dot and a magenta colored teardrop**.

A Minor Daybeacon has no light to assist detecting it at night or during restricted visibility. The construction of a daybeacon is the same as a light. It displays the same type of daymark. The location of a daybeacon is frequently at the navigable limits of a channel or in an isolated location, or on the danger or obstruction that it is marking.

The chart symbol of a daybeacon may be a **square** or **triangle**. Their charted position is approximate.

BUOYS

The buoy is the other component of the U.S. Navigation System. Buoys are floating aids to navigation anchored to the seabed, with an anchor rode and sinker. A buoy performs the same functions as a minor beacon, except its location is in deeper water.

The charted position of a buoy is its approximate position.

The environmental conditions and the channel requirements determine the size of a buoy.

A lighted buoy is a floating hull with a tower, called a *pillar buoy*, which supports a light high above the water. The nominal range of the light is approximately 3.8 nautical miles. It has a radar reflector that is part of the tower. Reliable radar detection is approximately four nautical miles.

The tower often houses an audible device such as, a bell, gong, or whistle.

The shape of a lighted buoy has no recognition feature.

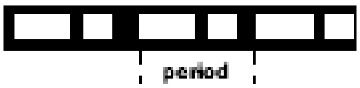
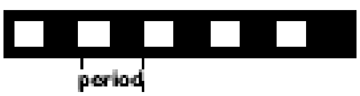
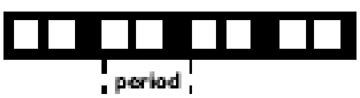
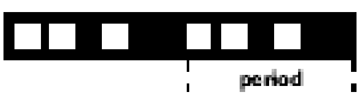
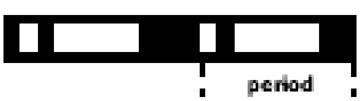
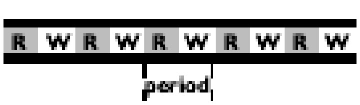
The chart symbol for a lighted buoy is a **diamond shape, with a small open circle surrounded by a magenta disc**.

An unlighted buoy has four shapes. They are can or cylindrical, nun or conical, spherical, and spar shaped. The unlighted buoys frequently used, in the U.S. Navigation

System, are can and nun buoys.

The U.S. Navigational System uses unlighted buoys when: A lighted buoy is not necessary. A channel has frequent shoaling and the use is discouraged for mariners without local knowledge. The chart symbol for an unlighted buoy is the small open circle and the diamond shape.

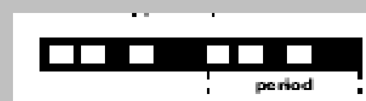
CHARACTERISTICS OF LIGHTS

Illustration	Type Description	Abbreviation
	1. Fixed. A light showing continuously and steadily.	**F**
	2. Occulting. A light in which the total duration of light in a period is longer than the total duration of darkness and the intervals of darkness (eclipses) are usually of equal duration.	
	2.1 Single-occulting. An occulting light in which an eclipse is regularly repeated.	**Oc**
	2.2 Group-occulting. An occulting light in which a group of eclipses, specified in numbers, is regularly repeated.	**Oc (2)**
	2.3 Composite group-occulting. A light, similar to a group-occulting light, except that successive groups in a period have different numbers of eclipses.	**Oc (2+1)**
	3. Isophase. A light in which all durations of light and darkness are equal.	**Iso**
	4. Flashing. A light in which the total duration of light in a period is shorter than the total duration of darkness and the appearances of light (flashes) are usually of equal duration.	
	4.1 Single-flashing. A flashing light in which a flash is regularly repeated (frequency not exceeding 30 flashes per minute).	**Fl**
	4.2 Group-flashing. A flashing light in which a group of flashes, specified in number, is regularly repeated.	**Fl (2)**
	4.3 Composite group-flashing. A light similar to a group flashing light except that successive groups in the period have different numbers of flashes.	**Fl (2+1)**
	5. Quick. A light in which flashes are produced at a rate of 60 flashes per minute.	
	5.1 Continuous quick. A quick light in which a flash is regularly repeated.	**Q**
	5.2 Interrupted quick. A quick light in which the sequence of flashes is interrupted by regularly repeated eclipses of constant and long duration.	**IQ**
	6. MORSE CODE. A light in which appearances of light of two clearly different durations (dots and dashes) are grouped to represent a character or characters in the Morse code.	**Mo (A)**
	7. Fixed and flashing. A light in which a fixed light is combined with a flashing light of higher luminous intensity.	**FFl**
	8. ALTERNATING. A light showing different colors alternately	**Al RW**

Lights and Light Characteristics

Lights have distinctive characteristics that distinguish it from other lights or relate specific information. A light characteristic repeated at a specific interval is the light's rhythm. The dark interval of the rhythm is the eclipse. The total duration of the light includes the period of light and the eclipse. The timing starts at the first appearance of the light, through the eclipse. The timing of the light rhythm stops at the appearance of the next light phase.

Example: Fl (2 + 1) 5_s – The light cycle begins at the first flash and continues through the periods of darkness and ends at the beginning of the next cycle.



Light rhythms have no lateral significance.

RACONS

A RACON is a transponder, receiver/transmitter, used on aids to navigations. A RACON responds to a received radar pulse by transmitting an encoded Morse character back to the radar set. The Morse character begins with a dash for identification. The word "RACON" and its identifying mark appears on the chart with the aid to navigation symbol. In the U.S. Navigational Buoyage System, a RACON has the following purposes:

It identifies both buoys and beacons (Lights, lighthouses, light towers).

It identifies a landfall or positions along an inconspicuous coastline.

It indicates navigable spans under bridges.

It identifies offshore oil platforms and similar structures.

It identifies and warns of environmentally sensitive areas (such as coral reefs).

The programmed cycle of a RACON, installed on U.S. buoy, transmits 50% of the time. A Racon is active for 20 seconds. Then it is off for the next 20 seconds.

SOUND SIGNALS ON BUOYS

Some buoys use wave actuated sound signals, in areas of frequently reduced visibility (Frequent Fog). The tones are random, meaning they do not have constant cycle. The sound signals used on buoys are:

A bell buoy has a bell, which produces a clear "bell-like" tone.

A gong buoy has an audible signal that produces multiple flat tones.

A whistle buoy produces a whistle tone produced by an air column passing through the whistle passage during the wave movement of the buoy.

An electric horn buoy is battery operated and has a timed audible frequency.

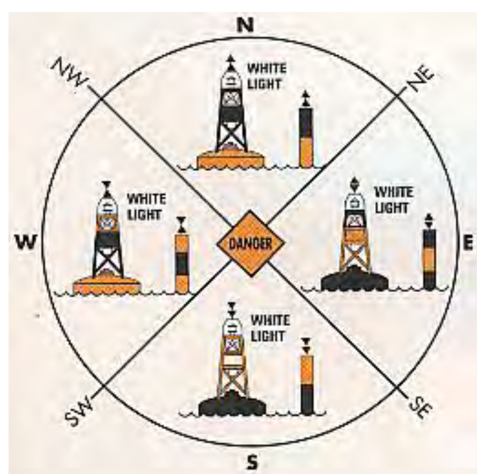
Audible signals have no lateral significance.

The sound signal on a beacon is a foghorn. It is also in an area of frequently reduced visibility. It has a timed audible frequency or phase. The chart symbol has the words - Fog Horn or horn with the sound phase or characteristic. (Example – HORN 1 blast ev.30s (3s bl.)

EPO #3: DIFFERENTIATE BETWEEN THE CARDINAL SYSTEM AND THE LATERAL SYSTEM OF BUOYAGE.

CARDINAL SYSTEM OF BUOYAGE

The cardinal system of buoyage is best suited for open waters with numerous dangers. A cardinal buoy takes its name from the 90º quadrant of the compass, which it marks. The 90º quadrants are as follows:



North Quadrant – NW – NE

East Quadrant – NW – SE

South Quadrant – SE – SW

West Quadrant – SW

Cardinal marks use compass direction to determine the direction the mark/buoy lies from the danger. Safe passage about a northern quadrant mark is to the north. The location of the north quadrant mark is north of the danger or obstruction. A vessel passing this mark/buoy keeps the mark between the danger and the vessel.

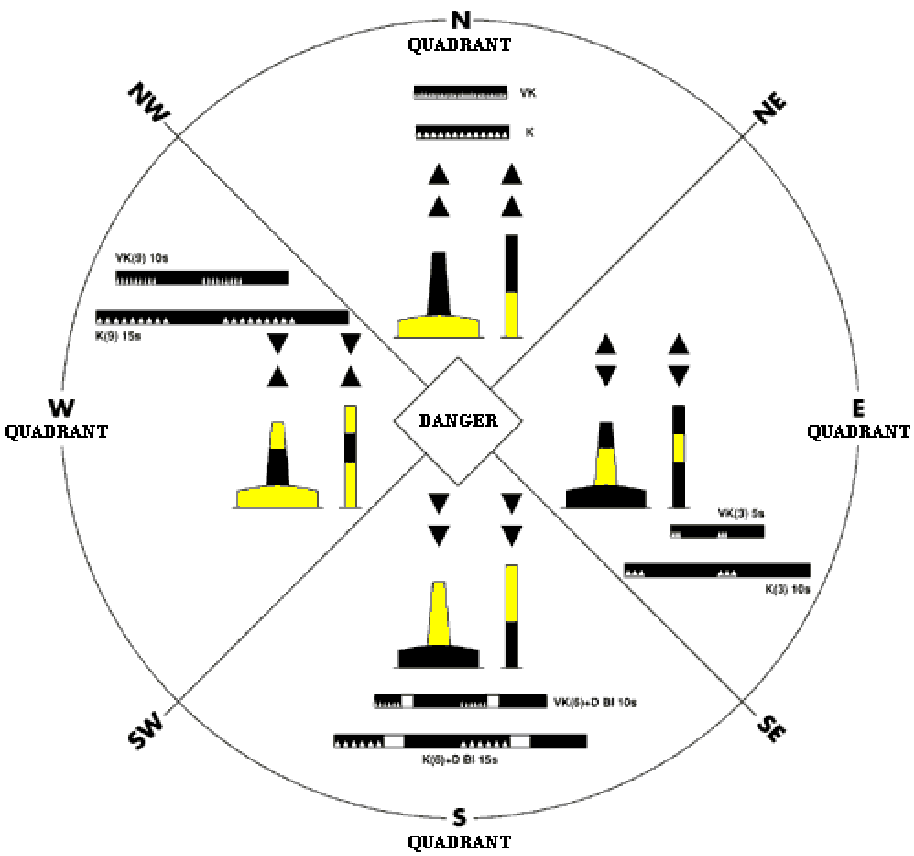
The readily identifiable recognition feature, by day, of a Cardinal mark/buoy is the top-mark.

The North Quadrant displays two cones pointing up.

The East Quadrant displays two cones. The top cone's apex points up; the bottom cone's apex points down.

The South Quadrant displays two cones with both apexes facing down.

The West Quadrant displays two cones with the apexes joined.



The readily identifiable feature, by night, of a cardinal mark/buoy is the white flashing frequency of their lights.

The North Quadrant has a continuous quick or very quick flashing light.

The East Quadrant has a quick or very quick flashing group of three flashes.

The South Quadrant has one long light flash followed by a quick or very quick flashing group of six flashes.

The West Quadrant has a quick or very quick group of nine flashes.

LATERAL SYSTEM OF BUOYAGE

The lateral system of buoyage is best suited for well-defined channels. The location of each mark indicates the limits of the channel relative to the course. The dangers lay outside of the channel limits. Lateral aids to navigation are those marks kept on the port or starboard side of a vessel, while proceeding from seaward. Lateral aids to navigation, in essence, mark the limits of the navigable channel. (Side Marks)

The U.S. Navigational Buoyage System is predominantly lateral aids to navigation and follows the IALA – B recognition features. Keep Red on the Right when Returning from Sea. (Conventional Direction - Red, Right, Returning)

Conventional Direction describes the general direction a vessel travels when proceeding from seaward towards the headwater. Traveling in a clockwise direction describes conventional direction.

On the St. Lawrence Seaway and upon the Great Lakes, the general direction of travel is West and North.

On the Mississippi River and other Western Rivers, general direction is towards the headwaters.

The U.S. Navigational System of Buoyage employs other marks described by the IALA.

EPO #4: DESCRIBE THE RECOGNITION FEATURES OF ALL AIDS TO NAVIGATION IN THE U.S. NAVIGATIONAL SYSTEM OF BUOYAGE.

The greatest number of aids to navigation found in the U.S. Navigation System is the lateral mark.

Lateral aids to navigation have very definitive recognition features. The recognition features of lateral marks found in the U.S. Navigation System and the IALA-B region are:

PORT CHANNEL SIDE

SHAPE - Square dayboard or cylindrical shaped can buoy

COLOR - Green

LIGHT COLOR – Green

NUBMERING - Consecutive Odd Numbers

STARBOARD CHANNEL SIDE

SHAPE - Triangle dayboard or conical shape nun buoy

COLOR – Red

LIGHT COLOR – Red

NUMBERING - Consecutive Even Numbers

Lateral marks display either red or green lights with light rhythms that do not exceed thirty flashes per minutes. They are regular flashing lights. Regular flashing light frequencies are:

Fl. 6s – A single flash every 6s. It flashes 10 times per minute.

Fl. 2.5s – A single flash every 2.5s. It flashes 24 times per minute.

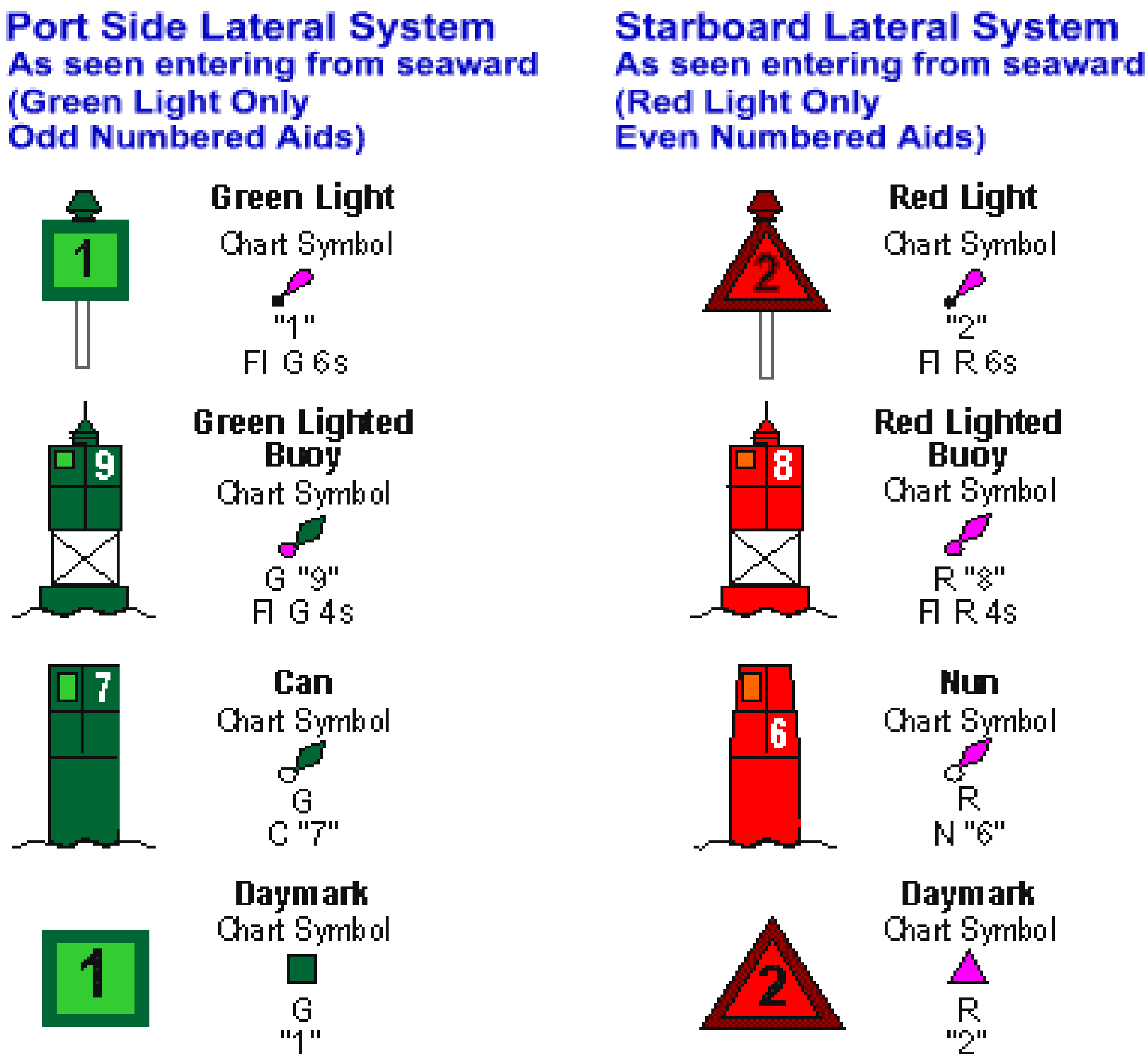
Fl. 4s – A single flash every 4s. It flashes 15 times per minute.

A <u>quick flashing light</u> **"Q"** is 60 flashes per minute. A quick flashing light on a lateral mark indicates:

A danger or obstruction is at the limits or just outside of the channel limits.

The channel turns sharply.

There is a narrowing or constricting of the channel.



PREFERRED CHANNEL

The Preferred Channel aid to navigation marks a channel junction, bifurcation, or a wreck or obstruction. Passing a preferred channel marks is normally to either side by a vessel, but it does indicate to the mariner the preferred channel.

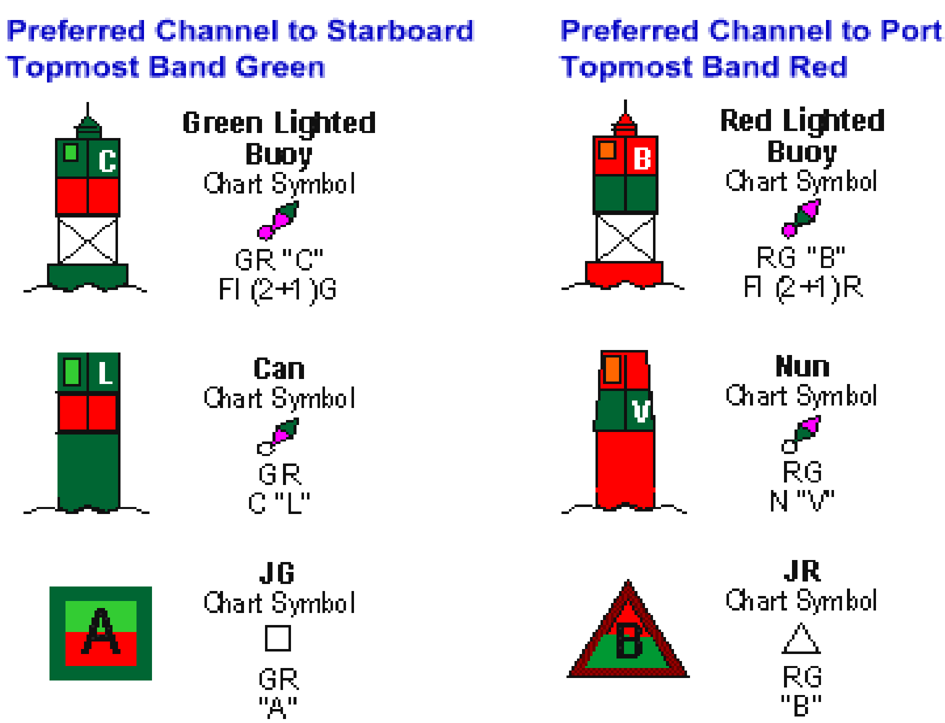
The preferred channel mark is either a red and green horizontally banded, **or** it is a green and red horizontally banded aid to navigation. The color of the top band indicates the preferred channel.

The top band of a preferred channel lighted buoy is red; to follow the preferred channel pass the mark on your starboard side, for vessels returning from sea, the channel is to port.

A preferred channel beacon, passed on the starboard side, has a triangular daymark, and horizontal red and green bands. The unlighted preferred channel buoy is a nun buoy with the same recognition features.

The top band of a preferred channel lighted buoy is green; the buoy serves as a port hand mark for vessels, returning from sea, following the preferred channel. The preferred channel is to starboard.

A



preferred channel beacon, passed on the port side, has a square daymark, and horizontal green and red bands. The unlighted preferred channel buoy is a can with the same recognition features.

The light rhythm for a preferred channel mark is a composite group **flashing (2+1)**. The color of the light is the same color of the top band.

Preferred channel aids to navigation have consecutive lettering, starting with the letter "A," not numbers.

> **CAUTION:** "It may not always be possible to pass on either side of preferred channel aids to navigation. The appropriate nautical chart should always be consulted." **COMDTPUB P16502.3 Page viii.

NON-LATERALMARKS

Non-lateral aids to navigation supplement lateral aids to navigation, used to mark the limits of a navigable channel. These marks identify natural dangers, wrecks, obstructions, safe water, regulated areas, and other important features.

Daybeacons or minor lights located outside of the navigable channel do not have lateral significance. These aids to navigation have diamond-shaped dayboards divided into four diamond-shaped sectors. The color of the side sectors is always white. The colors of the top and bottom sectors are either: green, red, or black sectors. The situation dictates the purpose of this aid to navigation. Refer to the U.S. Coast Guard Light List or the chart.

SAFE WATER MARK

The safe water mark indicates navigable water all around this aid to navigation. It is safe to approach this marker from any direction. The safe water mark indicates a fairway, mid channel, or the seaward end of a channel.

The recognition features of a Safe Water Buoy is:

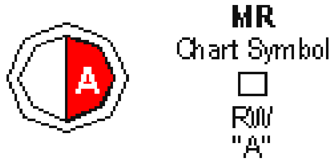
Red and white vertical stripes

Lighted buoy is pillar shape

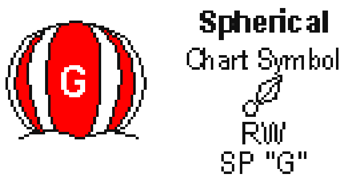
Displays a red spherical top-mark

Has a white Morse code "A" light frequency (– —)

Displays letters of the body of water it marks (STS)

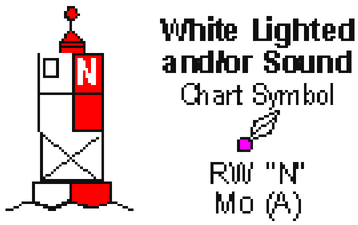


The shape of the unlighted safe water buoy is either: Spherical, Nun, or Can shape

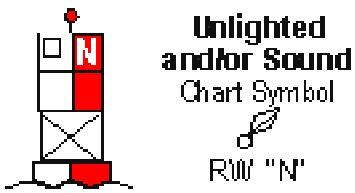


The recognition features of a safe water beacon are:

The dayboard is an octagon - it is half-red and half-white



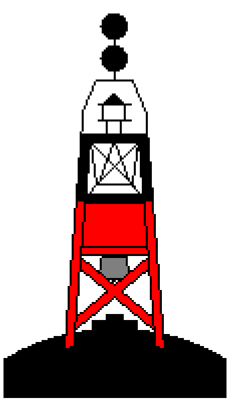
Has a white Morse code "A" light frequency

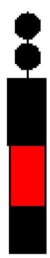


ISOLATED DANGER BUOY

The Isolated Danger Buoy marks an isolated obstruction that has navigable water around it. The mooring location of this navigational mark is directly above or near the isolated danger. Do not approach these marks close aboard. Refer to the chart to determine the size and depth of water around the danger. Alter course in a timely period.

The recognition features of an isolated danger buoy are:





A black buoy with at least one red band

A top mark of two black spheres

Has a white group flashing two (**Fl 2)** light frequency

It has letters, not numbers, for identification

SPECIAL PURPOSE MARK

A Special Purpose mark identifies special areas or features depicted on the chart or in other publications. Special purpose marks do not assist in safe navigation but alerts the navigator to some feature. The feature identified on the chart has the words

"SEE NOTES" to explain the feature. The "NOTE" has the Code of Federal Regulations for referencing details about the feature or an area, especially the boundaries.

Special purpose marks alert the navigator to the following:

Anchorages - Do not moor to a special purpose buoy marking an anchorage. Moor to white with a blue banded mooring buoys.

Cable or pipeline areas

Traffic separation schemes

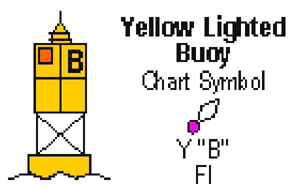
Military exercise zones

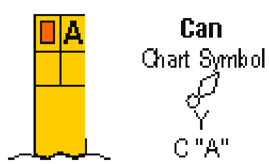
Fishing areas

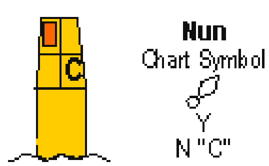
Disposal areas

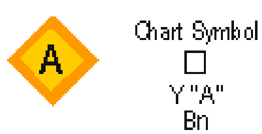
Weather data buoys, and others

The recognition features of a special purpose mark are:









Solid yellow color

Displays a yellow light with a fixed or slow flashing frequency

It has letter identification

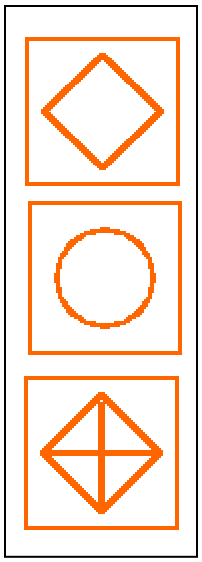
The unlighted special purpose buoy shape has no significance.

The special purpose daybeacon or lighted beacon is a yellow non-lateral shaped dayboard - a diamond shape.

REGULATORY AND INFORMATION AIDS TO NAVIGATION

Regulatory and information marks alert the mariner to warnings or regulatory matters. Regulatory and information marks use orange geometric shapes against a white background with black worded instructions to relay their purpose.

The recognition features and the meanings of the regulatory or information marks are:



Open-faced orange diamond – **Danger**
Example:
(DANGER Submerged Jetty)

An orange circular shape - **Operating Restrictions** - within a marked area
Example:
IDLE SPEED NO WAKE or **MANATEE ZONE 15MPH**

An orange diamond shape with a centered cross – **Exclusion Area SWIMMING AREA** - (excludes all types of watercraft from the marked area) - **PERSONAL WATERCRAFT AREA** - (excludes swimmers and all other watercraft)

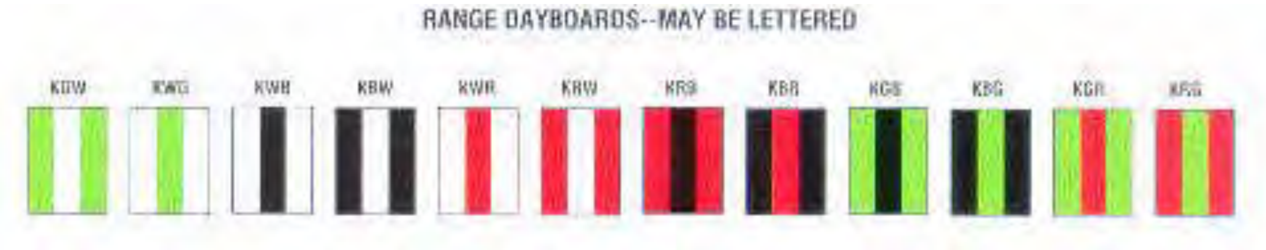
An orange square or rectangle - **general information, directions, or instructions**

Regulatory and information marks, when lighted, display a white light of various rhythms.

RANGES

A Range employs a pair of beacons, which mark the safe transit of the channel, when the structures appear in a straight line, or one behind the other. Consult the local chart to determine what section of the range your vessel can safely travel.

Ranges display rectangular dayboards with vertical striped color patterns. The common color pattern is the red (international orange) with a white vertical stripe in the center of the board. The color of the dayboards is dependent upon the surrounding background features.



Ranges, when lighted, display lights of any color, red, green, white, or yellow/amber lights. The light phases or frequencies are:

Front Range - Quick flash

Rear Range - Occulting or an Isophase

Other range light combinations are:

Front and Rear Ranges are daybeacons (unlighted range)

Front Range has a light and Rear Range is a daybeacon – The front range light may be of any color and light frequency. The front-range structure, because of its common location, at the limits of a channel, in addition, may display a lateral mark.

The technique used to align the two structures for safe transit is to steer toward the direction of the front-range beacon. As the mariner views the two structures of a range, they are not in alignment. The front-range appears to the left on the rearrange. Turn left towards the front structure until the rearrange appears in line.

BRIDGE MARKINGS

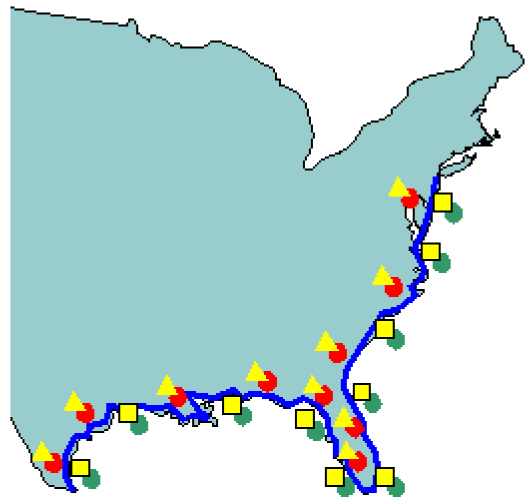
Bridges across navigable waters have red, green, and/or white lights for nighttime navigation. Red lights mark the bridge piers or a bridge's fender system. Red lights on a drawbridge or Bascule Bridge mean a closed bridge span for marine traffic.

Green lights on a drawbridge indicate the bridge span is open to marine traffic. On fixed-span bridges, green lights mark the centerline of the navigable channel.

White lights appear on fixed-span bridges, if there is a preferred channel through the bridge. The preferred channel has three white lights in a vertical line above the green light.

EPO #5: DESCRIBE THE CONVENTIONAL DIRECTION OF TRAVEL FOR THE U.S. INTRACOASTAL WATERWAY (ICW) AND THE IDENTIFICATION SYMBOLS FEATURED ON THE AIDS TO NAVIGATION.

The Intracoastal Waterway (ICW) provides a protected inland water route, for coastwise travel, from Manasquan Inlet, New Jersey to Brownsville, Texas. The conventional direction of buoyage on the ICW is clockwise. Clockwise on the east coast of the U.S. is a north to south direction. (Red on the Right and Green on the Left) Clockwise on the Gulf Coast of the U.S. is an east to west direction.



The ICW aids to navigation are no different than the marks described for the U. S. Navigation System with added identification. The additional identification on an ICW mark is a yellow symbol. Red aids to navigation have a yellow triangle. Green aids to navigation have a yellow square. Aids to Navigation without a lateral purpose have a yellow band at the bottom of the mark.

The ICW frequently follows other local channels and fairways in the conventional direction of travel. The ICW transits these waterways without any apparent differences of the local aids to navigation. The direction of travel of the ICW and these local channels are the same.

A Dual Purpose Channel exists when the direction of travel, of the local channel and the ICW, conflict or oppose. (*These channels travel in opposing directions*.) The local channel, returning from sea, is marked with the basic recognition features of shape, color, and numbers.

The yellow markings of the ICW will continue to appear on the same sides of the channel, marking the clockwise direction around the U.S. The yellow triangle marking the right side of the channel ***is on a green aid to navigation***. The yellow square marking the left side of the channel ***is on a red aid to navigation***.

Regardless of the color, shape, number, or light of the mark, the distinguishing yellow ICW symbols mark the clockwise direction of buoyage for the ICW.

U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

STUDENT TEXT

CHART INTERPRETATION

7503 (JUL/13)

~~WARNING~~

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INTRODUCTION

Charts are indispensable aids to safe piloting. To travel anywhere safely in a small boat one must have knowledge of the depths of the water, shoals and channels. One must know the locations of aids to navigation and landmarks. To determine the best course to your destination, you must know where it lies with respect to your present location, and recognize all navigational hazards along your proposed course line.

The vessel commander that travels in unfamiliar waters without the necessary navigational charts is foolhardy. A professional vessel commander always has the correct charts and knows how to read and use them.

A chart is a representation of a portion of the surface of the earth. Its design allows for convenient use during navigation. A chart is drawn and written on. Working on the chart allows for a graphic solution of navigational problems.

A nautical chart is concerned primarily with areas of navigable water. It features such information as coastlines, harbors, and depths of water, channels, aids to navigation, etc.

TERMINAL PERFORMANCE OBJECTIVE (TPO):
Given a scenario describing a series of navigational problems, the student will identify coordinates, type of projection, notes, features, scales, and navigational publications for accurately interpreting a chart. The student will also demonstrate measuring latitude/longitude, distance, and direction within the accuracies and tolerances established by practiced disciplines and conventions.

ENABLING PERFORMANCE OBJECTIVES (EPO):

EPO #1: IDENTIFY THE GEOGRAPHIC COORDINATE SYSTEM AND THE PROJECTION SYSTEM USED TO DEVELOP A CHART.

The Earth and its Coordinates

The earth is not a perfect sphere. It is an **oblate spheroid** (a sphere that is slightly flattened at the poles). The diameter of the earth at the Equator is roughly 6,888 miles. Its diameter through the poles is approximately 6,865 miles. However, for navigational purposes, it is considered to be a true sphere. This assumption allows relatively accurate solutions to navigational problems.

To solve navigational problems the navigator needs a system that accurately determines and easily identifies location. The cartographer uses certain principles of geometry to create a grid system of the earth's surface. That grid system is the geographic coordinate system. The geographic coordinate system employs intersecting parallels of latitude and meridians of longitude for determining and identifying location. This course discusses using the following geometric principles to create geographic coordinates:

Axis – The earth rotates about its polar axis, which is an imaginary line passing through the center of the earth, from the North Pole to the South Pole (i.e. the geographic or true poles).

Great Circles – A line formed on the surface of a sphere created by a plane passing through the center of the sphere is a great circle. Great circles divide the sphere into equal halves. Certain great circles are of primary interest to navigators.

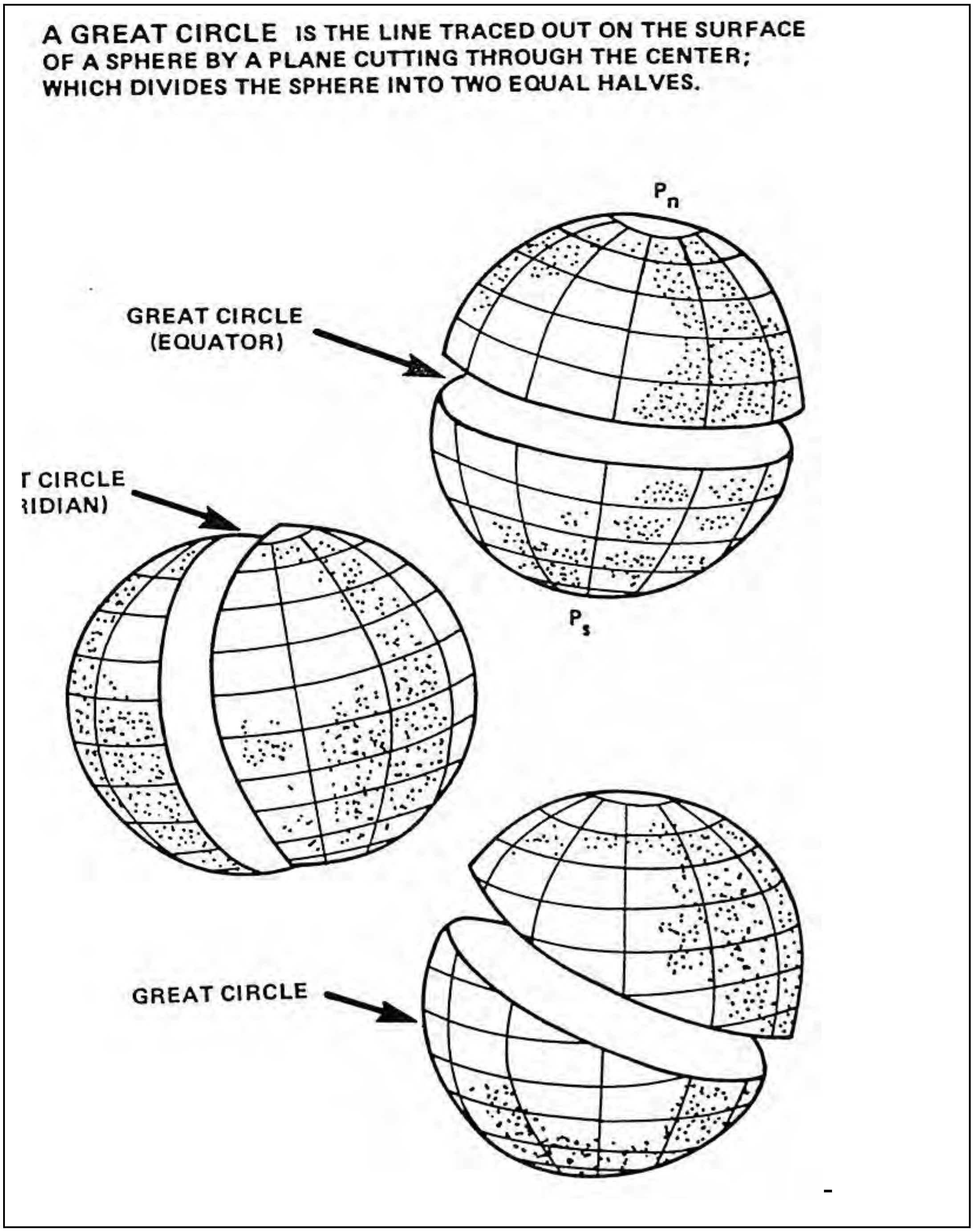
The great circle that divides the earth in half, equidistant from each pole, is the equator. It separates the earth into the Northern and Southern hemispheres.

Other great circles of interest are those formed by planes passing through both poles. These are meridians of longitude. There are an infinite numbers of meridians passing through both poles. These circles are also perpendicular to the plane that forms the equator. The meridian that passes through the Royal Naval Observatory at Greenwich, England is the Prime Meridian. It is 000^0 longitude. The Prime Meridian is the baseline from where you begin measuring the angular arc East or West to your position on the earth's surface.

On the other side of the earth is 180^0 longitude; commonly described as the "International Date Line." The International Date Line is an imaginary line drawn roughly along the 180th meridian; however, it bends to avoid passing over any land mass.

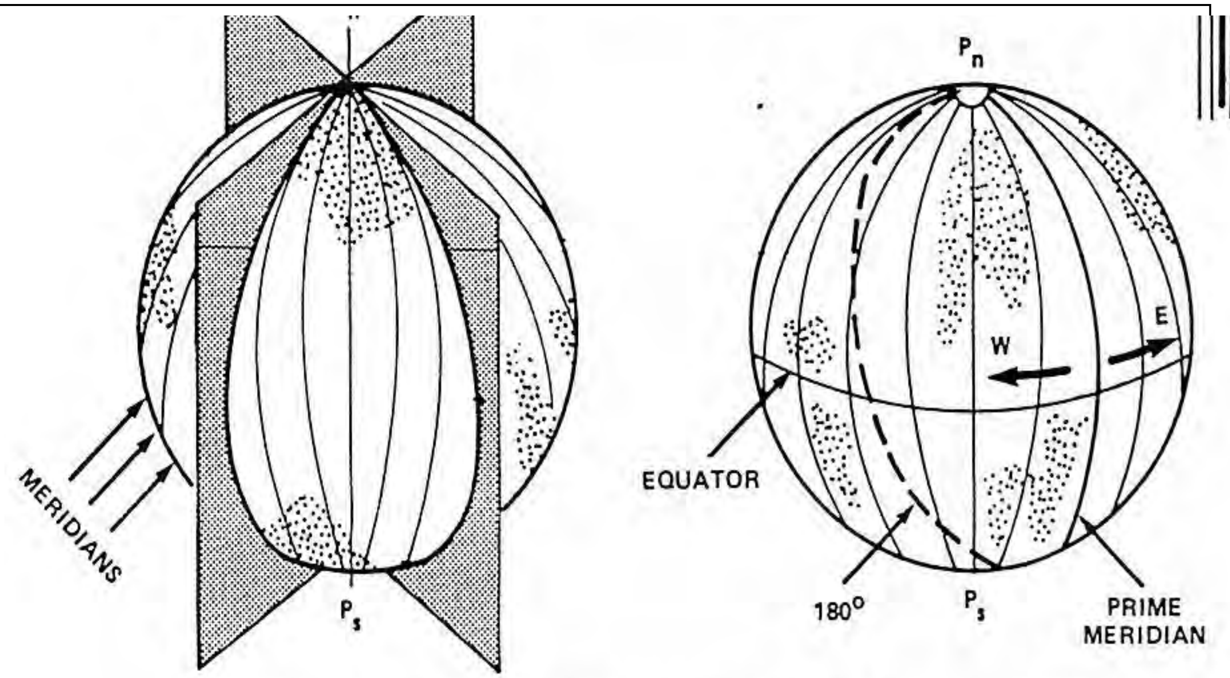
Time zones are related to meridians of longitude. Every 15 degrees of longitude is a time zone. As you move from one time zone into another, an hour change occurs.

360° divided by 15 equals 24 zones. Eventually, those hourly changes results in a day change which occurs at the International Date Line. Without time zones, half of the population would wake up when the sun was setting.



Meridians increase in angular value east and west from the Prime Meridian up to a maximum value of 180^0. The longitude location of any point on the surface of the earth is the angular distance measured along the equator, from the plane of the Prime Meridian to the plane of the great circle of that meridian and must be labeled East or

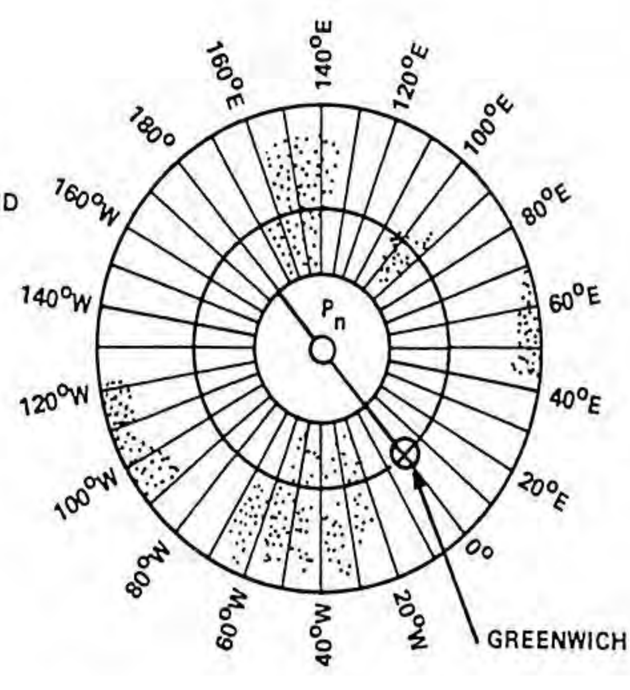
West. Longitude is always described using three digits for degree, i.e. 040^0 E.



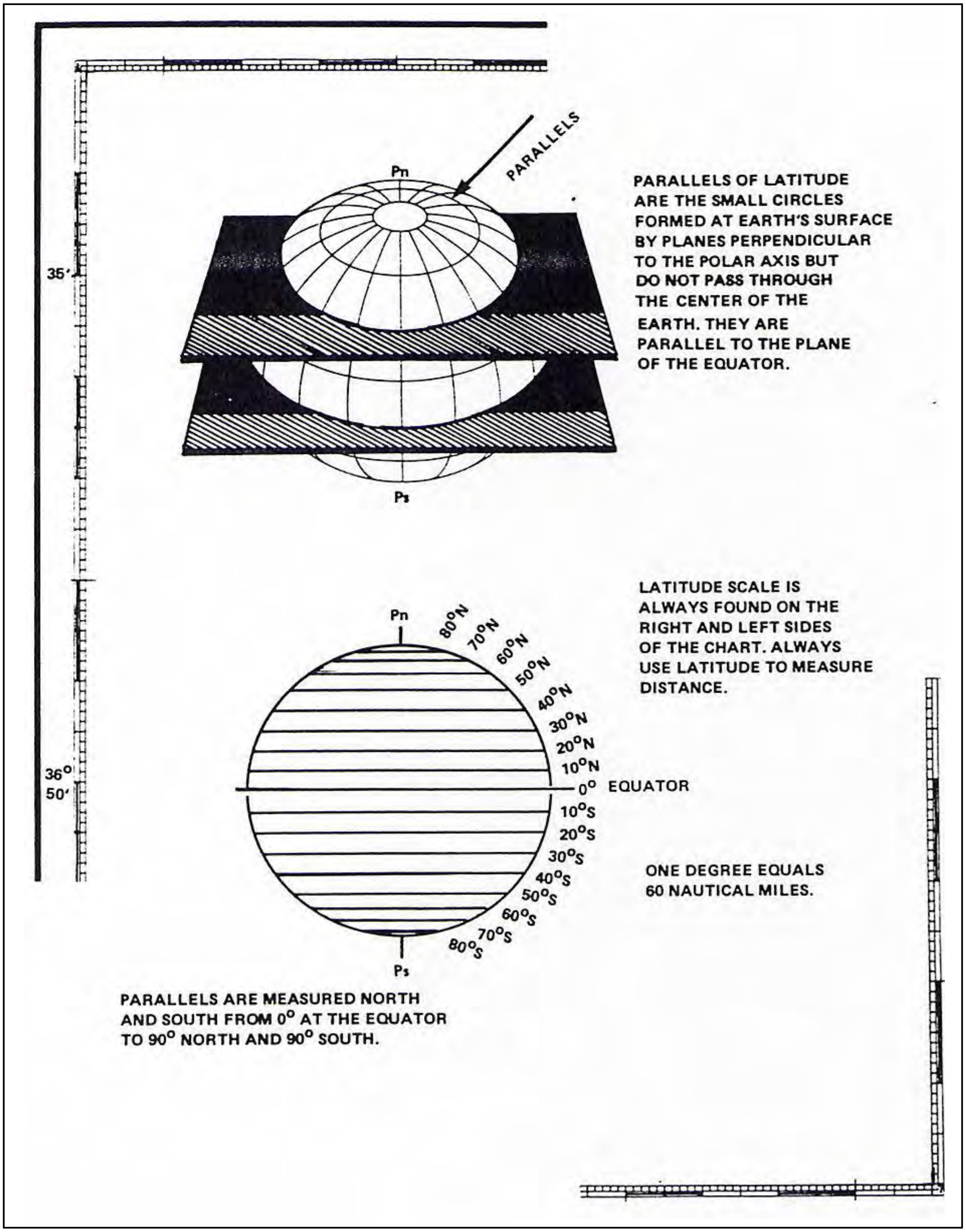
MERIDIANS OF LONGITUDE ARE FORMED ON THE EARTH'S SURFACE BY GREAT CIRCLES WHICH PASS THROUGH THE NORTH AND SOUTH POLES AND ARE MEASURED EAST AND WEST.

LONGITUDE IS MEASURED FROM THE PRIME MERIDIAN GREENWICH "ZERO" DEGREES TO 180 DEGREES AT THE INTERNATIONAL DATE LINE.

LONGITUDE SCALE IS ALWAYS FOUND ON THE TOP AND BOTTOM OF THE CHART. NEVER USE LONGITUDE TO MEASURE DISTANCE.



Small Circles – The line formed on the surface of a sphere by a plane that does not pass through the center of the earth is a small circle. Small circles that are parallel to the plane of the Equator are parallels of latitude.



The **Equator** is **00^o latitude**. Latitude increases in angular measurement to a maximum of 90^o North or South at each respective pole. The latitude describing a given position is the angular measurement from the plane of the Equator to the plane of the parallel at the given position measured from the center of the earth.

Determining Position

Lines of meridians and parallels intersect on the surface of the earth forming a grid. The grid uses a unit of measure called a **degree** to identify their angular position on the earth's surface. It is one 360th part of the circumference of a circle. We denote a degree using the symbol **º**.

A degree is divided into smaller units of measure called minutes and seconds, or tenths of minutes. A degree equals 60 minutes (just as an hour equals 60 minutes). We denote minutes with the symbol '.

A minute equals 60 seconds. We denote seconds with the symbol – ".

Navigators also read latitude and longitude in degrees, minutes, and tenths of minutes.

A tenth of a minute has six seconds (60 divided by 10 equals 6).

Mathematical conversions

Second to tenths of a minute: ***Seconds ÷ 60 = tenths of a minute***.
Example: 57" ÷ 60 = 0.95'

Tenths of a minute to seconds: ***Tenths of a minute x 60 = seconds***.
Example: 0.95' x 60 = 57"

A position on the earth is located by observing how many angular degrees it is north or south of the Equator and how many angular degrees, it is east or west of the Prime Meridian.

The latitude scale is on the right and left sides of a chart. In the Northern Hemisphere, the angular measure increases numerically from the bottom of the chart, north, to the top of the chart

The longitude scale is at the top and bottom of the chart. In the Western Hemisphere, the angular measure increases numerically from the right on the chart, westerly, to the left on the chart. Read the longitude scale from the right to the left.

State latitude first and denote it as either North (N) or South (S). Describe latitude in degrees as a two-digit number. The maximum latitude possible is 90º.

State longitude second and denote as East (E) or West (W). Describe longitude in degrees as a three-digit number (e.g. 001, 089, or 179).

Use two digit numbers to record minutes and seconds (e.g. 01' 10" or 10' 08").

State a position as **36^0 52' 30" N**, **075^0 31' 15" W**. The same position stated in tenths of a minute is **36^0 52.5' N**, **076^0 31.25' W**.

FOR BOTH LATITUDE AND LONGITUDE

1 DEGREE (1°) = 60 MINUTES (60')

1 MINUTE (1') = 60 SECONDS (60")

1/10 OF A MINUTE (.1') = 6 SECONDS (6")

USE THE LATITUDE SCALE FOR MEASURING DISTANCES

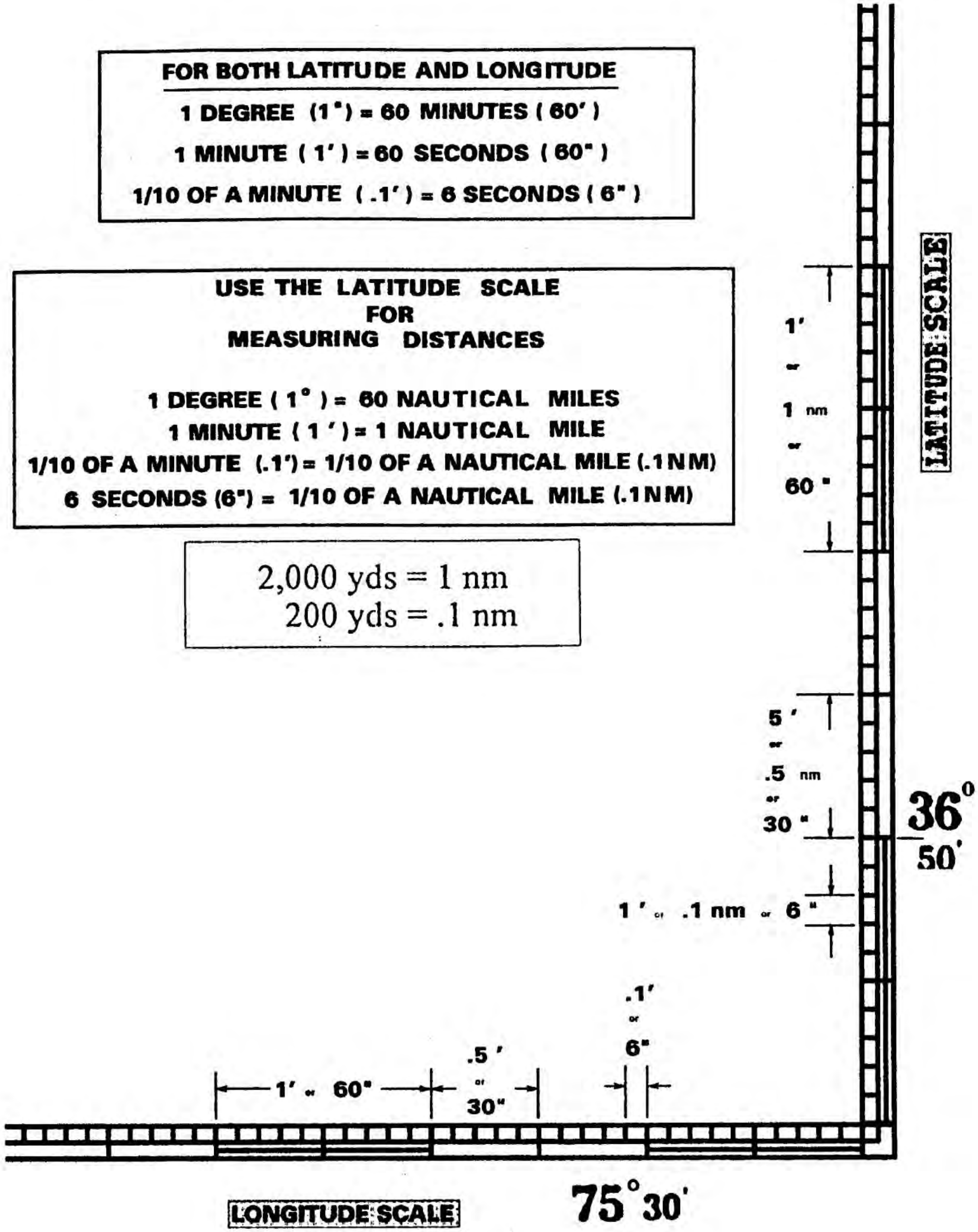
1 DEGREE (1°) = 60 NAUTICAL MILES

1 MINUTE (1') = 1 NAUTICAL MILE

1/10 OF A MINUTE (.1') = 1/10 OF A NAUTICAL MILE (.1NM)

6 SECONDS (6") = 1/10 OF A NAUTICAL MILE (.1NM)

2,000 yds = 1 nm
200 yds = .1 nm



CONVERTING TENTHS OF MINUTES OF LATITUDE AND LONGITUDE TO SECONDS OF LATITUDE AND LONGITUDE

TO CONVERT SECONDS TO TENTHS OF MINUTES

Divide seconds by sixty

EXAMPLE: 36" divided by 60 = .6' (of a minute)
EXAMPLE: 45" divided by 60 = .75' (of a minute)

TO CONVERT TENTHS OF MINUTES TO SECONDS

Multiply tenths by sixty

EXAMPLE: .8' multiplied by 60 = 48"
EXAMPLE: .4' multiplied by 60 = 24"

TO CONVERT TENTHS OF MINUTES TO YARDS*****Only with Latitude measurements, NEVER with Longitude** .

Multiply tenths by 2000 yards

EXAMPLE: .3' multiplied by 2000 yards = 600 yards
EXAMPLE: .25' multiplied by 2000 yards = 500 yards

TO CONVERT YARDS TO TENTHS OF MINUTES*****Only with Latitude measurements, NEVER with Longitude** .

Divide yards by 2000 yards

EXAMPLE: 600 yards divided by 2000 yards = .3' (of a minute)
EXAMPLE: 2500 yards divided by 2000 yards = 1.25' (minutes)

TO CONVERT SECONDS TO YARDS********Only with Latitude measurements, NEVER with Longitude** .

Divide seconds by 60 to get number of tenths of a minute, then multiply the tenths of minutes by 2000 yards.

EXAMPLE: 18" (seconds) divided by 60 = .3' (of a minute)
.3' (of a minute) multiplied by 2000 yards = 600 yards

All of these conversions are possible because of the relationship of the circumference of the Earth and that there is 360° (degrees) in a circle.

1° (degree of latitude) = 60nm (nautical miles) = 60'(minutes of latitude)
1'(minute of latitude) = 1nm (nautical mile) = 2000 yards = 60" (seconds of latitude)
.1'(tenth of a minute of latitude) = .1nm(nautical mile) = 200 yards = 6"(seconds of latitude)
1"(second of latitude) = 100 feet

ALWAYS REMEMBER TO USE THE LATITUDE SCALE ONLY TO MEASURE DISTANCE.

LATITUDE SCALE - Measures from 0°(Equator) - 90° and must be labeled N or S

LONGITUDE SCALE - Measures from 0° (Prime Meridian) - 180° (International Date Line) and must be labeled W or E. Longitude is always expressed using three digits for degrees, i.e. 90° W is properly written as 090 W and spoken as zero-nine-zero degrees west.

Rev.2/98 JF

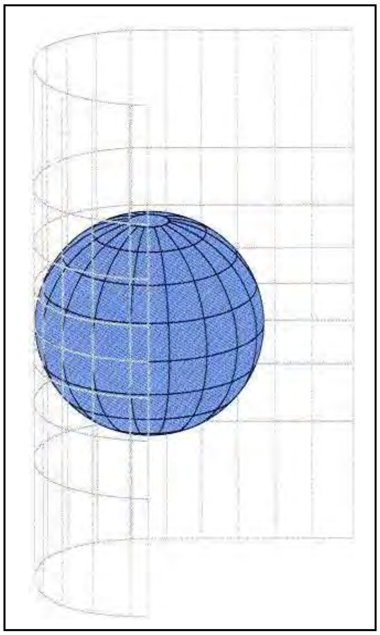
Chart Projections

A chart is a flat representation of the surface of the earth. However, cartographers cannot represent any part of a sphere on a flat surface without some degree of distortion. A sphere or the earth is “non-developable” it cannot be transferred to a plane or flat surface without severe distortion. The cartographer solves this problem by projecting the sphere onto a “developable” surface such as a cone or cylinder. A chart or map projection is the mathematical transformation linking points on one surface to complementary points on another surface.

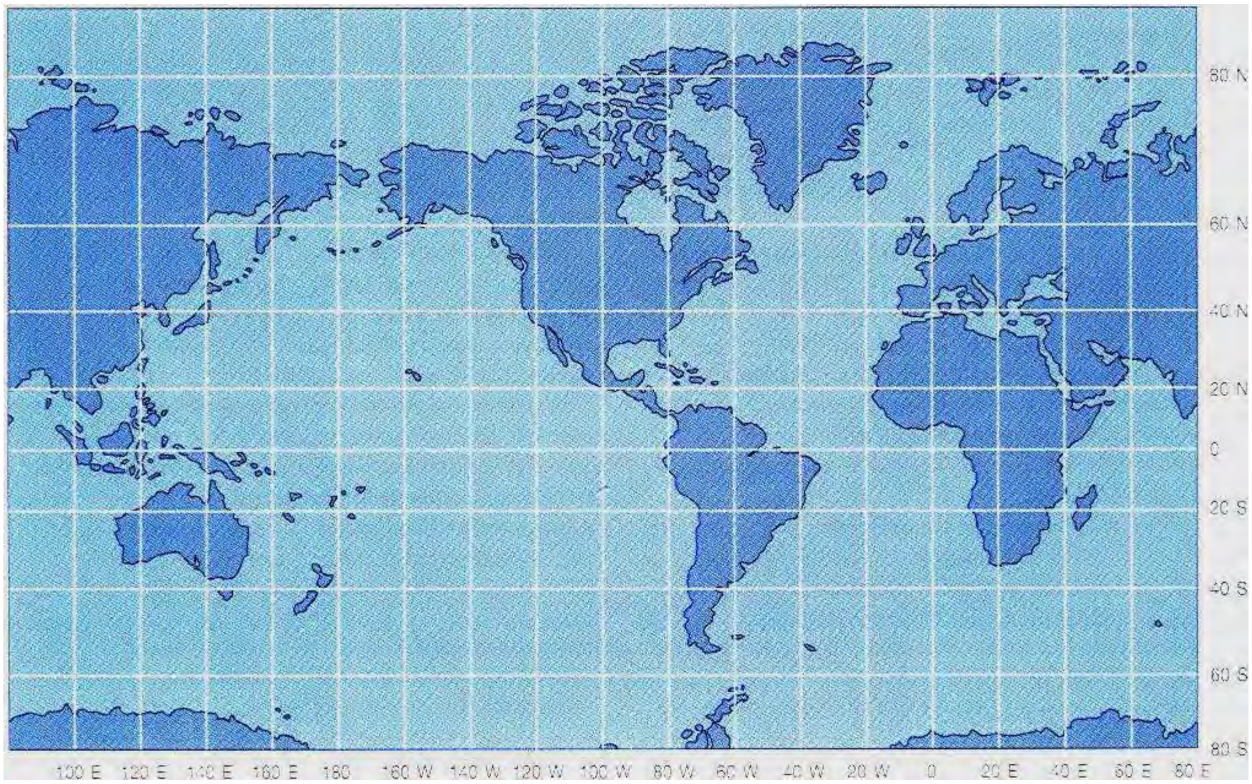
Projections are geometric or perspective, if the projected sphere is from a single point such as the center of the sphere. Another method of projection is conformal. It depicts true shape and correct angular relationships. Ideally, a chart projection should have certain desirable traits that are beneficial to navigation. Although it is usually possible to preserve, one or two of these traits in each type of projection, no single projection preserves them all.

There are three general types of projection. The name of a projection indicates the type projection, how the projection is centered: on the equator, the poles, or on some line or point between, and its principal use.

We can visualize the Mercator projection as a cylinder slid over the earth’s sphere tangent to the equator. It projects geometrically the features from the surface of the earth to the surface of the cylinder. When the cylinder is rolled out as a flat plane, the meridians appear as straight, equidistant, and parallel. This mathematical transformation also expands the latitude scale to compensate for the distortion of the longitude scale. The greater the distance from the equator, the greater the amount of distortion that appears on a Mercator chart. Using the largest chart scale possible, that shows the smallest geographic area, minimizes distortion on a Mercator chart. Maintaining shape is an important aspect of the Mercator chart. Again, using other words, charts of large geographical areas easily reveal the distortion of landmasses. On charts of small geographical areas, the distortion is negligible to the eye.

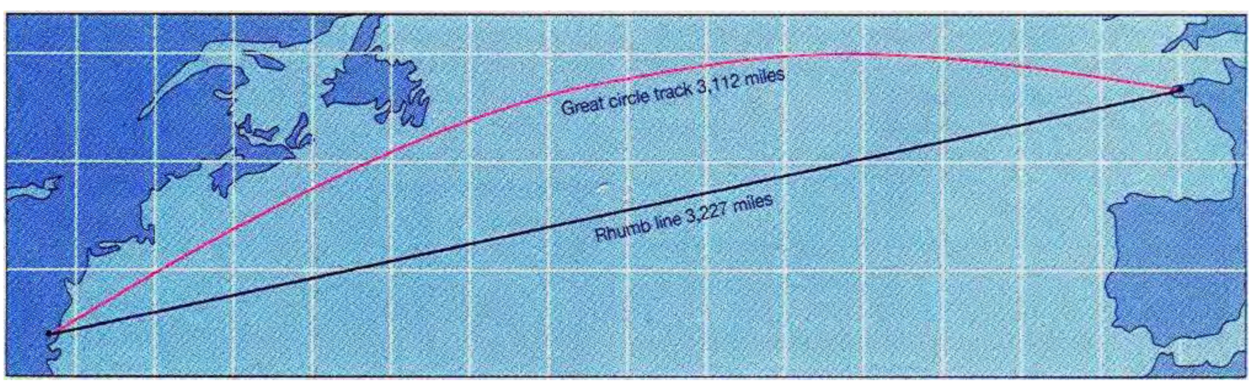


The grid composition of a Mercator chart is intersecting parallel lines of longitude intersecting at right angles with parallel lines of latitude. Mercator charts are conformal, allowing the



representation of rhumb lines as straight lines. The Mercator chart permits accurate measurement of direction and distance in all directions. Because of distortion and counter-distortion however, land areas near the poles are greatly exaggerated. Coastal and small craft navigation commonly use the Mercator chart.

A Rhumb Line is an imaginary line that intersects all meridians at the same angle. On the surface of a sphere, the rhumb line is a curved line, spiraling toward a pole. In small boat navigation, course lines drawn on charts are rhumb lines.



EPO #2: LIST THE INFORMATION DESCRIBED IN THE TITLE BLOCK AND OTHER PERTINENT INFORMATION LOCATED IN THE "NOTES."

Reading the Nautical Chart

A nautical chart concerns itself primarily with areas of navigable water, the adjacent landmasses, and topographical features. The chart contains large amounts of information, all of it necessary for the operation of a vessel. To accurately interpret a chart, the chart requires studying.

The title block shows the official name of the chart and the area of coverage. The name of the chart usually includes the name of the largest navigable body of water on the chart. In the title block the following information is presented:

The name of the agency producing the chart and its official seal is at the top of the title block. The National Oceanic and Atmospheric Administration produce all the coastal charts for the U.S. The National Ocean Service (NOS), a part of NOAA, under the Department of Commerce, is the agency responsible for charting the national and territorial coastal waters of the United States. These charts are "NOAA" charts.

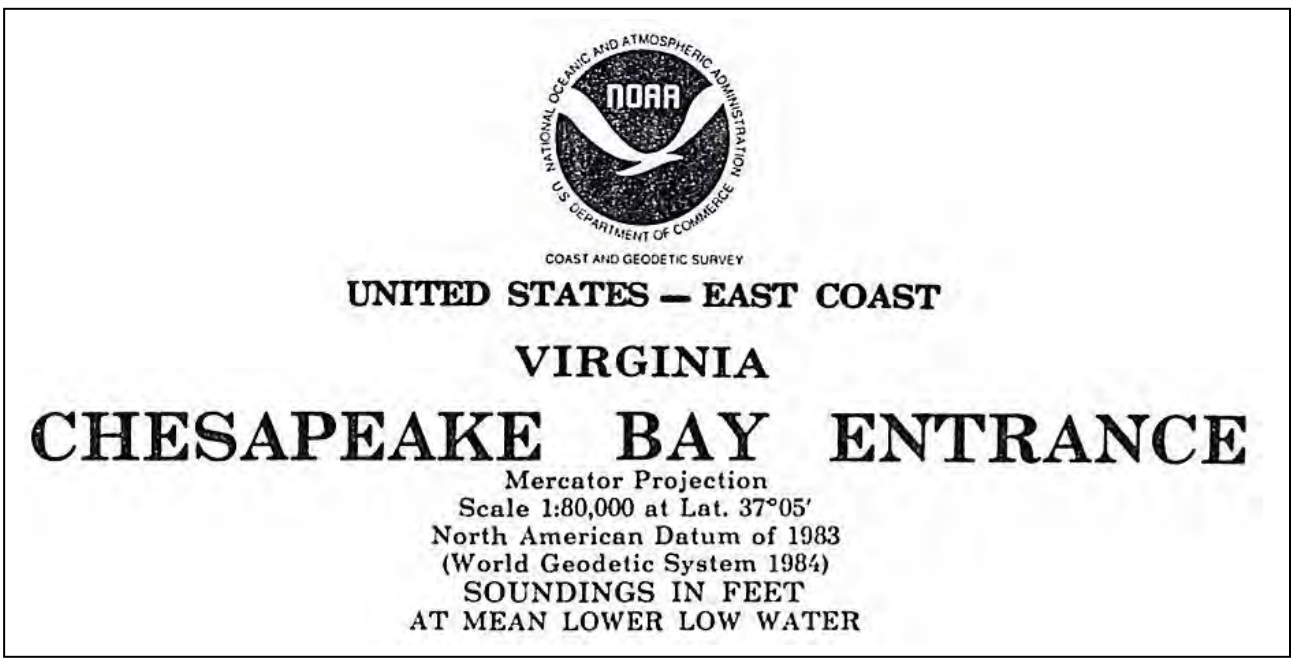


Chart projection. The Mercator projection is the projection used by the coastal navigator. On a Great Lakes chart, the title block may show Polyconic as the projection used.

Scale. Nautical charts use a "**natural scale**" to reduce actual distances for representation on the chart. This scale is a ratio of a given distance on the chart, to the actual distance on the surface of the earth. It is a fractional scale. The "Chesapeake Bay Entrance" chart is a ratio, 1:80,000. One unit of measure on the chart will equal 80,000 of that same unit on the surface of the earth. A ratio is also expressed as a fraction, 1/80,000.

The numerical scale, used on road maps, uses different units of measure to describe distance, for example: 1 inch equals fifty miles.

The chart scales are either a "large scale" or "small scale." You can understand this concept by remembering that a **large-scale** chart presents a **large amount of detail** and a **small-scale** chart presents a **small amount of detail**.

A small-scale chart covers large areas of the surface of the earth. Navigators use the small-scale chart for laying out track lines over great distances and for offshore sailing. The detail for landmasses necessary for making landfall is minimal. A small-scale chart covers a large geographic area.

A large-scale chart covers small areas of the earth's surface. The large-scale chart is for inshore sailing or harbor piloting. It offers the most information and detail necessary for piloting and making safe land fall. Always use the largest scale chart for the area you are navigating.

NOAA Charts and charts published by the National Imaging and Mapping Agency (NIMA) classify charts by scale:

Sailing Charts - These are the smallest scale charts, generally smaller than 1:600,000, used for long distance navigation. These charts only approximate the shoreline topography and provide detailed information only on the offshore soundings, primary lights, offshore buoys, and prominent landmarks.

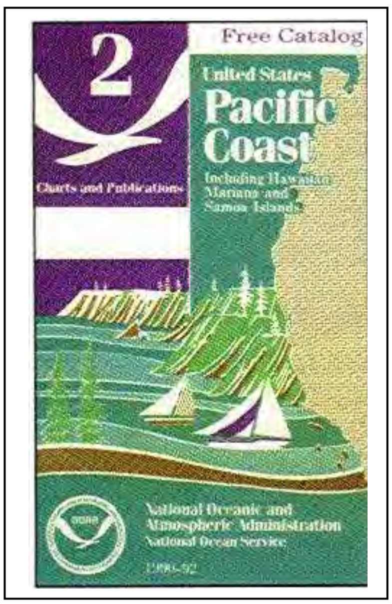
General Charts – These charts are for coastal navigation when a course is well offshore and the navigator fixes the position along the course using landmarks, buoys, and characteristic depths. The scale of these charts is 1:150,000 and smaller to 1:600,000

Coast Charts – These charts are for near-shore navigation, for entering or leaving large bays, inland waterways, and harbors. The scales are 1:150,000 and larger to 1:50,000.

Harbor Charts – Use these charts for navigation and anchoring in small harbors and waterways. The scale is 1:50,000 and larger. Harbor charts present detail including numerous soundings and all local aids to navigation to maximize positioning.

Small Craft Charts - These are special charts of inland waters, including the Intracoastal Waterway. They contain additional information of interest to the small boat operator including, information on marine facilities, tidal ranges, weather broadcast frequencies, etc. A small craft chart's scale is 1:40,000 and larger. It is designed for easy reference and plotting in limited spaces. Types of small craft charts are, folio charts, route charts, and modified route/recreational charts.

The NOS, publishes a Catalog of Nautical Charts. It identifies the charts available within an area. There are five separate catalogs, which are free. The volumes are:



U.S. Atlantic and Gulf Coasts.

U.S. Pacific Coast.

U.S. Alaska

U.S. Great Lakes

Bathymetric Maps and Special Purpose Charts.

The catalogs show the geographic areas covered by every NOS chart. They provide information about charts and publications of other agencies. They list by state the names and addresses of sales agents for charts and publications. Use the chart catalogs to order nautical charts and publications.

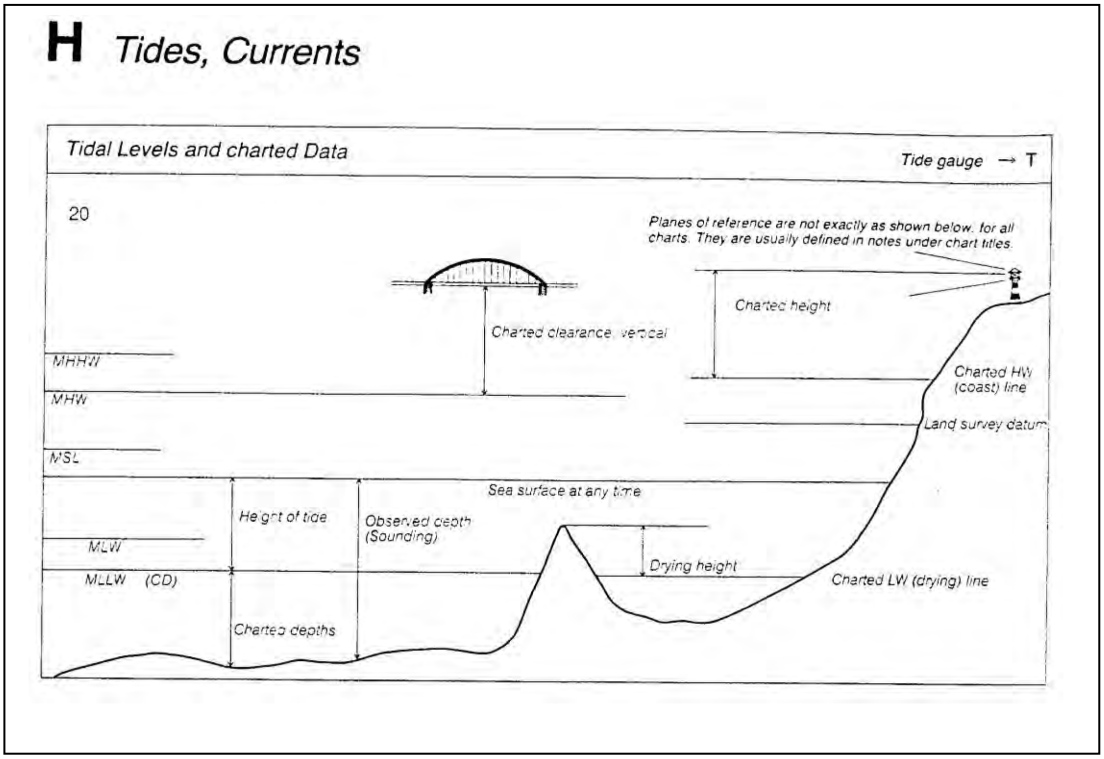
The Chart Datum - A **horizontal datum** is a set of constants specifying the coordinate system used for calculating coordinates of points (features) on the earth. Most NOAA charts use the "1983 North American Datum" (NAD 83). It is the standard for U.S. nautical charts. This datum is quite close to the *World Geodetic System of 1984 (WGS84)*.

The more recent the datum, the more accurate the positioning of geographic features will be. All new U.S. charts and reconstructed NOAA charts are based on (NAD83). When using electronic navigation system, such as GPS, use care when moving between charts with different datum. This is because the mathematical conversions employed in the receivers to convert the received signal to latitude and longitude depends upon the assumed. A shift from one datum to another could shift the position of the apparent fix by meters or miles.

Soundings - Soundings are the depths of the water measured in feet, fathoms, or meters. Besides being in the title block, depths appear, in capital magenta letters, at the top and bottom of the chart.

Hydrographic surveys are the basic source of soundings and related information. Sounding data derived and adjusted from these surveys reflect a common vertical plane or reference; ***mean lower low water (MLLW)***. MLLW is the **Chart Sounding Datum**. MLLW is the 19 year average of all the lowest water levels for a tidal day.

Vertical datum - Some of the notes on charts describe information on heights.



However, the information is a form of datum, a vertical datum. Charts measure the height of a landmark or the clearance of a bridge, power cable, or overhang from a datum described as mean high water. It is the average of all high-water levels averaged over a 19-year cycle. This datum ensures that clearances and heights are normally greater than the charted values.

Charts measure the shoreline at mean high water, as well. The chart reckons the height of a navigational light from mean sea level. Mean sea level is the average height of the surface of the sea for all stages of the tide.

Printed information found in the margins of the charts and Chart Notes.

Margin Information - Printed around the outside of the chart is a large amount of information, all of which is useful to the mariner utilizing the chart. The chart schematic found in *"Chart No.1 Nautical Chart Symbols, Abbreviations and Terms"* helps the reader to understand the layout of the nautical chart. This chart format is the general plan of organization or arrangement of a nautical chart including the layout of the margin notes, border, title block, and insets.

Catalog number - The catalog number is the identification number assigned to the chart by the NOS. It has a five-digit number. The first two numbers identifies the chart by region and sub-region. The last three digits denote the geographic sequence (counter clockwise) within the sub-region. The five digit number assignment is for chart scales of 1:2,000,000 and larger. These charts cover coastlines rather than significant portions of ocean basins. For ordering charts or planning a voyage, use the catalog/chart number to identify the appropriate chart in the "Nautical Chart Catalog."

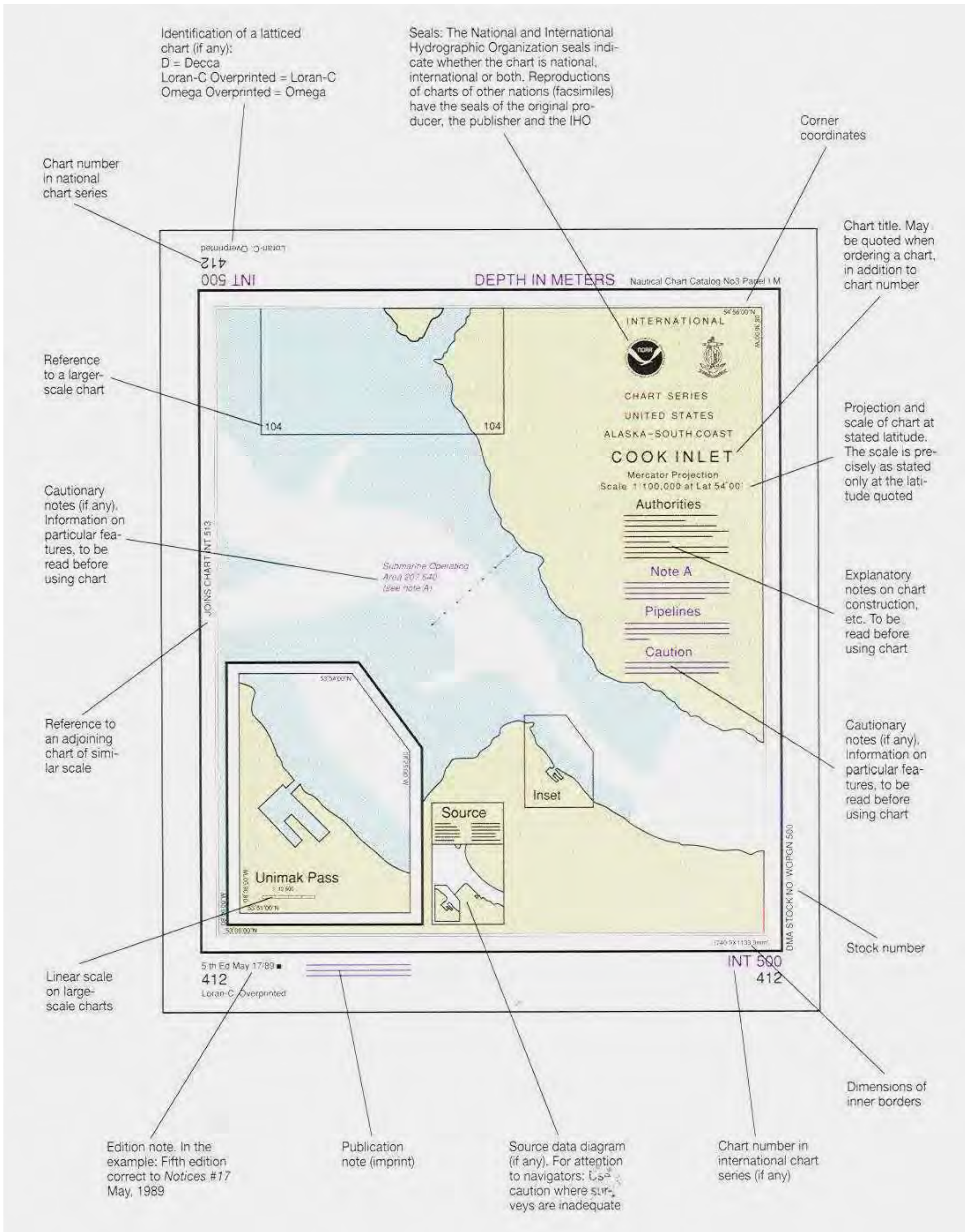
Overlays - Some charts have a printed overlay of a specific navigational system's position lattice. Those navigation systems include Decca, Loran, and Omega.

Number of the international chart series, if any - This number is not on the Chart 12221 used in this course.

Publication Note (imprint) - This shows the publisher's name and address.

Bar Code and Stock Numbers

Edition Number and Date - The edition number and date is located in the margin at the lower left-hand corner of the chart. It is the current edition number and date and is one of the most important items of information given on the chart. The date shown on the chart is the same date as the Notice to Mariners for which the chart is correct.



Identification of a latticed chart (if any): D = Decca Loran-C Overprinted = Loran-C Omega Overprinted = Omega
Seals: The National and International Hydrographic Organization seals indicate whether the chart is national, international or both. Reproductions of charts of other nations (facsimiles) have the seals of the original producer, the publisher and the IHO
Corner coordinates
Chart number in national chart series
Chart title. May be quoted when ordering a chart, in addition to chart number
Loran-C Overprinted
412
INT 500
DEPTH IN METERS
Nautical Chart Catalog No3 Panel I M
INTERNATIONAL
CHART SERIES
UNITED STATES
ALASKA–SOUTH COAST
COOK INLET
Mercator Projection
Scale 1:100,000 at Lat 54°00'
Authorities
Note A
Pipelines
Caution
Reference to a larger-scale chart
104
104
Projection and scale of chart at stated latitude. The scale is precisely as stated only at the latitude quoted
Cautionary notes (if any). Information on particular features, to be read before using chart
Submarine Operating Area 207 540 (see note A)
JOINS CHART INT 513
Explanatory notes on chart construction, etc. To be read before using chart
Reference to an adjoining chart of similar scale
Cautionary notes (if any). Information on particular features, to be read before using chart
Inset
Source
Unimak Pass
DMA STOCK NO. WOPGN 500
Stock number
Linear scale on large-scale charts
5 th Ed May 17/89
412
Loran-C Overprinted
INT 500
412
Dimensions of inner borders
Edition note. In the example: Fifth edition correct to Notices #17 May, 1989
Publication note (imprint)
Source data diagram (if any). For attention to navigators: Use caution where surveys are inadequate
Chart number in international chart series (if any)

A function of a Notice to Mariners keeps the marine community apprised of corrections/changes to the chart. *The location of the very first edition and date is at the top center of the chart*.

A new chart edition supersedes all earlier editions. New editions are published when the corrections from previous editions are too numerous or the list of changes/corrections too extensive. Mariners need to remember charts are corrected to the date indicated on the chart not the purchase date.

Demand and significant changes to geographic areas drive the printing of new editions of charts. The Government prints more frequently chart editions of high-traffic areas, areas with significant changes, and charts that have low inventories because of high demand.

Revision date. The revision date appears just to the right of an edition date. A revised edition contains corrections previously published in a Notice to Mariners. It does not supersede the current edition of the chart. (Example 5th ed. May 17/99; Revised Dec 01/2001).

Source data diagram (if any). Navigators should use caution when using charts based on inadequate surveys. The value of a nautical chart depends upon the accuracy of the surveys. The chart reflects what field surveys found and reported to the NOS. The chart represents general conditions at the time of the surveys and does not necessarily portray present conditions. The source diagram represents the most recent hydrographic survey information evaluated for charting. The source diagram will show how the chart depicts information from different surveys (i.e. dates and types of surveys used).

The U.S. Army Corps of Engineers periodically resurveys the channels it maintains. The chart shows the tabulations of these channel surveys in a table describing the channel. The table shows the controlling depths of the channel, from seaward and the project's dimensions.

Dimension of inner border - The neat line is the inner border of the chart. On Chart 12221, the dimension is 80.95 cm N S x 107.44 cm E W. The neat line dimension with the chart scale allows the calculation of the geographic area covered by the chart.

Corner Coordinates - Charts sometimes display these coordinates in the opposite corners of the chart.

Chart Title or Title Block - (Previously discussed above.)

Explanatory Notes on chart construction

The NOAA Seal

Projection type and the scale of the chart - The scale is precisely as stated only at the latitude quoted.

Linear scales or large-scale insert charts - The Marine Training Branch stresses the use of the latitude scale for measuring distance as the preferred measuring discipline.

Reference to a larger scale chart - The word “Chart,” followed by the chart number, refers the navigator to a larger scale chart. The word chart and the chart number are in magenta-colored, italic print.

Cautionary notes – Present a variety of general and/or particular information. The prudent navigator reads these notes prior to using the chart. The location of Notes, on a chart, is anywhere they do not obscure relevant data or navigational information.

References to adjoining charts - Margin notes refer the navigator to adjoining charts of similar scale.

EPO #3: IDENTIFY THE USES OF THE VARIOUS NAUTICAL PUBLICATIONS.

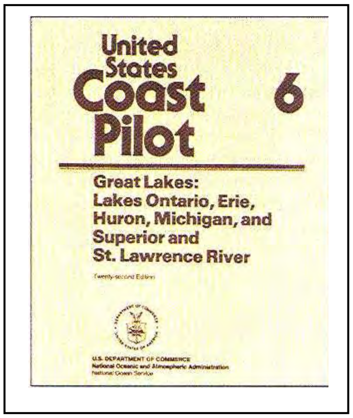
Nautical Publications

The chart has a wealth of information pertaining to that geographical area. However, the chart does not display all the available information. If all the information available about an area were on the chart, it would have a much more cluttered appearance.

As you have learned, the chart is accurate to the edition date. The navigator is responsible for the accuracy of the charts and maintaining currency. The following publications provide additional information to the navigator and the allow navigators to maintain accurate charts.

The U.S. Coast Pilot is a nine-volume publication that supplements the information given on U.S. Charts. These volumes present critical information for safe navigation not printed on the chart due to space limitations. Each volume contains area information, dangers, obstructions, channels, and the controlling depths of channels. They list harbors, anchorage areas, marine supply dealers, and repair facilities. The sources for updating the Coast Pilot include NOAA; information published in Notices to Mariners, NOAA Hydrographic vessels, other Government agencies, State and local governments, maritime and pilotage associations, port authorities and mariners.

The Coast Pilot, by chapter, describes the following information:



Chapter I General information:

- Federal regulations and Federal Agencies providing maritime services
- Distress Signals and Communication Procedures
- Distress Assistance and Coordination Procedures
- Radio Navigation Warnings and Weather
- How to report chart deficiencies
- Recognizing aids to Navigation and reporting discrepancies
- Navigation Restrictions and requirements for Traffic Separation Schemes

Chapter II Navigation Regulations CFR Title 33:

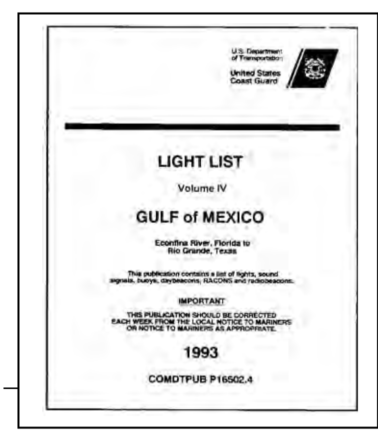
- Vessel Bridge-to-Bridge Radiotelephone Regulations
- COLREGS Demarcation lines
- Anchorage Regulations
- Drawbridge operation Regulations
- Ports and Waterways Safety-General

- Inland Waterway navigation Regulations
- Regulated Navigation Areas and Limited Access Areas
- Shipping Safety Fairways
- Offshore Traffic Separation Schemes
- Navigation Regulations
- Danger Zones and Restricted area Regulations

Chapter III and successive chapters describe geographic regions within the overall volume.

- The appearance of the coastlines, mountains, landmarks, and visible foliage
- Anchorage facilities
- Navigational aids
- Local prevailing weather conditions
- Bridges and vertical clearances
- Repair facilities, fuel, provisions; waste pump-out facilities, shore transportation, local industries
- Description of ports and harbors with pictures
- Distance and bearings to navigation features

To use the Coast Pilot: locate the index at the back of the manual. Locate the topic or chart feature with the referencing volume page number. A chart feature, such as *Cherry Stone Inlet 12224* also has the chart number printed.


U.S. Department of Transportation
United States Coast Guard

LIGHT LIST
Volume IV
GULF of MEXICO
Econfina River, Florida to Rio Grande, Texas
This publication contains a list of lights, sound signals, buoys, daybeacons, RACONS and radiobeacons.
IMPORTANT
THIS PUBLICATION SHOULD BE CORRECTED EACH WEEK FROM THE LOCAL NOTICE TO MARINERS OR NOTICE TO MARINERS AS APPROPRIATE.
1993
COMDTPUB P16502.4

The U.S. Coast Guard Light List is a seven-volume publication providing a more complete description of all U.S. Aids to navigation. Each volume covers a specific geographic area including all of the United States and possessions of the U.S.

The arrangement of aids to navigation within these volumes follows a geographic order, or a clockwise direction.

Listed first are Seacoast Aids to Navigation, those aids to navigation a mariner would detect first because of the intensity of the light or their geographic location while making landfall.

Listed second are Entrance and Harbor Aids to Navigation from seaward to the head of navigation.

Listed third, where applicable, are Intracoastal Waterway Aids to Navigation from north to south on the East Coast, and east to west on the Gulf Coast.

The names of aids to navigation, and how they are printed in the Light List, help to distinguish at a glance the type of aid to navigation, as follows:

Seacoast Lights and Secondary lights

Radio Beacons

RACONS

Fog Signals

RIVER, HARBOR, AND OTHER LIGHTS

Lighted Buoys

Day beacons and Unlighted Buoys

Each aid to navigation has an assigned "*Light List number.*" This resolves any problems or ambiguities when identifying similarly named aids to navigation, in the Light List. The sequencing of light list numbers is, numbering by fives. Other numbers and decimals show newly established aids to navigation, in their geographic sequence, listed between previously numbered aids to navigation.

The pages of the Light List have eight columns to describe each aid to navigation.

Column (1): Light List number

Column (2): Name of the aid to navigation

Column (3): The geographic position of the aid to navigation in latitude and longitude. The position is approximate, only to the nearest tenth of a minute. This position only facilitates locating the aid to navigation on the chart.

Column (4): Light characteristic

Column (5): Height above water from the focal plane of a fixed light to mean high water

Column (6): The nominal range of the light in nautical miles

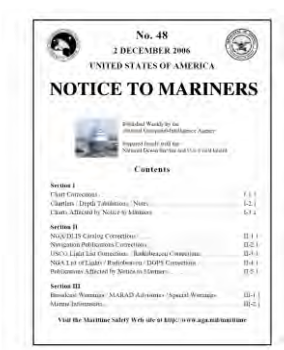
Column (7): Structural Characteristic. It will give a description of a fixed structure, for example TR on a Pile. A structural characteristic of buoy would be red nun.

Column (8): General remarks - The general remarks describe all other features not covered by the other columns: fog signal characteristic, a Racon's Morse code characteristic, a light sector's arc of visibility, and an emergency lights characteristic.

To use the Light List, locate the alphabetical index in the back of the volume. The aid to navigation is located by referencing the locally named channel. Note the light list number to the right of the name. Reference that number within the manual.

Federal agencies publish Notices to Mariners which provides marine information affecting the safety of navigation. Navigators correct and keep current charts and other marine publications based on the information provided in the Notice to Mariners.

There are three different forms of Notice to Mariners:


No. 48
2 DECEMBER 2006
UNITED STATES OF AMERICA
NOTICE TO MARINERS

Contents

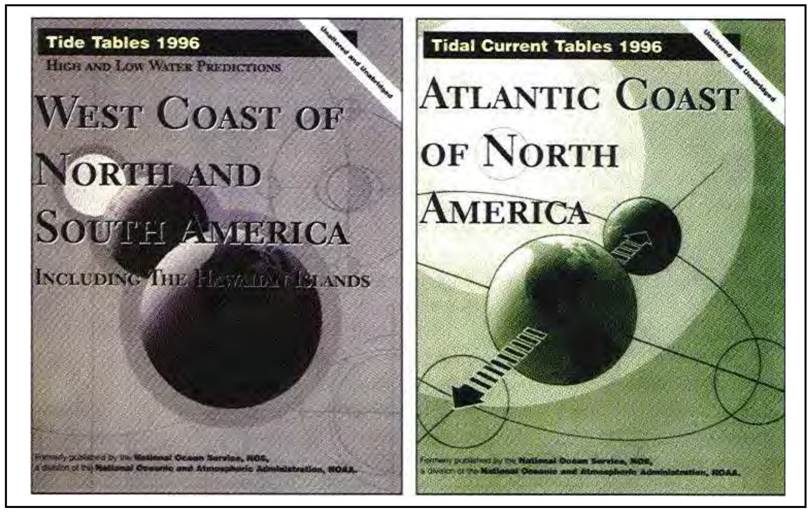
1. The Notice to Mariners is a weekly publication of the National Imagining and Mapping Agency in cooperation with the National Ocean Service and the Coast Guard. Each issue contains information on important changes affecting navigational safety. It includes aids to navigation worldwide. This is especially important if the mariner is using international charts.


United States Coast Guard
LOCAL NOTICE TO MARINERS
WEEKLY EDITION
District: 7 Week: 44/06

2. Local Notice to Mariners (LNM) is a weekly bulletin published by each Coast Guard District. The information relating to small craft charts appears only in the LNM.

3. Broadcast Notice to Mariners is a radio broadcast on VHF-FM radio. Coast Guard Group Units broadcast the timeliest information on issues of navigational safety. The time of day each CG Group Office broadcasts this information is in the respective Coast Pilot.

These broadcasts provide the mariner with the timeliest information concerning information of maritime safety. This information includes the establishment of new aids to navigation, discontinuance of an aid, or discrepancies in characteristics or location. The broadcasts include important information such as marine obstructions, dredging operations, channel changes, or other marine hazards.



The Tide Tables are an annual publication printed in four volumes. Each volume lists the time and heights of tides for selected reference stations. Correction factors for additional subordinate stations provide local tidal computations. Each volume also contains tables for sunrise and sunset, moonrise and moonset, and phases of the moon. Many mariners use computer software programs, based on these tables, which automatically computes the time differences between reference stations and a specific subordinate station. They produce easy to read daily prediction charts with the ability to quickly interpret times and tidal stages at any time of the day.

The Government publishes the Tidal Current Tables annually in two volumes. It has the same format as the Tide Tables. However, instead of time and height of tides, the tables provide information on slack water and maximum current (given in knots). Each volume also contains tables for computing velocity at any intermediate time, computing duration of slack water, and computing weak currents.

NOS prints Chart Catalogs and distributes them free. A catalog of nautical charts provides a listing of NOS Charts and publications, and publications of other agencies. There are four catalogs representing:

Atlantic and Gulf Coasts – including, Puerto Rico and the Virgin Islands.

Pacific Coast – including Hawaii and the other U.S. Pacific Islands.

Alaska – including the Aleutian Islands.

The Great Lakes - and adjacent waterways.

The catalogs have small–scale coastal outline with diagrams, showing the areas covered by each NOS chart.

Maps and Charts from other Agencies

There are other useful maps and charts for maritime law enforcement. They are available from sources other than the NOS.

Charts of Foreign Waters – National Imagery and Mapping Agency.

Charts of Western Rivers - U.S. Army Corps of Engineers.

Maps and Charts of Canada - Canadian Hydrographic Service.

Maps and Charts of the Tennessee Valley Authority - TVA.

Topographic Maps - U.S. Geological Survey.

County Soil Maps - Division of Public Documents.

EPO #4: IDENTIFY VARIOUS CHART SYMBOLS, FEATURES, AND ABBREVIATIONS DESCRIBED IN *CHART NO. 1, (USA) NAUTICAL CHART, SYMBOLS, ABBREVIATIONS, AND TERMS.*

Chart Number 1

The chart uses many symbols, colors, and abbreviations to display information in a condensed format. The various chart symbols, features, and abbreviations, used on charts published by the NOS and NIMA, are shown in "Chart 1, Nautical Chart Symbols and Abbreviations." It is important to remember the symbols are not drawn to scale but do show a feature's accurate location. The symbols in "Chart 1" incorporate the symbols contained in the International Hydrographic Organization (IHO) Chart No. 1 (INT 1).

Coloring is an important feature of a chart. Colors are optional for depicting features on a nautical chart. On NOS charts, three colors depict water. Deep water is white, shallow water is light blue, shallower water is a darker blue. The colors are not specific to a given range of depths, but are relative to the water depicted on a specific chart.

The land color is generally a beige/gold color on NOS charts or gray on DMA charts. Tidal area is moss green and it indicates that land area is awash at some stage of the tide.

Lateral aids to navigation are colored green or magenta. On newer charts special purpose marks are yellow.

The color, **magenta or nautical purple**, identifies boundaries, navigational lights, and items of special significance or importance. Charts use the magenta color instead of red because; red becomes invisible when viewed under a red light. Mariners generally use a red light (to preserve night vision) to view the chart during night navigation.

Lettering standards. Cartographers have adopted lettering standards, for certain, features.

Vertical lettering indicates the item is referenced to the shoreline plane. It is used for features that are dry at high water and not affected by tidal change or current.

Slanted or italic lettering identifies names of water areas, underwater features, floating aids to navigation, and names of hydrographic features. It does not indicate the depth of water.

In "Chart 1," there are hundreds of symbols, abbreviations, and terms. If one spends any amount of time on a particular chart, they will become knowledgeable of all those features. However, you will not stay on one chart or remain in one area always. No one remembers all of these symbols.

"Chart No. 1" is easily referenced to interpret all of its symbols, abbreviations, and terms. The back cover is a visual guide to the Table of Contents.

The Table of Contents section follows the numbering format standard by the IHO. Each page lists the current U.S. symbols shown on NOS and NIMA charts. In separate columns, there are the IHO symbols and the symbols used on foreign charts reproduced by NIMA.

The schematic layout of "Chart 1" is on page seven (07) of "Chart No.1, Nautical Chart Symbols Abbreviations and Terms." It describes in detail the:

Section Title, Section Designation, Subsection, Supplementary National Symbols, and Cross-references

Six columns identify the symbols, abbreviations, and terms. On page seven of "Chart 1" a schematic layout is provided describing the information found in the six columns. The green, circled numbers 6-10 specifically describe that information.

Interpreting water depths on the chart is an obvious aspect of safe navigation and properly using "Chart 1." To interpret depth information, reference the back cover of "Chart 1." Locate the Hydrographic Section. "Depths" is located in chapter "I"; you will find depths on page 39.

Block 10. Individual soundings are in feet, fathoms, and meters measured relative to MLLW. The chart may show fractional soundings to report the depth more accurately. The smaller number indicates a portion of the standard, i.e. fathoms. Newer charts use meters and tenths of meters (i.e. decimeters).

Blocks 20 - 22. Limits of dredge channels and controlling depths

Block 24. Numbers with an underlined bracket is the depth at chart datum. The area is “swept” with a wire drag.

Block 25. Unsurveyed or changing areas

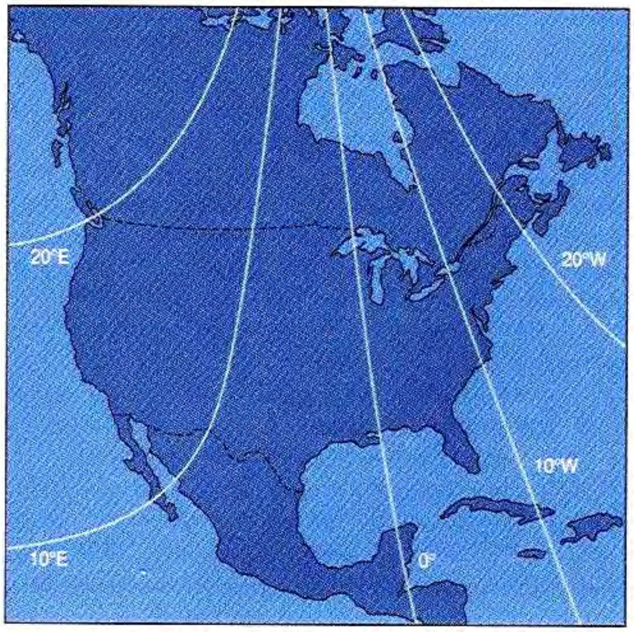
Block 30. Depth Contour Lines, or fathom curves is a line connecting points of equal water depth which is sometimes significantly displaced outside of soundings, symbols, and other chart detail for clarity as well as safety.” A solid depth curve is broken at intervals with the printed depth. (——— 25 ————) In depths of water 18 feet and less, notice the contours are continuous, dotted lines. The observer must be able to discern the depth at six-foot intervals. This is determined by noting the individual soundings on both sides of the contour.

EPO #5: IDENTIFY THE RINGS OF THE COMPASS ROSE AND THE ANNUAL ADJUSTMENT DATA

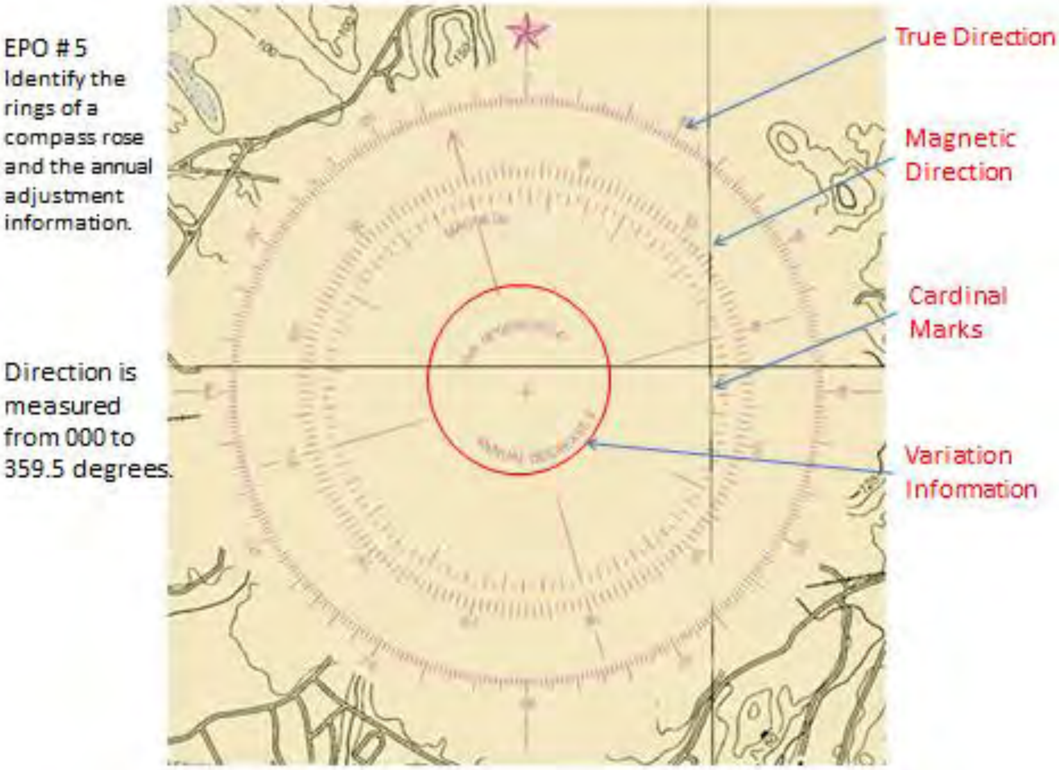
The Compass Rose is a circle graduated in degrees, from 000^0 clockwise to 360^0. Compass Roses are conveniently located on the chart for plotting direction. The Compass Rose is composed of <u>several concentric scales</u>. The <u>outer scale</u> is oriented so the <u>zero heading and the star point to the geographic North Pole</u>. On the Mercator chart, the meridians of longitude and the outer compass rose point to the geographic North Pole.

<u>The inner scales, of the compass rose, are oriented towards magnetic North Pole</u>. The first scale is the magnetic compass rose. This scale is in degrees. The innermost scale is in points and quarter points of the compass. A point of direction is 11.25^0. Some charts omit this scale.

The magnetic North Pole is located in Canada’s Northwest Territories, at approximately 78.9 degrees North Latitude and 103.8 degrees West Longitude. It is several hundred miles removed from the geographic North Pole. The earth has a weak magnetic field, generated by the flow of the liquid iron-alloy core of the planet. This field, termed a dipole field, is similar to a magnetic field generated by a large bar magnet. This dipole field also moves about the earth. Scientists are capable of measuring this secular movement and include the diurnal adjustments in the center of the compass rose.



The angle created at the center of the compass rose, between the star and the arrow symbol, is the variation for that area and the year stated. Variation is the difference between the true direction and the magnetic direction. The information, in the center of the compass rose, is given to the nearest 15'. For example: (Var. 5^0 45' W (2001). The value of variation changes as the observers location changes on the earth. Variation is either east or west according to the deflection of the compass needle. When viewing the chart's compass rose, the magnetic zero heading is left of the True heading, the variation is described as westerly. When viewing the chart's compass rose, the magnetic zero is right of the True heading the variation is easterly.



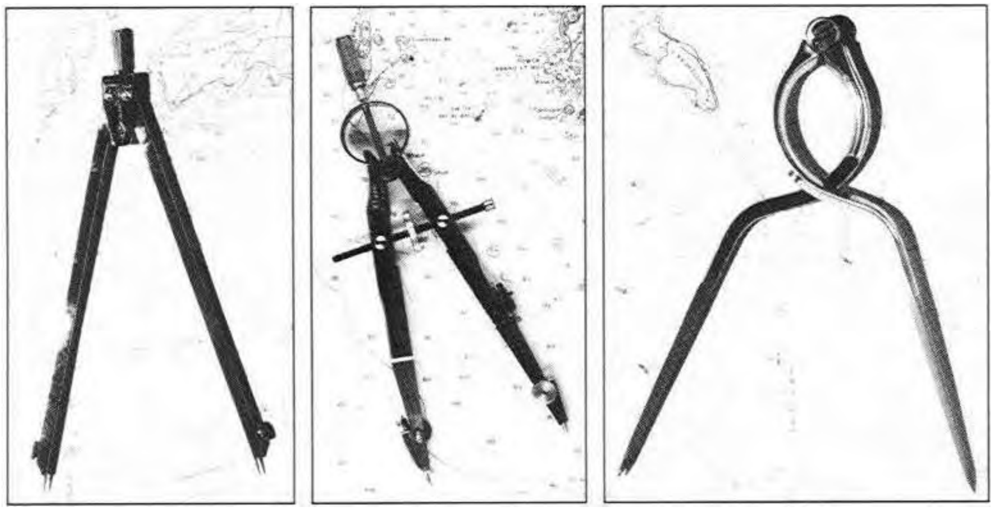
The center of the compass rose also notes the annual change to the nearest one-minute. This annual change can be an increase or decrease. This permits the adjustment of the variation to the current year.

EPO #6: DEMONSTRATE HOW TO MEASURE DISTANCE AND DIRECTION ON A NAUTICAL CHART

Measuring Distance

There are four measures of distances in use on charts. Ocean and coastal charts use the nautical mile. The nautical mile equals 1/60th of a degree of latitude. It is better and commonly described as: **1 nautical mile equals - 1 minute of latitude**.

- On charts of the ICW, the Western Rivers, and the Great Lakes, distance is in statute miles.
- On other nautical charts, distance is in nautical miles.
- Distances of less than a mile are in yards or meters. U. S. charts are increasingly using meters.



Large-scale charts have graphic, bar scales printed in several units of measure (Miles or nautical miles, meters, or yards). The internationally established nautical mile is 1,852 meters or approximately 6076.1549 feet. A statute mile is 5,280 feet. A nautical mile is approximately 1.15 statute miles

One degree (^{0}) of Latitude equals **sixty nautical miles (nm)**.

A **minute (‘) of latitude** is equal to **one nautical mile (nm)**.

A **nautical mile (nm)** is equal to **one minute (‘) of latitude**.

A tenth of a minute of latitude (.1') is equal to a tenth of a nautical mile (.1 nm).

One nautical mile equals **2025.4 yards**, rounded mathematically to 2000 yards. Rounding to 2000 yards is for the practical purpose of navigation.

A **tenth of a nautical mile** (**0.1)** or **6 seconds (“) of latitude** converts to **200 yards (yds)**

It is imperative to use the latitude scale to measure distance.

Direction.

Mercator charts are oriented to the true geographic pole. True direction can be directly measured from any meridian of longitude. Measure direction using the true compass rose or against the meridians of longitude.

Position.

Express geographic position as latitude and longitude. Latitude or longitudes are arcs of measure expressed in degrees, minutes, and seconds (or tenths of a minute).

Common Navigations Tools:

Parallel Rulers

EPO #6: Demonstrate how to measure distance and direction on a nautical chart.

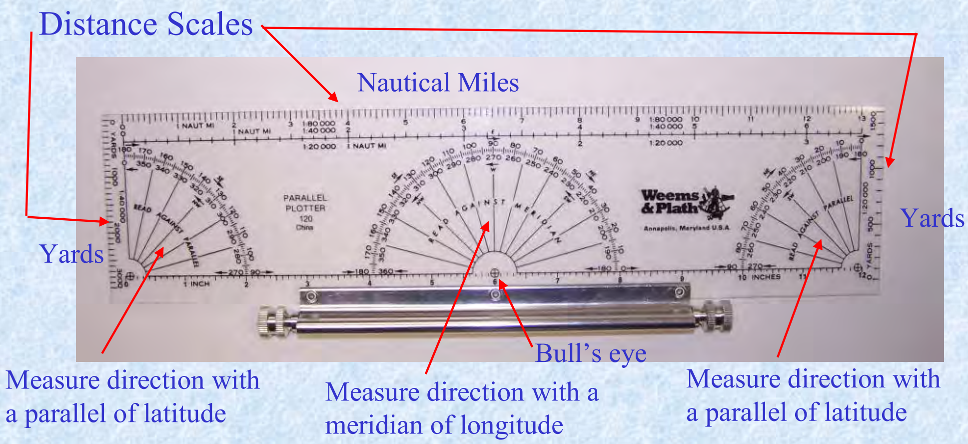
Parallel Rulers

- **Are used to measure direction, only**.
- Used in conjunction with the Compass Rose,
- Or, if graduated around it’s perimeter, may be used, instead, with any meridian of longitude found on the chart.
- Can transfer a predetermined direction to a position on the chart,
- Or determine the direction of a course line already drawn on the chart.

Parallel Plotter (Roller Plotter)

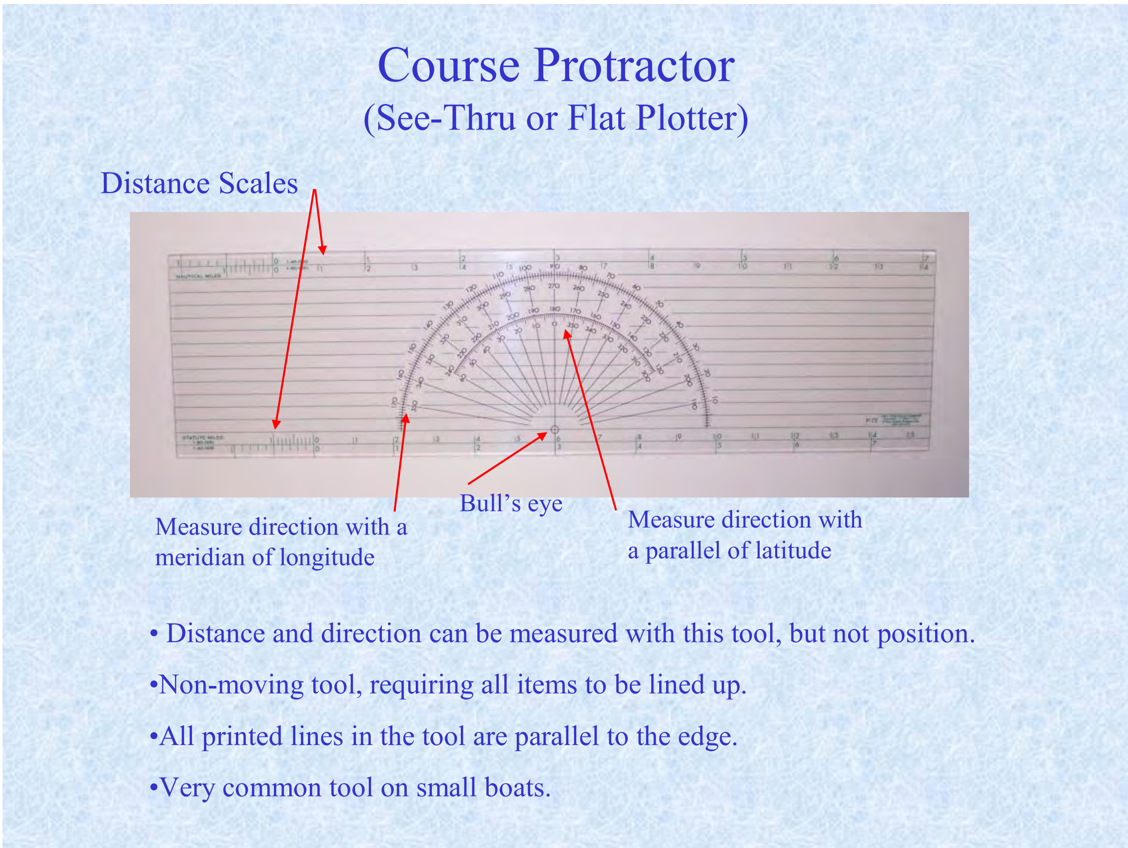
Parallel Plotter

(Roller Plotter)



- For direction, must be used in conjunction with a parallel, meridian, or compass rose.
- Parallel Plotter will measure distance and direction anywhere on the chart, but not position.
- Must have a flat smooth surface to work on.
- Does have moving parts, which can malfunction.

Course Protractor (See-Thru)



Dividers

Dividers

- Used to measure distance and position
- Most accurate way to measure distance when utilizing the latitude scale
- Can place a latitude and longitude anywhere on the chart with the aid of a straight edge
- Can determine the latitude and longitude of a particular point on the chart
- Is also helpful when using other navigation tools.
- Can be used with two metal points or a metal point and a lead.

ATTACHMENT 1

MARINE LAW ENFORCEMENT TRAINING PROGRAM

CHART INTERPRETATION WORKSHEET I

Chart #12221, 78th Ed. Revised 02/09 JF

Chesapeake Bay Entrance

This worksheet should take approximately 30 minutes to complete. If you have problems, please ask the instructor to assist you.

1. Why is a Mercator projection chart the chart of choice for coastal navigation?

    ____

    ____

2. Which scale, latitude or longitude, would you use to accurately measure distance on a Mercator projection chart and where on the chart is it located?

    ________________________ ________________________

3. What are the primary advantages of using the largest scale chart possible?

    ____

4. How many nautical miles equal a minute of latitude?

    ____

Identify the following chart symbols and abbreviations by referring to Nautical Chart No. 1:

5. ---------36---------

6. PA

7. MHHW

8. 

9.  ED

10. What does the color tan indicate on a nautical chart?

11. Where would you locate information concerning the local magnetic variation on a nautical chart?

12. How is the five-fathom (30’) contour line depicted (graphically) on chart 12221?

Use NOAA Chart #12221, 78th Ed., Chesapeake Bay Entrance, to answer the following questions:

13. What horizontal and vertical datums are used on this chart?

14. What symbol and color is used on the chart to depict fish trap areas?

15. What chart would you switch to if you were going to navigate in Hampton Roads?

Determine what aid to navigation, landmark or other feature is located at each of the following geographic coordinates:

16. 37^0 07.4' North 075^0 54.4' West

17. 36^0 54.3' North 075^0 42.8' West

18. 37^0 14.1' North 076^0 23.2' West

19. 37^0 18.0' North 076^0 16.6' West

ATTACHMENT 2

MARINE LAW ENFORCEMENT TRAINING PROGRAM

CHART INTERPRETATION WORKSHEET II

Chart # 12221, 78th Ed. Revised 02/09 JF
Chesapeake Bay Entrance

This worksheet should take approximately 35 minutes to complete. If you have problems, please ask the instructor to assist you.

1. When working with latitude and longitude how do you convert

   seconds to tenths of minutes ? ______________________________

2. How many nautical miles are in six tenths of a minute (.6') of

   latitude? _________________________________

3. How many yards, rounded off, are in a nautical mile?

   ____

4. How many yards would equal three tenths of a minute (.3') of

   latitude? __________________________________

5. How many yards would equal forty-eight seconds (48") of

   latitude? _____________________________________

Identify the navigational aid, landmark or other feature located at the following geographic coordinates:

6. 36^0 55' 36" North
   076^0 00' 24" West ____

7. 37^0 12' 36" North
   076^0 15' 15" West ____

8. 37^0 07' 24" North
   075^0 41' 00" West ____

9. 37^0 17' 39" North
075^0 34' 39" West ____

10. 37^0 00' 24" North
075^0 55' 45" West ____

What is the latitude and longitude of the following Aids to Navigation? Give your answer in **Degrees, Minutes and Seconds**.

11. Wolf Trap Light
Fl 15s 52ft 14M
____________________N
____________________W

12. Savage Neck Vortac Station
____________________N
____________________W

13. Old Point Comfort Light
Fl(2) R 12s 54ft 14M
____________________N
____________________W

14. Old Plantation Flats Light
Fl 4s 39ft 8M
____________________N
____________________W

15. What is the true direction, and distance, from Cape Charles lighted buoy "14" (Fl R 2.5s BELL) to North Chesapeake Entrance lighted buoy "NCA", (Fl Y 2.5s BELL)?

_____ T _____ nm

16. What is the true direction, and distance, from Chesapeake Light (Fl (2) 15s 117ft 19M HORN Racon **—— -**) to Middle Ground lighted buoy "4A" (Fl R 4s BELL)?

_____ T _____ nm

17. What is the true direction, and distance, from Thimble Shoal Channel lighted buoy "3" (Fl G 4s) to Thimble Shoal Channel lighted buoy "15" (Fl G 4s) ?

_____ T _____ nm

18. What is the distance from York River Entrance Channel lighted buoy "14" (Q R GONG) to York River Entrance Channel lighted buoy "6" (Fl R 2.5s) ?

_____ nm

19. What the true course for the course between Wolf Trap Light (Fl 15s 52ft 14M) and the York Spit Channel lighted buoy "37" (Fl G 2.5s)? __________ T

ATTACHMENT 3

Points to Highlight on Chart 12221

Words-Great Machipongo Inlet

Hog Island Lighted Buoy R "12" Fl R 2.5s

Cape Charles Lighted Bell Buoy R "14" Fl R 2.5s BELL

Chesapeake Light Fl (2) 15s 117ft 19M HORN RACON ------- --

RW “CB” Mo (A) WHIS RACON

------- -- -------

Rudee Inlet RW “RI” Mo (A) WHIS

Cape Henry Light Mo (U) 20s 164ft 15M

and red sector details

RW “CH” Mo (A) WHIS RACON

------ -- ------ --

R “2C” Fl R 2.5s BELL

R “2CH” Q R

Y “NCA” Fl Y 2.5s BELL

Middle Ground buoy R “4A” R 4s BELL

R Nun Buoys 2, 4, 6, 8, 10 going toward Navigational opening

Words-Nautilus Shoal

Cape Charles Light Fl 5s 180ft 24M

Navigational Opening between Trestle C & Trestle D

Chesapeake Channel Tunnel north & south lights F Y 32ft HORN Priv & F Y 32ft BELL Priv

Words-Chesapeake Channel

Navigational Opening – 3 fixed spans in Trestle B

Thimble Shoals Channel Tunnel north & south lights F R 32ft HORN Priv & F G 32ft BELL Priv

Trestle A Navigation Openings (two with common descriptor)

Words-Lynnhaven Inlet & Q G 15ft 5M “1”

Words-Little Creek & Q G 70ft 8M “3”

Old Point Comfort Light Fl (2) R 12s 54ft 14M

Thimble Shoals Light Fl 10s 55ft 20M HORN

Tue Point Light Fl 6s 41ft 7M

Swash Channel Light Fl G 4s 15ft 4M "3"

Words-York Spit Light

York Spit Light Fl 6s 30ft 8M

Words-York River Entrance Channel

New Point Comfort Abandoned Lighthouse

New Point Comfort Light Fl R 2.5s 15ft 5M "2"

Wolf Trap Light Fl 15s 52ft 14M

Words-Savage Neck & VORTAC station

Words-Old Plantation Flats & Light Fl 4s 39ft 8M

Words-York Spit Channel

ATTACHMENT 4

Internet Web Sites for charting and navigation.

CHART CORRECTIONS: http://chartmaker.ncd.noaa.gov

LIGHTLIST CORRECTIONS:
http://www.navcen.uscg.gov/pubs/LightLists/LightLists.htm

COAST PILOT CORRECTIONS: http://chartmaker.ncd.noaa.gov/NSD/coastpilot.htm

NOAA WEATHER BUOY SITES: http://www.ndbc.noaa.gov/

WEATHER: http://www.intellicast.com/
http://www.noaa.gov/wx.html

NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY
http://www.nga.mil/portal/site/nga01/

U.S. COAST GUARD NAVIGATION CENTER:
http://www.navcen.uscg.GOV/

NGIA MARITIME SAFETY INFORMATION CENTER: http://pollux.nss.NGA.mil/index/

USCG LICENSING INFORMATION:
http://www.uscg.mil/STCW/

LOCAL NOTICE TO MARINERS:
http://www.navcen.uscg.GOV/

COAST AND GEODETIC SURVEY CONTROL POINTS:
http://www.ngs.noaa.gov/FORMS/dsarea.html

U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

Homeland Security

STUDENT TEXT

PILOTING AND DEAD RECKONING	
7504	**JUL/2013**

INTRODUCTION

The Marine Law Enforcement Officer/ a Vessel Commander (VC) understand and apply all the disciplines necessary to navigate a vessel safely.

The word navigation comes from “navis” (ship) and “agere” (to direct). Navigation is the skill of directing the movement of a craft from one place to another safely and efficiently.

This course presents the science of navigation in a “classical” method, which is applicable to coastal navigation. The course emphasizes the responsibility of safe navigation is upon the vessel commander.

To solve problems in navigation the vessel commander identifies what dimensions of navigation are known and then solves for the unknown dimension.

The vessel’s electronic navigational equipment; Global Positioning System (GPS), with a chart plotter, integrated with the radar display is a great navigational aid, when properly used. The vessel commander’s ability to navigate safely relies heavily on their interpretation of the vessel’s electronic navigation equipment. The use of electronics traditionally collaborates what the VC has previously determined using the classical principles of navigation. Understanding the classical practices of navigation is the problem solving, the decision making, and the graphic solution the electronics can only replicate.

The marine electronics are computers. They solve problems based on the information entered into them.

Remember these sayings or terms associated with the navigator who is solely dependent on the electronics:

“Garbage in – Garbage out”

“An electronically assisted grounding”

“An electronically assisted collision”

Exclusive use of electronics will not exonerate you in the event of a collision or grounding. Check the owner's manual.

EPO #1: Describe the four types of navigation.

Marine navigation is a blend of science and art used to direct the boat's movement. This presentation teaches the science of navigation; however, developing the art of navigation comes from practice and experience. In marine law enforcement, the VC is responsible for directing the movement of their vessel from one point to another safely and efficiently. (Navigation)

Navigation methods and techniques vary with the vessel type, your experience, and the conditions. Tactically navigating a maneuverable and speedy enforcement boat obviously differs from navigating a commercial or a naval ship.

However, all prudent navigation requires:

Gathering information from every available source

Evaluating the information

Determining the present position frequently

Comparing the presently fixed position with a pre-determined position called "Dead Reckoning Position" (DR) on the DR Plot or voyage plan.

Electronic navigation systems solve navigation problems quickly with the results or solution depicted on the unit's display screen. However, efficient use requires the observer to understand the equipment's limitations and exploit the advantages.

The user/observer needs to know the basic operating concepts of the equipment. Some may describe this as button pushing, but it is important. The integrated systems provide an enormous amount of data

The output accuracy of this equipment requires evaluating. How does the user accurately interpret the video display to reveal critical information? Or, how is the unit tuned for the ambient conditions? What critical navigational data is available and how is the display screen set up to display the information? How will the user determine dangers or proximities of danger? Just like a chart the smaller the area viewed the greater the quality of detail. The user must change the scale of chart plotter to confirm the where about of potential dangers. The integrated system <u>*assists*</u> the user in safe navigation

<u>How do electronics determine the best navigational decision?</u> They don't! All electronics require input and accurate interpretation by the user. The GPS specifically, provides the user with the most direct navigational route. "The shortest distance between two points is a straight line."

Small craft electronic navigational equipment does not calculate how to avoid dangers, obstructions, shallow water, or other avoidance requirements. It does not make decisions. The vessel commander makes all decisions. The GPS only solves the navigational problems accurately entered through the touch pads. The pre-determined information, solved on a chart and then entered into the GPS, by the user, keeps the vessel on a safe course. The information out of the computer is only as good as the data entered. Therefore, it aids the user in the navigational process. Safe navigation only comes from understanding the principles of navigation.

There are four types of navigation:

- Piloting
- Dead Reckoning Navigation
- Radio or Electronic Navigation
- Celestial Navigation

CAUTION NOTE: DO NOT RELY SOLELY UPON ONE TYPE OF NAVIGATION**;** choose a method or methods appropriate for the situation.

Piloting is directing the movement of the boat using aids to navigation, landmarks, and soundings.

Piloting requires using a chart. Reading the chart, in advance of your present location, alerts you to the location of future aids to navigation and features designed so the navigator can make a safe landfall, follow a channel, or fix a position.

Correct and timely use of the depth recorder prevents groundings. Do not look at the depth recorder to determine only the present depth at the present time. Compare the chart's depth contour and tidal data along the perspective course, with the present depth of water and the present tidal stage. This is how you determine safe depth of water.

Running an expensive and specially equipped law enforcement vessel aground is not just fate or just an accident. Most of the time, it takes a great amount of careless effort to ignore the danger indicators, or complacency, inexperience, or negligence.

NOTE: Local knowledge is an important skill developed by each VC. Its use is exclusive to a limited area. A good VC is capable in all disciplines of navigation, which allows them to operate safely, without impairment, outside of their normal area of responsibility.

Piloting requires experience, constant vigilance, sound judgment, mental alertness, and a thorough knowledge of navigational principles.

Piloting occurs continuously during coastal and inland waterway navigation, even though other forms of navigation may simultaneously be in use. When navigational features are recognizable, use the following piloting techniques.

Do not pass close to any aid to navigation.

Buoys are not always on station.

Daybeacons and lights are frequently in shallow water or positioned on the danger or obstruction, which they mark.

Soundings can help determine position.

A depth contour followed along a straight shoreline assists in determining position.

A depth observed along a line of position can assist in determining position.

Local knowledge alerts the vessel commander to depth changes by the color of the water.

Movement of water over shallow depths frequently reveals the danger on the water surface.

Know your ability in judging distance (seamen's eye), especially at night.

At night, do not align your vessel directly at an aid to navigation's light. Orient the vessel towards a mark that allows safe passage along the correct side.

In a narrow-channel, keep a constant bearing on a distant forward landmark.

Stay in the center of the channel by being equal-distant from either bank.

Follow a steady heading.

Use your boat compass and maintain a constant heading.

Stay in the center of the channel by locating landmarks on your vessel's stern and bow.

When rounding a bend, keep an aid to navigation or landmark on your beam. This assists in tracking a constant arc along the channel shoreline.

Use danger bearings. (The section describing *direction* discusses bearings).

Dead Reckoning Navigation is calculating your vessel's position or future position *by applying the true course and the distance traveled FROM the last accurately determined position.* Think of it as a voyage plan.

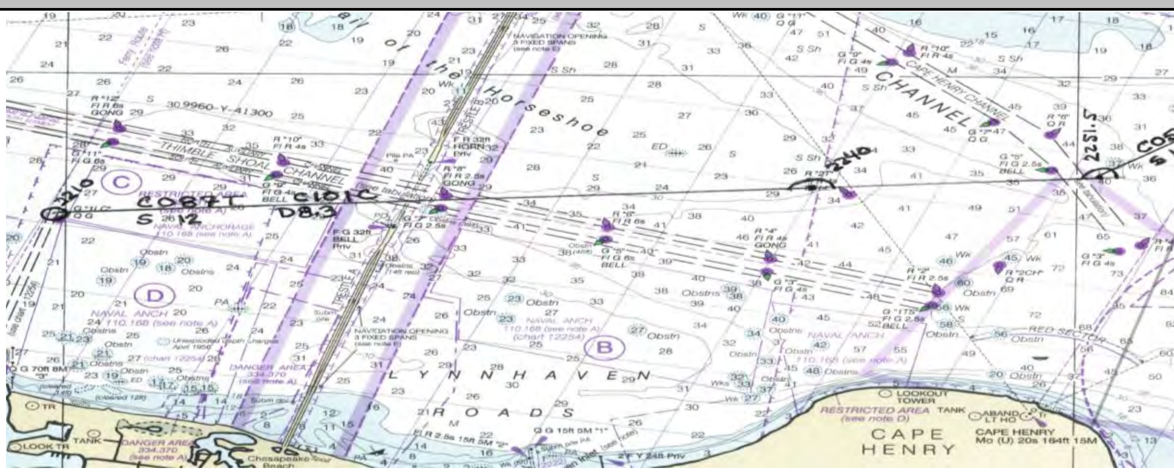
It is the most basic form of navigation. All other forms of navigation are incomplete until compared to the *dead reckoning plot*.

The true origin of the term is lost in antiquity. The word "dead" may be "ded" a contraction for the word deduce. (To calculate) The word reckoning is ascertaining a ships position.

The process of dead reckoning is *a graphic solution* plotted on a chart. It is the *voyage plan*.

The dead reckoning plot identifies the last known position, future positions, the distance needed to travel, and the direction of travel. The chart allows the marine law enforcement officer to solve navigational problems not typically encountered by the recreational boater or someone using recreational skills.

NOTE: The DR plot is a graphic solution. The lines drawn on the chart reveal what dangers exist in the vicinity of the vessel. Take note to what is underneath and immediately beside the line just drawn.



The dead reckoning plot or *voyage plan* normally makes no allowance for current, leeway, or steering errors, when constructed.

The Dead Reckoning Track is the path the vessel intends to follow. The path the vessel actually travels may be different (due to wind, waves, current, etc.)

A Dead Reckoning Position (DR) is the practice of estimating a position or a future position by advancing a known position along a course for a given time and speed.

The DR plot adheres to certain basic navigational principles.

Always start a DR Track from a *known position*.

Only use *True Direction to plot a DR track* on the chart.

Only use the speed through the water to determine distance traveled along a DR track.

Update the DR plot whenever it deviates from the planned route, A speed change occurs.

A course change occurs.

The current position is accurately fixed.

Restart the DR plot whenever the updated fixed position is well off the original plot.

The DR plot is a desirable safety measure when encountering unexpected variations in current, fog, or other restricted visibility conditions. This course of instruction also requires a DR position placed along the course to steer every thirty minutes.

Electronic Navigation is simply navigating by means of electronic equipment. The expression Electronic Navigation is more inclusive than the term Radio Navigation.

Radio Navigation is the means of determining position or information relating to position by propagation properties of radio waves. Specifically this is any device using radio waves, such as radar, GPS, Loran, and other receivers to determine position.

The discussion, interpretation, and operation of electronic navigation devices are in subsequent courses, of the MLETP.

Celestial Navigation is not practical for the rapid moving requirements of the vessel commander.

EPO #2: Describe the three dimensions or problems of navigation.

The Problems or Dimensions of Navigation are:

1. **Position**
2. **Direction**
3. **Time** – The variables associated and calculated with Time are **Speed** and **Distance**.

Other variables important to safe navigation, that require measuring or calculation include:

Water depth

Heights of objects and overhangs

Tides

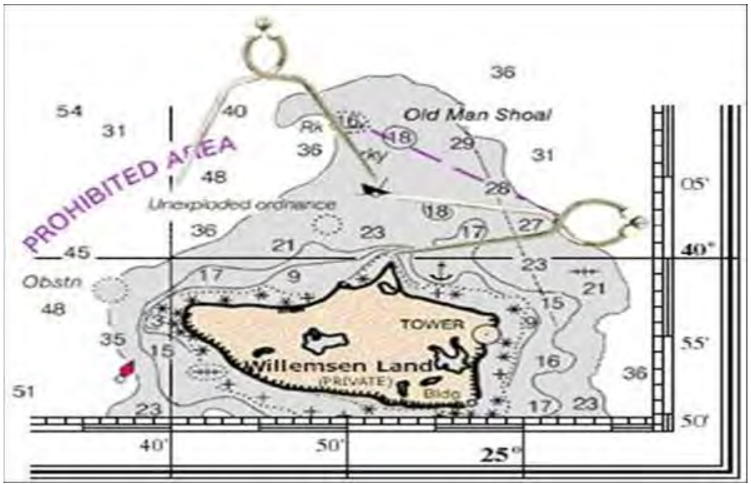
Currents

Wind

Not all the dimensions of navigation are known immediately. The navigator plots the known information on the chart and using of a simple formula readily solves the unknown dimension or navigation problem

The ability to solve these problems requires the navigator to recognize what information is available or known.

Position



Knowing position, or where one is, at any given point in time is a critical factor in navigation. Frequently determining position is a necessary precaution. Knowing location is a necessity in police tactics for summoning back up or other assistance.

Determining Position

Relative position is a location determined from known navigational features, measured as *direction and distance*. Some may know this as triangulation, or in land navigation as a back azimuth.

A Dead Reckoning Position (DR) is the practice of estimating a future position by calculating a distance along the track at a set speed for a set period of time. It is the procedure for advancing a future position from a known position. Label the DR position with a half circle and a dot on the track with the calculated time.

Always *record the time when calculating or observing a position*.

Observe the *water depth* when calculating or observing a position.

Direction

Direction, defined by "Bowditch," is the position of one point relative to another, without reference to the distance between them. It is a line making the same angle with all meridians.

Direction is not an angle, but often described as the angular distance from a referenced direction. The chart compass rose measures direction, clockwise, from 000°T to 360°T. Describe direction as a three-digit number.

Direction is not absolute, but oriented to four references.

True Compass direction has its reference as the geographic North Pole. It is a location on the earth's surface where all lines of longitude intersect. All longitude lines drawn on a Mercator Chart are parallel to each other, and at the top of the chart they point towards the True North Pole.

NOTE: This course requires drawing all lines on the chart as True direction.

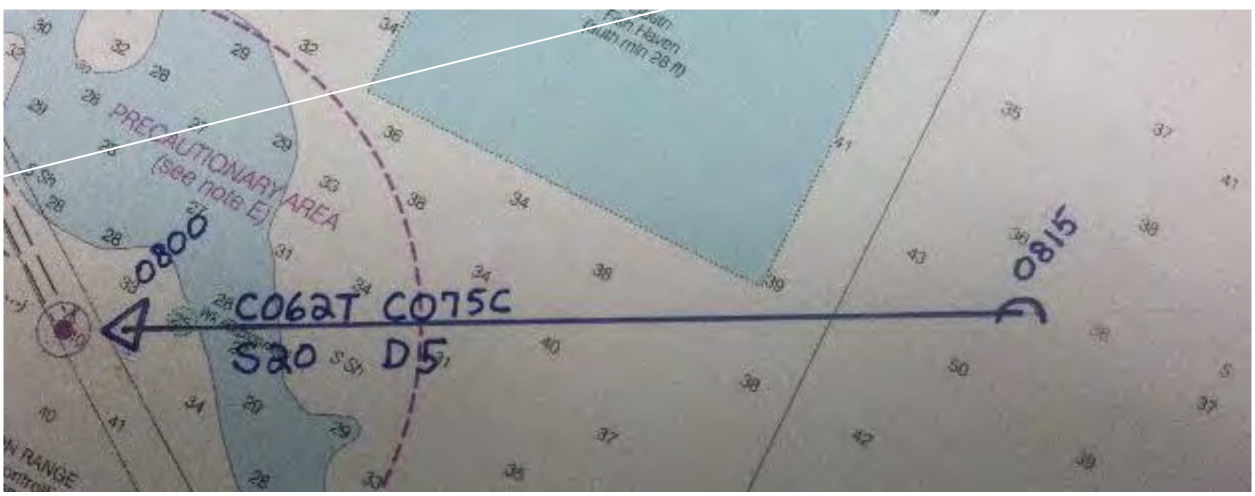
Magnetic Compass direction is the direction the north seeking pole, or magnetic compass needle, points towards solely because of the influence of earth's magnetic field.

Boat compass direction has no reference to direction on a chart. The boat compass direction is deflected away from the magnetic axis because of the disturbing magnetic influence near the compass. *Never plot* the boat heading or compass course on the chart. However, do label the compass course along the track.

Relative heading has its reference as the bow of the boat. Never plot a relative direction on the chart.

> NOTE: C*ourse lines* or a line of position is accurately measured to the nearest half of a degree.
>
> The testing requirement requires measuring direction to within a scientific accuracy of ± one (01) degree.

A course (C) is the average heading or the horizontal direction in which a vessel intends to steer. It is a straight-line, drawn on a chart, from the departure point to the arrival point. The referenced direction (T) is in degrees true, followed by the boat compass direction (C_____C).

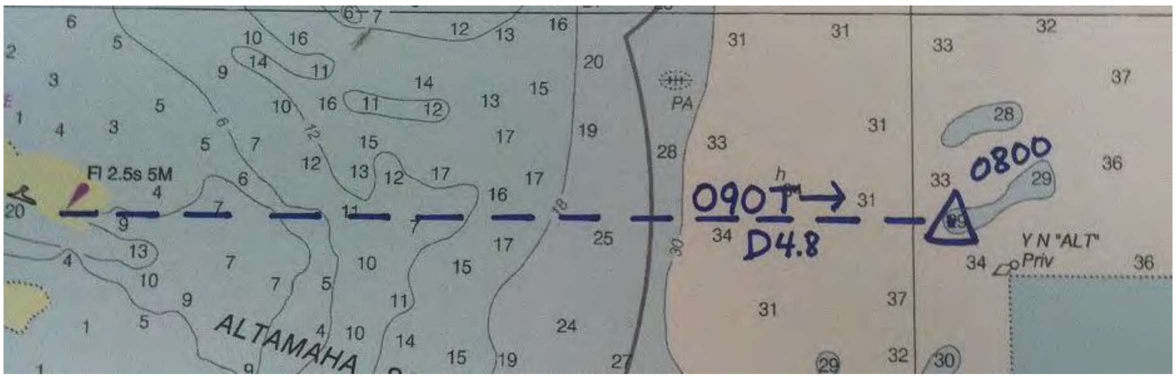


Track (TR) The intended direction of travel with respect to the ground. It is often associated with course (C).

Course Over the Ground (COG) is the actual direction followed by the boat, over the ground, usually in an irregular line.

Course Made Good (CMG) is a single line resultant from the point of departure to a future point at a given arrival time.

A Line of Position (LOP) is a line along which an observer presumes to be located. A single line does not determine position. However, the line does describe where the boat is not located. An LOP is a direction or a bearing described in degrees true, to or from a known landmark. Two or more LOP intersecting at a point, or within a small area establishes a known position called a fix. *Draw the LOP* on the chart as a *dashed line.*



The word, “to”, describes how the observer views the direction when looking towards a landmark. The word “from” is the reciprocal of that direction, and usually represents how the line is drawn on the chart. Draw the LOP from the known location (the landmark), out to the observer. This is the reciprocal of how the object was observed.

> +NOTE: To solve a reciprocal, *when the direction is less than 180°, add 180°.* To solve a reciprocal, *when the direction is more than 180°, subtract 180°.*

Time

Time is a critical factor for navigating safely. The navigator uses the twenty-four (24) hour clock to describe time. Express time as a four-digit number.

0935 – 2135 are examples.

The twenty-four hour clock simplifies computing the differences in time. The computation of time utilizes a base 60 and not a base 10 unit of measure. The two calculations readily practiced are:

Calculating the difference in time

Calculating arrival times

Example Problems:

Problem #1: Using the format found on the training vessels "A" Check list solve for the difference in time.

Ending Time	1545	
Start Time	0912	
	0633	Time difference is 6hr 33min

Problem #2: Using the same format:

Ending Time	1508	
Start Time	0849	
	0619	Time difference is 6hrs 19 min

Problem #3: The time it requires to travel a certain distance is 1hr 36min (01:36).

The departure time is:	2342	
The travel time is:	0136	I Hr 36 min
What is the ETA?	0118	

> CAUTION: Do not use a calculator to solve problems for time. The calculator is a base 10 system while time is a base 60 measure.

Speed

Speed (S) is the rate-of-motion, or the distance of travel per the unit of time. The unit of speed used in navigation is a rate of one (01) nautical mile per hour. (KNOT) The distance traveled in one hour equals the rate of speed traveled.

Example: A vessel traveling at a speed of 24 KTS, for one hour, travels a total distance of 24 (nm).

Other examples of speed observations are:

Speed of Advance (SOA) Indicates the speed to make along the intended track.

Speed Over the Ground (SOG) Actual speed of the vessel over the surface of the earth at any give time.

Speed Made Good (SMG) is a calculation of the distance measured between two points divided by the elapsed time of travel.

Distance

Navigation measures Distance (D) as the length of a Rhumb line connecting two points. It is the shortest distance between two points drawn on a Mercator Chart.

Distance (D) in navigation is a nautical mile. It equals 1.15 statute miles. It equals approximately 2000 yards. However, the mariner normally describes distance in units of nautical miles and tenths (.1) of nautical miles. (Example: 6.7 nm.)

Measuring Distance

The accurate measure of a nautical mile is the length of one minute of latitude.

A minute of latitude equals *one nautical mile*.

A degree of latitude has sixty minutes of latitude and equals *sixty nautical miles*.

The accurate measure of less than one nautical mile is either:

One tenth of a nautical mile equals *(.1') or 200 yards*.

There are 60" seconds in a minute of latitude. 6" *equals 200 yards* or (.1′) nm.

Use the latitude scale to measure distance on the chart. Make a practice of measuring distance on the latitude scale in the area in which you are plotting. On small-scale charts, it is important to measure distance in the area of your work or plot because the Mercator projection expands the length of the scale, as latitude increases.

Measure distance with a set of dividers.

Extend the dividers to the length of the course line and compare it to the latitude scale. For a long course line, it requires measuring a convenient distance first, i.e. five nautical miles; then, "end-for-end" the dividers walking them along the course line until the dividers need adjusting in-order to measure the remaining distance.

NOTE: Distance is accurately measured to the nearest .05 nm.

The testing requirement measures distance to within a scientific accuracy of ± one tenth nautical mile (.1nm).

EPO #3: Solve a time, speed and distance problem when two of the three variables are known.

Calculations involving Time (T), Speed (S), and Distance (D) are common in navigation. Determining an estimated time of arrival requires knowing what the distances, described in nautical miles, and the intended speed, described as knots, are to solve for the time of transit. The time, speed, and distance formula is a simple algebraic formula.

What is understood in this theorem is:

- *Time* is a function of distance and speed.
- *Speed* is a function of distance and time.
- *Distance* is a function of Time and speed.

The formula states whenever two variables are known the third unknown variable is algebraically solved.

The formulas used for small boat navigation are:

T (in minutes) **= 60 x D ÷ S** **S = 60 x D ÷ T** (in minutes) **D = S x T** (in minutes) **÷ 60**

Note: The variable of time is always expressed as minutes. If the time variable is more than one hour convert the hour and minutes to just minutes.

Example: Convert one hour and seven minutes (01:07) to 67 minutes before solving the problem.

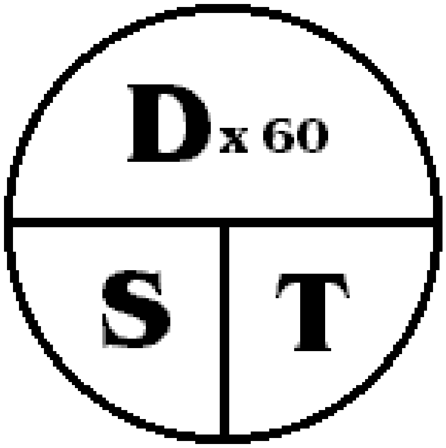
The known quantities in practical navigation are readily determined. The first is distance. It is a fact, when plotting the start position and the destination on a chart, the resultant is distance. It requires accurate measuring. It is a graphic solution.

The second is speed. The vessel commander knows the characteristics of the vessel, its capability in various sea conditions and selects speed.

When two variables are known simply solve for the third unknown.

The third unknown, typically, is time. The time required to travel a known distance at a predetermined speed. Apply the time of travel to the departure time to establish the ETA.

A model for easily solving a time, speed, and distance problem is a street address:



$S = D \times 60 / T$

$T = D \times 60 / S$

$D = S \times T / 60$

Time, Speed, and Distance

The model is easily remembered. Each student should draw the model in the margins of their chart. Enter the variables known in the appropriate section and apply the formula. It requires measuring distance accurately, correctly interpreting the other variable described, and with the model and the calculator problem solving is quick and accurate. The "**60D ST** "is the only aid each student has to recall the formula. The mathematical formulas are not allowed on the chart during final plot.

<u>The Six Minute Rule</u>

The Six Minute Rule is an efficient mental calculation of distance. It states the speed of a vessel divided by ten equals the distance traveled in six minutes.

A speed sustained for one hour is the distance traveled in one hour. Therefore, both the speed and the distance are both divided by ten.

Six minutes equals 1/10th of an hour or described mathematically

60 minutes ÷ 10 = 6 minutes

The speed divided by 10 equals the distance travel for a six-minute period.

A vessels speed of 24knots divided by 10 equal the distance of 2.4 nautical miles traveled in six-minutes.

24 kts ÷ 10 = 2.4 nm traveled in six minutes

To perform this mental calculation simply move the decimal point one place to the left.

24.0 kts = 2.4 nm traveled in six minutes

Developing a Speed curve

A speed curve is a table comparing engine RPM to speed. It is not a constant value. It is an observation of the rpm the vessel is operating at with the speed over ground. *At best it is an average*. The amount of current, wind, how a sea condition is attacked, and the ability to maintain a constant course determines the effective speed over ground.

A speed curve is only as accurate as the amount of effort used to develop it. A speed curve is not a casual observation of the GPS to determine present speed, but a developed table of RPM with the observed related speeds. The rpm speed curve allows the navigator to plan an ETA or in the event of an electronic failure the ability to continue to navigate safely.

The RPM Speed Curve is a table of engine speeds, tachometer readings in revolutions per minute, measured over an elapsed time.

- At a constant RPM, run a measured distance in one direction. Record the elapsed time.
- Repeat the process in the opposite direction at the same RPM. Record the elapsed time.
- Compute the speed using the Distance x 60 ÷Time formula.
- Average the two speeds to take in account the effects of Wind and Current.
- Repeat the process at differing RPM.

The primary factors affecting the reliability of the RPM Speed Curve are weight and trim. Load and fuel the boat for average conditions. Do not trim the boat for maximum performance.

EPO #4: Given known values solve for the unknown values in compass error.

The three directions used to compute navigational courses are true direction, magnetic direction, and boat compass direction. Magnetic and compass directions differ from true direction by successive external influences called errors.

The difference between true direction and magnetic direction is variation.

The difference between magnetic direction and the compass direction is deviation. Variation and deviation are declinations described commonly as ***Errors.***

The description of the three directions and their errors are:

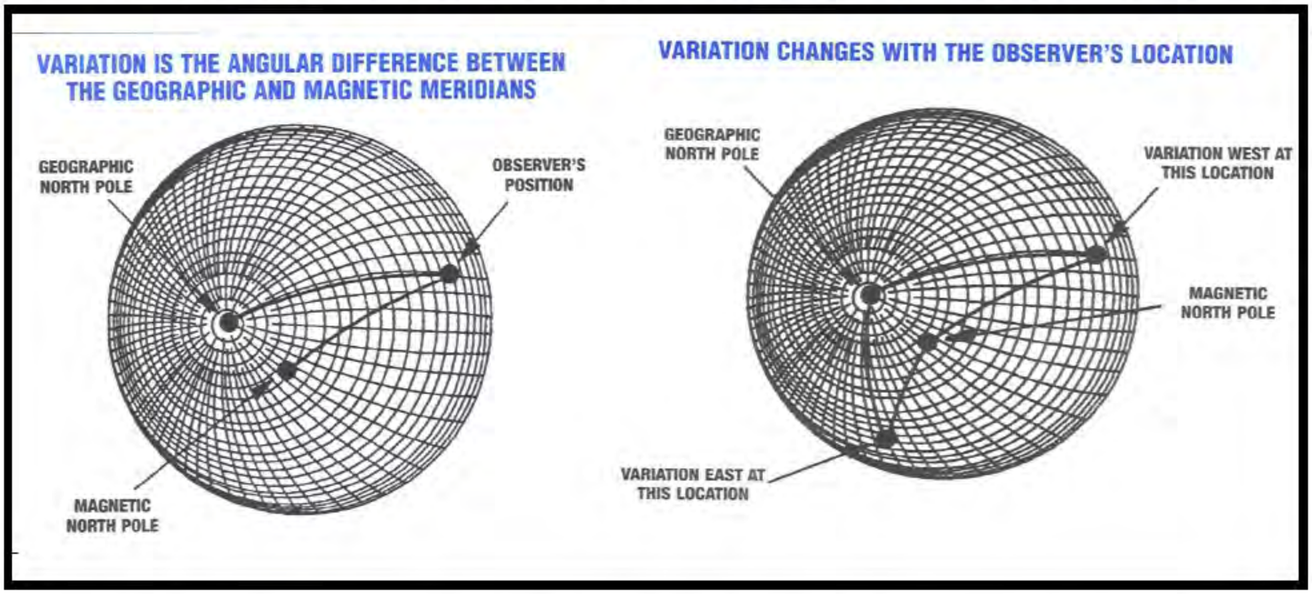
- True direction references direction towards the True North Pole.
- The orientation of the outer circle of the compass rose, with the star “Polaris”, is true north.

Magnetic Direction is the horizontal direction of a line measured as an angular distance from the magnetic north or a magnetic meridian. In 1984, the approximate location of the Magnetic North Pole was 78.9°N latitude, and 103.8° W longitude. The earth has a weak magnetic field, which generates magnetic flux lines. The flux lines flow out from the south auroral zone. The flux lines return through the northern auroral zone.

The northern auroral zone is the location of the Magnetic North Pole. The magnetic north pole and the magnetic meridians shift around. A long-term shift of the magnetic North Pole is a secular change. Noted on the chart, in the center of a compass rose with the date of observation, is the secular information.

Variation is the amount of error or declination between True direction and magnetic direction. The observed angle between the magnetic north pole and the geographic North Pole, from any location on the earth's surface, is the local variation.

- The amount of variation varies with the geographic location.
- The value of variation stays constant for all headings, within a geographic area.



- Whenever the magnetic meridian, 000° M, depicted on the chart's compass rose is to the left of True North; label the variation as a *westerly error.*
- An easterly error (variation) exists when the magnetic meridian is to the right or east of True north.

Deviation is the amount of error or declination between the magnetic axis and the boat compass direction. The term deviation describes how the compass heading differs from the magnetic heading.

Every vessel or boat has its own signature magnetic field. The magnetic disturbance near the compass creates an observable angle between the local magnetic meridian and the axis of the boat compass.

Unlike variation, which always stays constant in a geographical area, the deviation changes value whenever the compass heading changes.

SOLVE for the value of Deviation.

TRUE	VARIATION	MAGNETIC	DEVIATION	COMPASS
		042		**044.5**
		120		**122**
		230		**227.5**
		303		**301**
		345		**345**

Describe deviation as either an easterly or a westerly error. The axis of the boat compass is to the left or westward of the magnetic meridian, a westerly error exists. The axis of the boat compass is to the right or eastward of the magnetic meridian, an easterly error exists.

A deviation table is an observation of the differing error, recorded a minimum of every fifteen degrees of heading.

- When the compass heading *is less than the* magnetic heading the error is east. (Compass least Error is east)
- When the compass heading *is greater than the* magnetic heading the error is west. (Compass best Error is west)

"Swing ship" is the term used to compensate and provide a table of deviation. "Swinging ship" is a service frequently completed by a professional compass adjuster.

The following is a procedure for developing a deviation table.

- Measure the direction of a charted range in degrees true.
- Apply the value of variation to true and solve for magnetic direction.
- Observe the boat compass heading while transiting the range-line.
- Deviation is the difference between the magnetic and compass headings.

Solving problems using compass errors

A process for converting a true direction to a compass direction is **UNCORRECTING**.

This mathematical process requires the *adding of any westerly error*, and the *subtracting of any easterly error*.

The Uncorrecting process follows this procedure:

- Measure the direction of a line drawn on the chart between two points, in degrees true.
- Apply the value of variation, found on the compass rose, to the true direction and solve for the magnetic direction.
- Apply the value of deviation recorded on the boats deviation table, to the magnetic direction and solve for the compass heading.

UNCORRECTING

+W - E

→

TRUE	VARIATION	MAGNETIC	DEVIATION	COMPASS
031	**11W**	**042**	**2.5W**	**044.5**
292	**11W**	**303**	**2.0E**	**301**
239	**09E**	**230**	**2.5E**	**227.5**

A process for *converting a compass direction to a true direction* is **CORRECTING**.

This mathematical process requires the *adding of any easterly error*, and the *subtracting of any westerly error.*

The Correcting process follows this procedure:

- First, take the observed compass direction and apply the value of Deviation. Solve for the magnetic direction.
- Apply the value of variation to the magnetic direction and solve for the True direction.
- Plot the True direction on the chart.

CORRECTING

+E -W ←

TRUE	VARIATION	MAGNETIC	DEVIATION	COMPASS
031	**11W**	**042**	**2.5W**	**044.5**
292	**11W**	**303**	**2.0E**	**301**
239	**09E**	**230**	**2.5E**	**227.5**

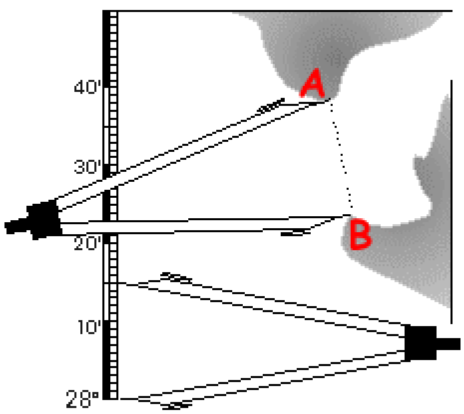
EPO #5: Demonstrate the proper use of various navigational tools.

<u>Dividers and drawing compass</u>

The navigator uses dividers to measure distance on a chart and the drawing compass to draw an arc of distance, on a chart. The navigator touches one point of the divider/compass on the latitude scale and the other point/drawing tip at the desired distance.

For an accurate measure:

- Extend the divider no greater than a 45° to 60° angle.
- Keep the needle points straight and evenly extended.



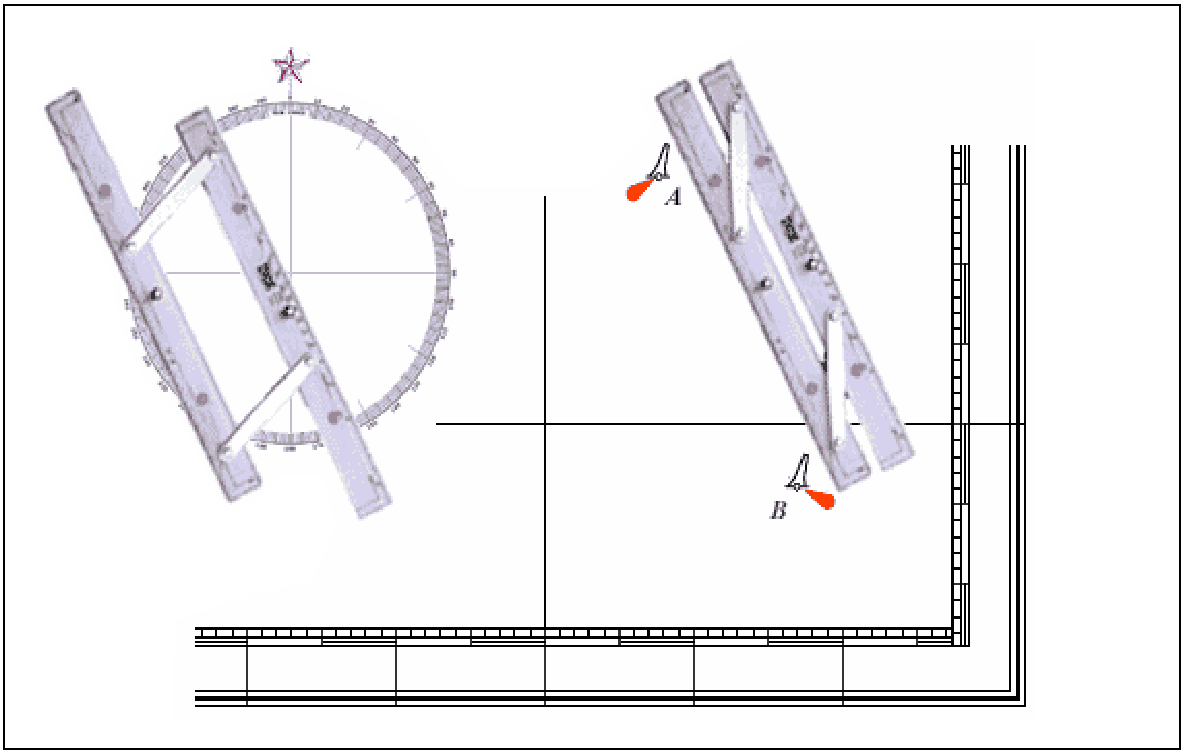
Place one point of the dividers at position A and the other point at position B. Then, maintaining the spread, measure the distance using the **latitude** scale. In this case, the distance is 15 minutes or 15 nautical miles. Always use the latitude scale located in the same horizontal region that you are measuring.

- Keep the pencil lead sharpened on the drawing compass with the needle and drawing lead also evenly extended.
- Over extending the tools lessens the measuring accuracy.

<u>Parallel Rulers</u>

Navigators use this tool to measure direction. For best accuracy, use the clear plastic parallel rulers on a flat surface. Avoid using warped tools.

Parallel Tools - All parallel plotters, issued to the students, are clear plastic with at least one compass rose printed on the tool. This allows measuring distance along the nearest *line of longitude.*



To use, align the mechanical edge along two points. Draw the line. Hold one ruler firmly to the surface, and move the other ruler. Repeat the process alternately moving each ruler until aligning the mechanical edge at the center of the chart's compass rose and the arc of the True compass rose. Read the direction.

Or, alternately move each ruler until the "S" reference line just meets the nearest meridian. Close the ruler. Observe the meridian touching the "S" reference and the tool's *compass rose inscribed on the perimeter of the parallel tool*. Read the corresponding direction.

- Read the compass rose on this tool from right to left.
- Read the angular directions from 000° to 180° and the reciprocal direction reads from 180° to 360°.
- Reverse the process for transferring a direction to a feature or desired coordinate.

Align the mechanical edge along the center of the compass rose and the desired arc of direction, or the reference "S" touching the line of longitude which strikes the arc of the compass rose at the desired direction.

Move the parallel tool in the same manner described above until it arrives at the feature or desired coordinate.

Parallel Plotter (Roller Plotter)

The parallel plotter is a roll-able tool which measures distance and direction.

To use this tool, align the straight edge along two points. Roll the tool to the nearest compass rose and align the tool's edge as previously described. Or, using the compass rose printed in the center of the plotter, roll the tool to the nearest line of longitude. Center the compass rose on the longitude and observe the longitude, like a spoke, strikes the arc of the compass rose. Read the direction off the rose in degrees true.

Parallel plotters have distance scales, printed in nautical miles, along the plotter's drawing edge.

The distances are for the following chart scales:

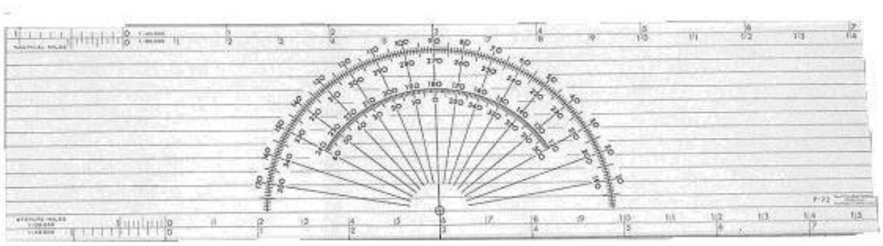
1:80,000

1:40,000

1:20,000

Course Protractor Plotter

The course protractor plotter measures courses and bearings on charts and plotting sheets. Unlike the parallel plotter and the parallel ruler this tool has no moving parts.



To measure courses or bearings:

- Place either of the long edges, or any of the parallel lines, along the course line.
- Slide the plotter along this line until the central point of the protractor is over a meridian.
- The course of bearing is read on the outer protractor scale where it intersects the meridian.

- The auxiliary scale is the inner protractor scale. Use this scale to measure direction when it is difficult to slide the central point to a meridian.
    - Align the tool along the course or bearing line.
    - Slide the central point to the nearest line of *latitude*.
    - Read the direction from the proper auxiliary scale. Use this scale when the measured line is nearly north or south.

To draw a course or bearing line from a given point, place a long edge of the plotter against the point with the central point over a meridian.

- While keeping the plotter against the point and the bulls eye over the meridian slide the plotter until the desired course is read on the protractor scale at the intersection of the meridian.
- Draw the desired line.

<u>Nautical Slide Rule</u>

The nautical slide is a calculator for solving time, speed, and distance problems. It has two circular dials, an inner and outer dial, mounted on a plastic base.

The outer circular dial displays the distance scale, read the dial at the upper right hand corner of the base plate.

> The outer concentric circle describes distance in nautical miles.
>
> The inner concentric circle describes distance in yards.

The inner circular dial has viewers for both speed and time.

> The Speed scale reads from 0ne (01) to 100 knots.
>
> The Time scale displays hours in green figures and minutes and seconds in black figure.

The nautical slide rule, like the formula, requires the user to know two of the three variables. Example: Time is the unknown quantity. Manipulate the tool as follows:

- First dial in the distance, on the outer dial, and hold the dial at that increment.
- Next, slide the inner dial around until the speed is at the speed arrow.
- Read the time scale.

The nautical slide rule is a very accurate tool for field use. However, it is an interpolator. Its accuracy is suspect for scientific classroom calculations.

Calculators

The calculator is the tool recommended, for this course, to solve problems relating to time, speed, and distance, and other calculations. The calculator solves "base 10" problems.

To solve problems of "base 60", which are differences of time and ETA, use the longhand mathematical process.

Use the calculator to solve the navigational problems presented in the practice plots and the final exam plot, to arrive at answers within the desired scientific tolerances.

EPO #6: Demonstrate the ability to fix a geographic position and relative position on a navigational chart.

There are two types of position. There is *geographic position* and there is *relative position*.

A geographic position is the intersection of latitude and longitude coordinates.

A relative position defines a position relative to other known landmarks or features using range (distance) and bearings (direction).

A line of position or bearing, to or from, a known landmark describes a relative position.

Several measured distances from known landmarks also describe a relative position.

A combination of bearings and distances describe a relative position.

The FIX is the navigational term describing a position occurring at a *specific time* and to *a high degree of accuracy*.

An electronic FIX uses the boat's GPS or the radar, or another sources electronics for defining position.

The GPS FIX

- Record the geographic coordinates from the GPS receiver
- Observe the time of observation
- Plot the coordinates and the time on the chart

The Radar FIX

- Observe a bearing and distance to a landmark feature
- Record the observed time.
- For a heads-up radar display, convert the relative bearing to a True bearing.
- Determine the reciprocal.
- Plot the reciprocal direction and measure the distance from the known landmark.

An electronic fix plotted on a chart uses a triangle symbol and the time of observation. Δ

EPO #7 Demonstrate the ability to plot and properly label a Dead Reckoning plot.

The Dead Reckoning Plot depicted on the chart is a graphic solution to a navigational problem, a voyage plan, or evidence of a vessel's movement downloaded from their GPS and presented in court. No matter the reason the chart requires exact interpretation.

The requirement for accuracy, neatness, and completeness establishes a need for labeling. The FLETC Marine Training Branch conventional rules of labeling are:

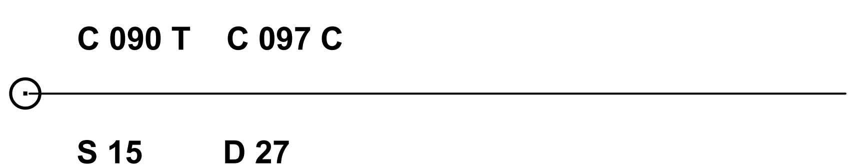
- Draw lines on charts lightly and no longer than necessary.
- Draw course lines as solid lines

NOTE: Immediately after drawing any line on a chart, or plotting any point, label it.

- The label for any line is placed along the line.
- The label for any point is at an angle to the point and not placed along the line.

Labeling data for a course line appears along the line with course data above, with speed and distance below the line. Do not contort your writing style however; it is often the direction of the line which appears to complicate the label writing. Be comfortable.

- The direction label is above the line.
    - Label the course with the True course closest the last position as: Example - C090T. (Course 090 True)
    - It is immediately followed with the boat compass course: Example - C097C. (Course 097 Compass)
- Label speed and direction below the line.
    - Label speed directly below the Course True. Example - S 15
    - Label distance directly below the Compass Course. Example - D 27



- A FIX, a known position, always starts the DR Plot.

> **EXCEPTION**: Label only the course true and the speed for any *OTHER VESSEL*. Label another vessel's DR position as previously discussed: change of course, change of speed, or every thirty minutes.

    - A triangle with a dot centered sitting on the line is an electronic fix.
    - A circle with a dot centered sitting on the line is a visual fix.
    - The FIX is a point on the chart, with the time always noted. Do not write the time along the course line. Write it at an angle.
- A "DR" position is placed on the track every time there is a course change, a change of speed, or every thirty minutes along a continuous course. The label is a half circle sitting on the line, indicating the measured distance.
    - The times of all DR positions are calculations. T-S-D calculation.
    - The DR position is a point. Label the time at an angle.
- Draw a line of position (LOP) or a bearing line as a dashed line.
    - Place the True bearing above the line of position with a directional arrow, indicating the direction the dashed line is drawn FROM the known feature towards the unknown position.
    - Place a distance under the dashed bearing line, when applicable.
    - Label the fixed position with a triangle for an electronic fix or a circle for a visual fix.
    - The FIX, like all positions, must have a time notation.

Label Course Lines:

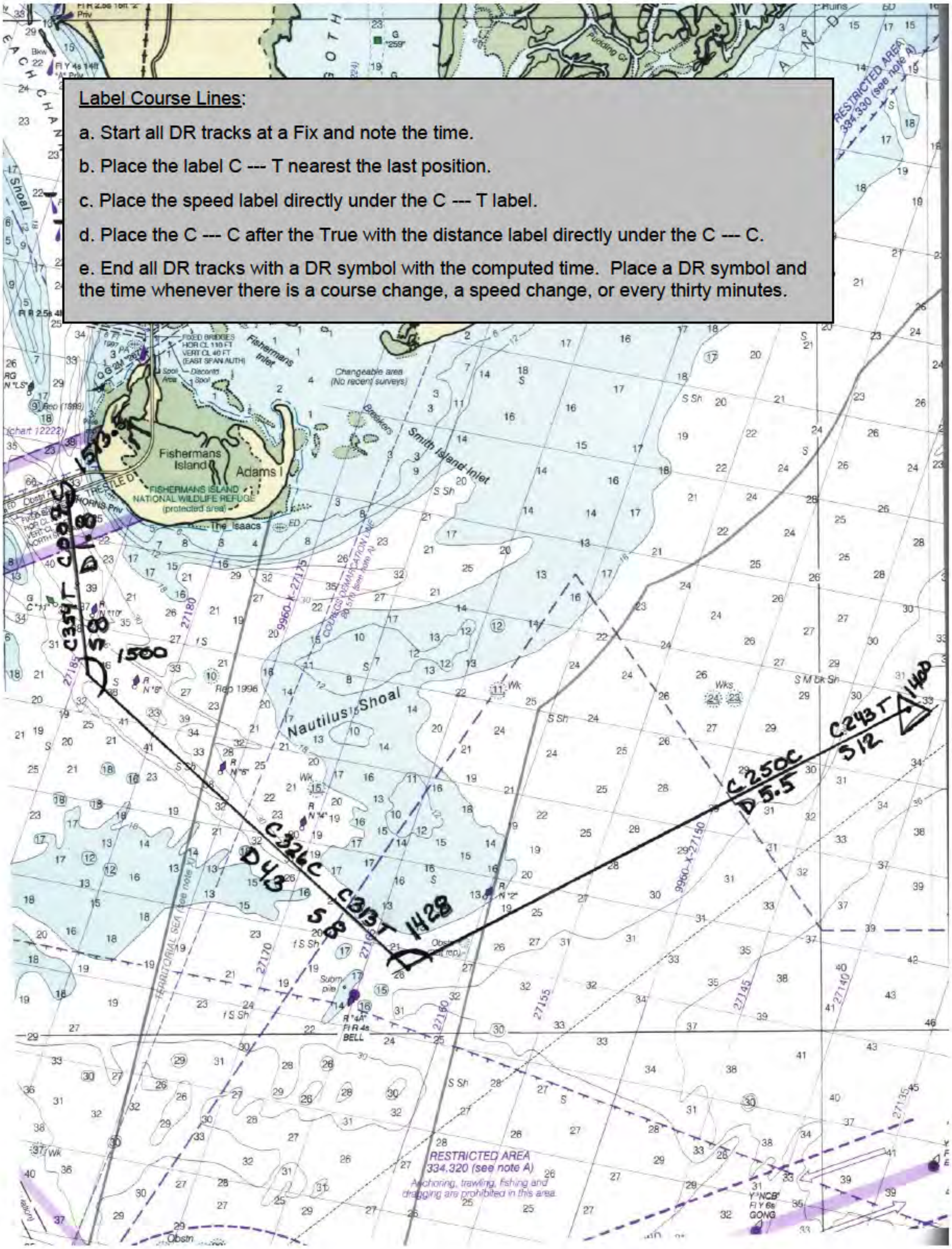
a. Start all DR tracks at a Fix and note the time.

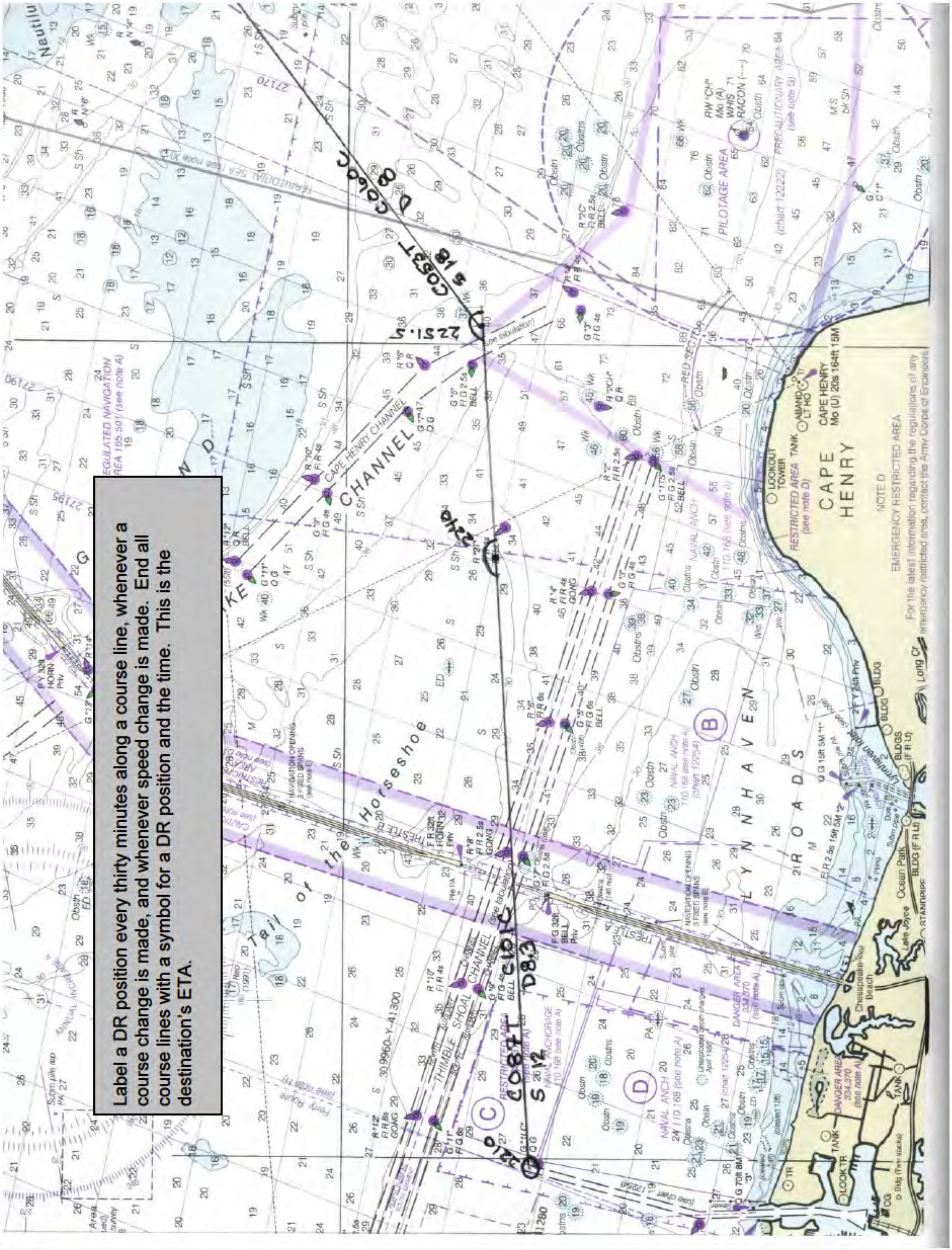
b. Place the label C --- T nearest the last position.

c. Place the speed label directly under the C --- T label.

d. Place the C --- C after the True with the distance label directly under the C --- C.

e. End all DR tracks with a DR symbol with the computed time. Place a DR symbol and the time whenever there is a course change, a speed change, or every thirty minutes.





Label a DR position every thirty minutes along a course line, whenever a course change is made, and whenever speed change is made. End all course lines with a symbol for a DR position and the time. This is the destination's ETA.
CAPE HENRY
CAPE HENRY CHANNEL
THIMBLE SHOAL CHANNEL
Tail of the Horseshoe
LYNNHAVEN ROADS
PILOTAGE AREA
RESTRICTED AREA
NOTE D
EMERGENCY RESTRICTED AREA
For the latest information regarding the regulations of any emergency restricted area, contact the Army Corps of Engineers

ATTACHMENT 1

MARINE LAW ENFORCEMENT TRAINING PROGRAM

TIME, SPEED, AND DISTANCE WORKSHEET

Chart #12221, 72nd Ed. Revised 07/02 JF

Chesapeake Bay Entrance

Using the formulas for time, speed, and distance solve the following problems.

Remember:

$$D = \frac{S \times T}{60} \quad \text{D = Distance in nautical miles}$$

$$S = \frac{D \times 60}{T} \quad \text{S = Speed in knots}$$

$$T = \frac{D \times 60}{S} \quad \text{T = Time in minutes}$$

1. Measure the distance between Chesapeake Light **(**Fl (2) 15s 117ft 24M HORN Racon (**—** •) **)** and Chesapeake Bay Entrance lighted buoy RW "CB" **(**Mo (A) WHIS Racon (**—** • **—**) **)**. ___________nm

How long will it take you to travel this distance at a speed of 15 knots?

___________mins

2. You are at York Spit Channel Lighted buoy "37" (Fl G 2.5s) at 2100 hours. At what speed must you travel to reach New Point Comfort Light "2" (Fl R 2.5s 15ft 5M) by 2130 hours? ___________kts

Locate the fish trap area on New Point Comfort Shoal. This triangular fish trap area is centered on 37o 15.3' N, 076o 13.4' W. What are the lengths of each side?

_______ ________ ________nm

How long would it take you to travel the perimeter of the Fish Trap area at 12 kts?

__________mins

4. Your speed is 20 knots, how long will it take you to travel from Thimble Shoal Channel lighted buoy "17" (Fl G 2.5s GONG) to Thimble Shoal Channel lighted buoy "1TS" (Fl G 2.5s BELL)?

_________mins Total Distance Traveled ___________nm

5. At what speed must you travel in order to navigate from York Spit Channel Lighted Buoy "38" (Fl R 2.5s) to York Spit Channel Lighted Buoy "16" (Q R) in 42 minutes? (Stay in the center of the channel.)

_________kts Total distance __________ nm

6. At 2234, you are at Chesapeake Bay Entrance safe-water mark RW "C" (Mo (A) WHIS). Proceeding via Cape Henry Wreck Lighted Buoy "2CH" (Q R), how fast will you have to travel to reach the center of the Chesapeake Channel Tunnel between buoys "13" (Fl G 4s) & "14" (Fl R 4s) by midnight (2400)?

__________ kts

For the following problems, use the formulas for correcting and uncorrecting compass error. The *variation is 9.5^o W*. Obtain the deviation from the deviation table provided.

7. You are at York Spit Channel lighted buoy "18" (Fl R 2.5s). What are the characteristics of the aid to navigation you will be alongside of if you travel for 14.5 minutes at a speed of 24 knots on a compass heading of 096^o?

What is your course in degrees true? _________ T

What is the distance traveled? _________ nm

8. You are at York Spit Channel lighted buoy "13" (Fl G 4s). Describe the characteristics of the navigational aid you will just be passing in 10.2 minutes on a course of 149^o magnetic at 28.5 knots.

What is your true course? _________ T

What is the distance traveled? _________ nm

What is your compass course? _________ C

ATTACHMENT 2

DEVIATION TABLE

MAGNETIC or COMPASS HEADING	DEVIATION
000	0.0
015	1.5 W
030	2.0 W
045	2.5 W
060	3.0 W
075	3.5 W
090	2.5 W
105	2.0 W
120	1.0 W
135	0.0
150	0.0
165	1.0 E
180	1.0 E
195	1.5 E
210	2.0 E
225	2.5 E
240	3.0 E
255	3.0 E
270	2.5 E
285	2.5 E
300	2.0 E
315	1.5 E
330	1.0 E
345	0.0

ATTACHMENT 3

COMPASS ERROR WORKSHEET

TRUE	VARIATION	MAGNETIC	DEVIATION	COMPASS

ATTACHMENT 4

ALLOWABLE ERROR FOR PRACTICE AND FINAL PLOTS

Item	Allowable Error
Direction	(+ or -) 1 degree
Latitude and Longitude	(+ or -) 0.1 minute
Distance	(+ or -) 0.1 mile
Speed	(+ or -) 1 knot
Time	(+ or -) 1 minute

STANDARD LABELING FOR PLOTS

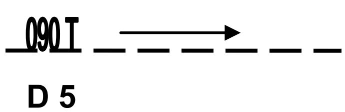
⊙ (With time)

Visual Fix .... Used when position is determined by visual bearings from fixed points.

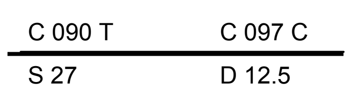

(With time)

Electronic Fix ....Used when position is determined by RADAR, LORAN, GPS, or VORTAC radial with DME.

DR Position ....Used for all positions that are not fixes.



Bearing lines Used whenever any bearing (visual, radar, VOR/VORTAC radial) is plotted.



Course lines Used to show the actual and projected courses of all vessels.

Note: A compass course can only be determined for your vessel. Course True always goes first (next to the point of departure] on a course line, with Speed under True.

NOTE: a DR position is plotted at every course change, every speed change, or every 30 minutes on a course line where direction and speed have not changed.

FINAL PLOT

Labeling Grading

20 Points

Points are <u>DEDUCTED</u> for:

Missing or Improper Fix or Fix label ------------------- 1 point

Missing or improperly Labeled DR ------------------- ½ point

Improperly Labeled Bearing Line ------------------- 1 point
[Any part wrong, yields the deduction]

Improperly Labeled Course Line ------------------- ½ point
[Any part wrong, yields the deduction]

At the conclusion of MLETP 706, the after-class Staff Mtg revealed issues dealing with grading the labeling discipline.

1. First read chapter seven of the Piloting & Deadreckoning ST or LP.
2. While assigned to a plotting lab, team up with those instructors who routinely correct the charts at the conclusion of Final Plot and insure you are advising the students correctly on the labeling discipline. Use the classroom plotting handouts as a guide.
3. The grading Criteria

[redacted] (b)(7)(E)

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

(b)(7)(E)

[redacted]

U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

STUDENT TEXT

VESSEL INTERCEPTS	
7510	MAY/11

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DEVELOPED BY: **(JUN/04)**

Anthony Blanda, Senior Instructor, Driver and Marine Division (Team Leader)

Based upon the 2003 CRC the Lesson Plan Air Sea Ops was Greatly Modified. It was rewritten to meet the new TPO and EPO's. The lesson plan number was maintained however, the name of the lesson plan was updated to reflect changes.

REVISED BY: **(SEP/04)**

Cole Maxwell, Senior Instructor, Driver and Marine Division
Note: Revised EPO to comply with current 94-01 format. Adjusted Cover page.

REVIEWED BY: **(OCT/05)**

Anthony Blanda, Senior Instructor, Driver and Marine Division (Team Leader)

REVISED BY: **(MAY/07)**

Anthony Blanda, Senior Instructor, Driver and Marine Division (Team Leader)
David Bryant, Lead Instructor, Driver and Marine Division (Team Member)
Dewey McCollough, Senior Instructor, Driver and Marine Division (Team Member)

Note: Revised, simplified the intercept solution described in EPO#1 paragraph 2 to reflect current trends and procedures for attaining a rapid intercept with two vectors. The student text and the power point presentation also reflect simplified intercept solution. Developed two new test questions.

REVIEWED BY: **(AUG/08)**

Anthony Blanda, Senior Instructor, Driver and Marine Division (Team Leader)

REVISED BY: **(MAY 10)**

Anthony Blanda, Senior Instructor, Driver and Marine Division (Team Leader)
Troy Devries, Lead Instructor, Driver and Marine Division
Note: Lesson Plan, Student Text, Power Point and Test Questions all updated to reflect consistency in their respective texts. References updated. PP formatted for FOUO

REVISED BY: (MAY/11)

Anthony Blanda, Senior Instructor, Driver and Marine Division (Team Leader)
Troy Devries, Lead Instructor, Driver and Marine Division
Steve Rodriguez, Detailed Instructor, U.S. Border Patrol

INTRODUCTION

The vessel intercept is first a navigational solution and then a tactical response.

It is a navigational solution because the vessel commander must determine whether the intercept is possible. To create an intercept you must recognize the known dimension of navigation for each vessel.

How does the vessel commander (VC) determine quickly the future positions of a suspect vessel? A quick method is the six-minute rule. Plotting the future positions of a suspect vessel, the VC can quickly determine whether the intercept is possible. All of the necessary information about course, distance, and time to intercept are simple calculations.

The tactical portion of this problem describes the LE vessel [redacted] (b)(7)(E)

Most suspect vessels use the cover of darkness to conceal their felonious activity. The intercept course is really a collision course, so you must be aware, always, of your proximity to the suspect and other LE assets as the distances diminish. The VC must use their crewmembers to assist in the intercept and give them responsibilities to help detect the location of the suspect vessel and other LE assets. These include use of the [redacted] (b)(7)(E).

Finally, we will discuss the role of [redacted] (b)(7)(E) to the suspect vessel.

EPO #1 Solve an intercept, using the six-minute rule and the basic principles of navigation.

The vessel intercept is first a navigational solution.

A mathematical theorem that applies directly to navigation is; the speed in knots traveled in one-hour equals the distance traveled in nautical miles. This also describes a vector.

The six-minute rule is a simple process for converting a quantity of speed traveled during a specified period to the distance traveled.

An example of the first theorem is: A vessel traveling at 24 knots for a period of *1-hour* travels a distance of 24 nautical miles.

An example of the six-minute rule is: The distance traveled in *six-minutes* at 24 knots equals 2.4 nautical miles.

The Six-Minute Rule is a handy mental calculation solving distance traveled. It states the speed divided by 10 equals the distance traveled in six minutes.

1. *60-minutes ÷ divided by 10 equals six minutes, or 1/10th of an hour.*
2. *The other known quantity in the formula is speed. The speed of the vessel divided by 10 equals the distance traveled during a six-minute period.*
3. *The speed of 24knots divided by 10 equals the distance of 2.4 nautical miles traveled in six-minutes.*

To divide by 10 quickly, simply move the decimal point one place to the left.

Procedures for solving an intercept

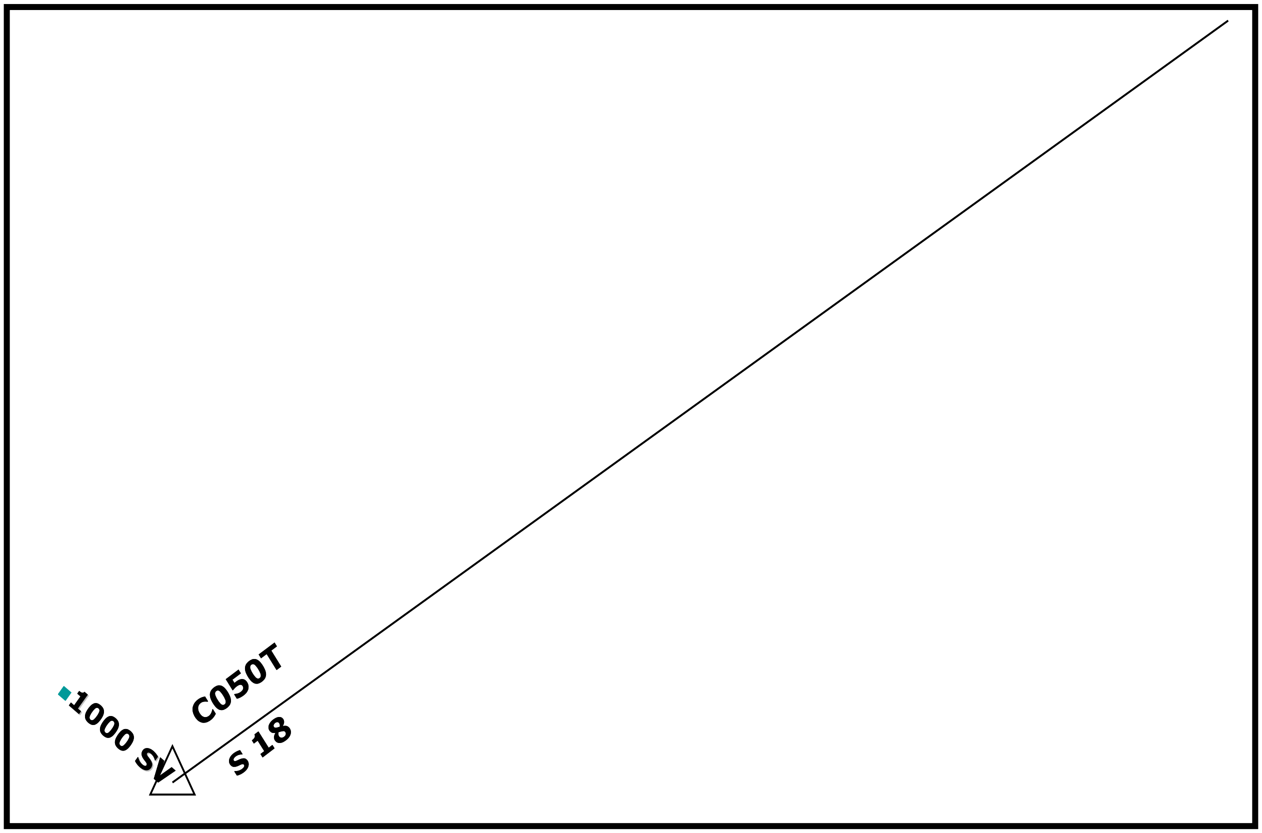
The intercept solution solved on a chart is the [redacted]

This navigational problem requires identifying the dimensions of navigation for both vessels. The dimensions or problems of navigation are position, direction, and the compilation of time, speed, and distance.

Intelligence, provided by [redacted] will provide the needed data for the suspect vessel. The intelligence needed is:

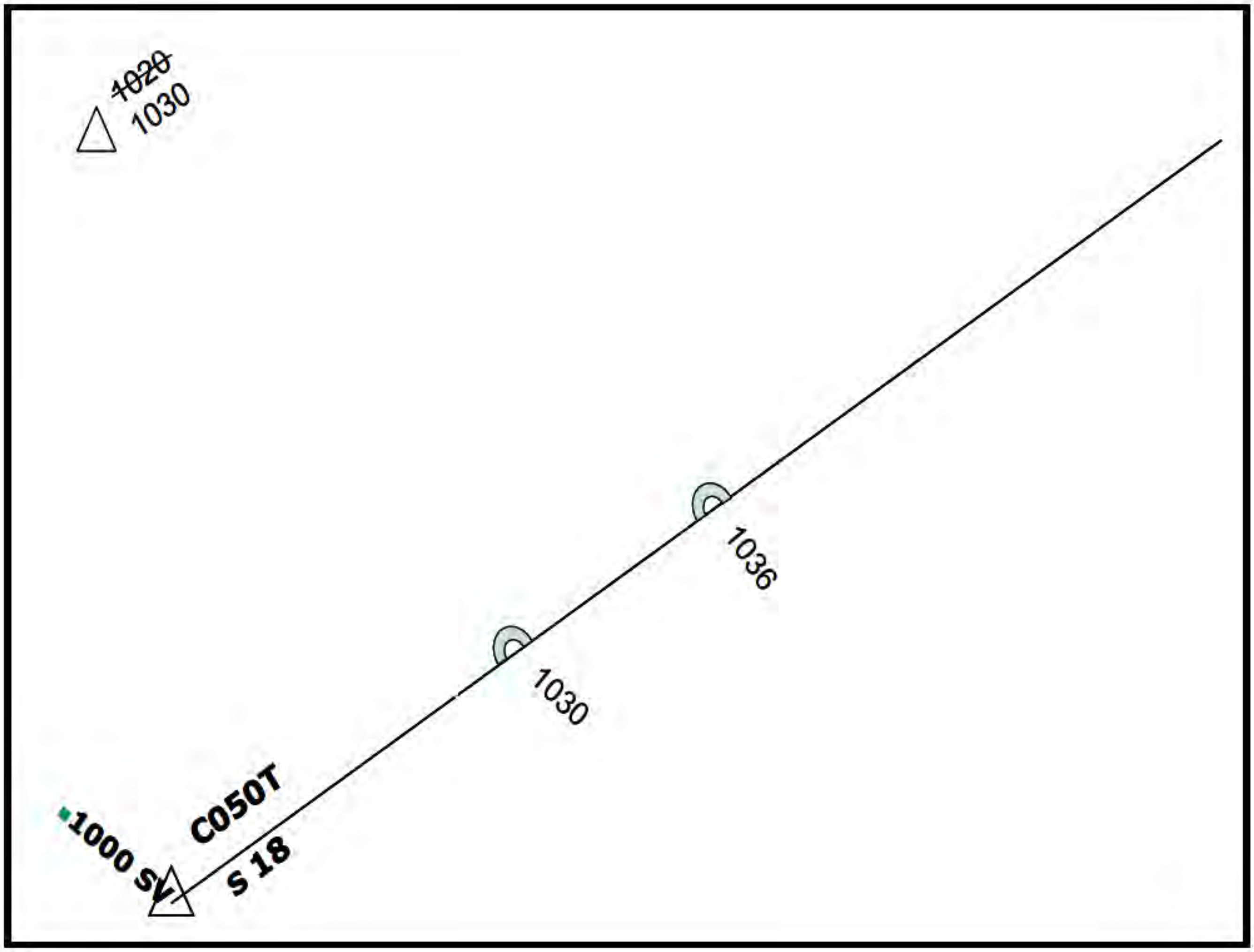
[redacted]

Plot the suspect vessel's navigational data on the chart.



Create the tactical plot

(b)(7)(E)



(b)(7)(E)

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

•

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

- with the direction and distance solved on the chart means accurately entered GPS information.

EPO #2 Identify LE boat tactics for affecting an intercept using air asset assistance.

The intercept plot is a tactical plot. It provides the best information towards an intercept point [redacted] (b)(7)(E)

[redacted] (b)(7)(E)

[redacted] (b)(7)(E)

(b)(7)(E)

[redacted]

> **Caution:** The "International Regulations for Prevention of Collisions at Sea, 1972, (72 COLREGS)" does not make exceptions for law enforcement vessels not using navigation lights when required. Know your agency policy for running without navigation lights.

The vessel commander is responsible for all phases of the mission, crew, and vessel. However, it is not a one-person job, where the VC, attempts to drive the vessel, communicate with additional assets, and operate the electronics. This is a team effort. The recommended crew responsibilities are:

(b)(7)(E)

[redacted]

[redacted]

SUMMARY

Solving an intercept is just another navigation problem. The navigator must identify the known factors, in order to solve for the unknown value. The unknown factor to solve for is [redacted]

[redacted] (b)(7)(E)

LEARNING ACTIVITY

[redacted] (b)(7)(E)

ATTACHMENTS

1. Intercept Work Sheet

ATTACHMENT ONE

VESSEL INTERCEPT WORK SHEET

Use Chart 12221

Nav Tools

Variation for this problem is 11W

Label all lines according to disciplines presented.

Solve an intercept using a tactical plot.

(b)(7)(E)

[redacted]

U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

Homeland Security

STUDENT TEXT

MOTORBOAT TRAILERING

7511 APR/11

~~WARNING~~

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TERMINAL PERFORMANCE OBJECTIVE (TPO):

Given a scenario involving a vehicle and a trailed vessel, the student will identify the requirements and procedures for towing, launching and retrieving, and the proper maintenance in a manner that ensures safety to the officer and the public.

ENABLING PERFORMANCE OBJECTIVES (EPO):

INTRODUCTION

In marine law enforcement, small trailerable boats extend the limits of patrol activity within a given patrol territory and provide access to shallow back-waters. Safety when working with small trailerable boats depends on following correct procedures. Driving a vehicle and towing a trailer are not difficult once familiar with the proper techniques. The correct procedures must also be followed when launching and retrieving a vessel. An amusing afternoon can be had at any public boat ramp watching inexperienced operators trying to launch and retrieve their boats. Avoid becoming the object of such amusement by learning the proper techniques and be assured a safe tow, launch and retrieval of your boat.

EPO#1: Identify or demonstrate the equipment required to safely tow a vessel.

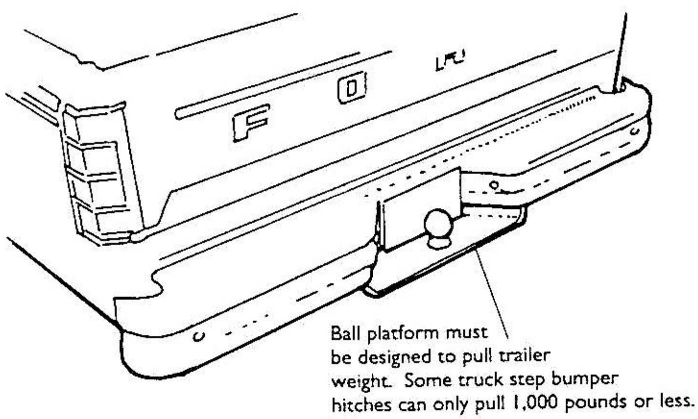
Towing Hitches, Couplers and Balls

When setting up a vehicle and trailer for towing one of the primary things to determine will be the weight of the complete towed package: trailer, boat, equipment. Hitches, couplers and balls are rated for a maximum weight capacity and all use the same numerical rating system. Each hitch should be equipped with an appropriately rated ball, and the coupler should match the ball.

Hitches

There are basically two types of towing hitches used in trailer towing; weight carrying and weight distributing. The type used is to a large extent dictated by the expected towing weight. The simplest and least expensive of the weight carrying hitches is the "bumper" hitch. This hitch is mounted on the rear bumper of the tow vehicle with no connection to any other structural member. This hitch is adequate only for towing light trailers. Some states have banned this type of hitch completely.

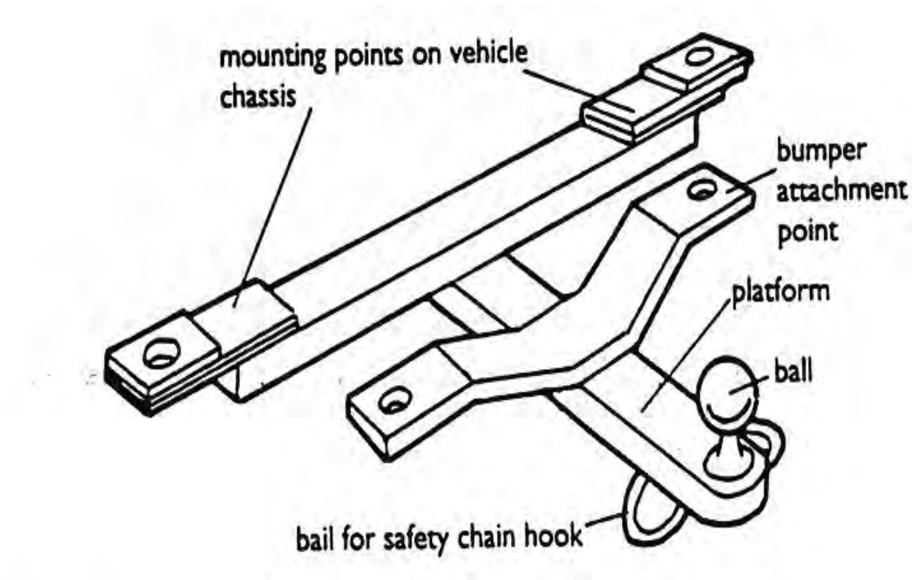
One type of weight carrying hitch found on many trucks is the "step bumper" hitch. These are not considered "bumper" hitches because they are an integral part of the bumper which is mounted securely to the truck. In fact, some are rated at 3500-4000 pounds and considered Class 2 hitches.



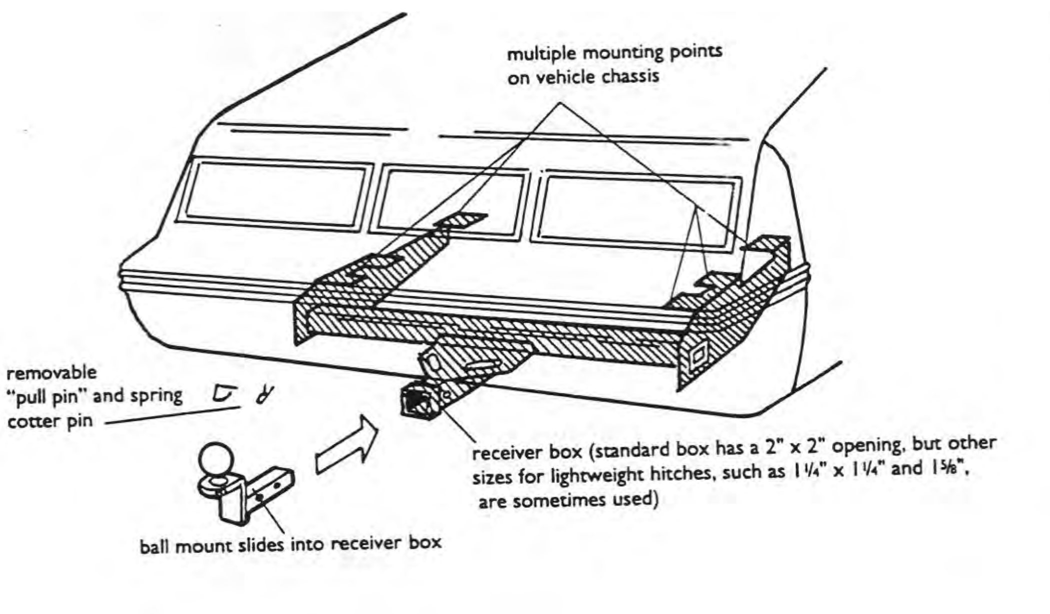
Step Bumper Hitch

"Frame" hitches are weight carrying devices that bolt to at least two of the vehicle's structural members (frame, unitized body, etc.). These can be of either a fixed platform or receiver type configuration.

"Receiver" type hitches offer more versatility than the fixed platform type. The hitch bar can be removed and stored inside the vehicle for security and to forestall rust. Reversible hitch bars allow adjustment to the height of the hitch. Different hitch bars may be carried for different size balls and can be quickly changed to match the coupler size of different boat trailers.

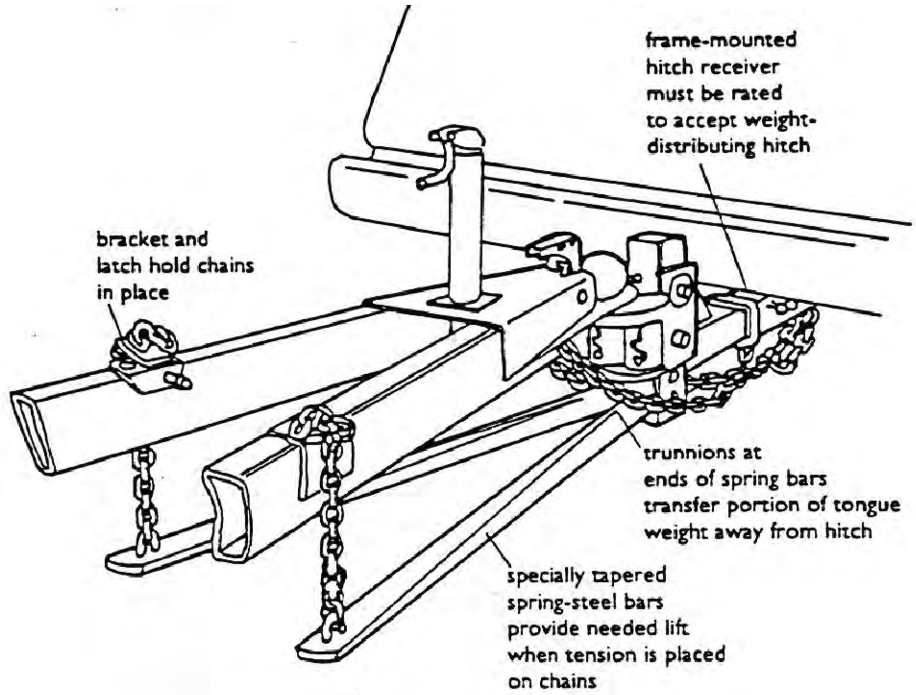


Fixed Platform



Receiver Type Hitch

Weight Distribution or "equalizing" hitches are used to relieve some of the strain placed on the tow vehicle. A heavy trailer can place too much weight and strain on a tow vehicle's rear tires, shocks, and springs. This excess weight on the rear of the tow vehicle reduces the weight on the front tires causing a loss of control both in braking and steering. A weight distributing hitch distributes the tongue weight between all four tires of the tow vehicle and the wheels of the trailer which results in better handling, safer operation and less wear and tear on the tow vehicle.

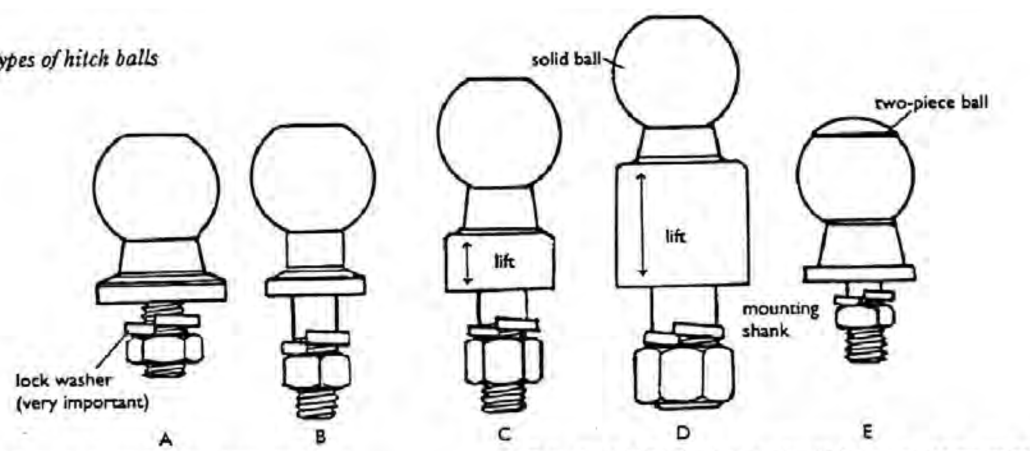


NOTE: Some surge brake systems may be affected by a weight distributing hitch, depending on the specific design of each. Check with the dealer or manufacturer of each.

Hitch Balls

There are a variety of hitch balls available. Common sizes are 1 7/8", 2", 2 5/16". Select one to match the size of the coupler and of an appropriate capacity.

Types of hitch balls



A. Standard heavy-duty ball. Note wide neck.
B. Standard light- or medium-duty ball. Note narrower neck.
C. "High lift" ball raises coupler 1".
D. Taller "high lift" ball raises coupler 2". Note heavier mounting shank. Shanks come in 3/4", 1", and 1 1/4" diameters.
E. Two-piece ball - not recommended except for lightest loads.

Th
e

class of hitch required depends on the Gross Vehicle Weight and Tongue Weight of the trailer. Each hitch is capable of carrying 10% of its towing weight as tongue weight.

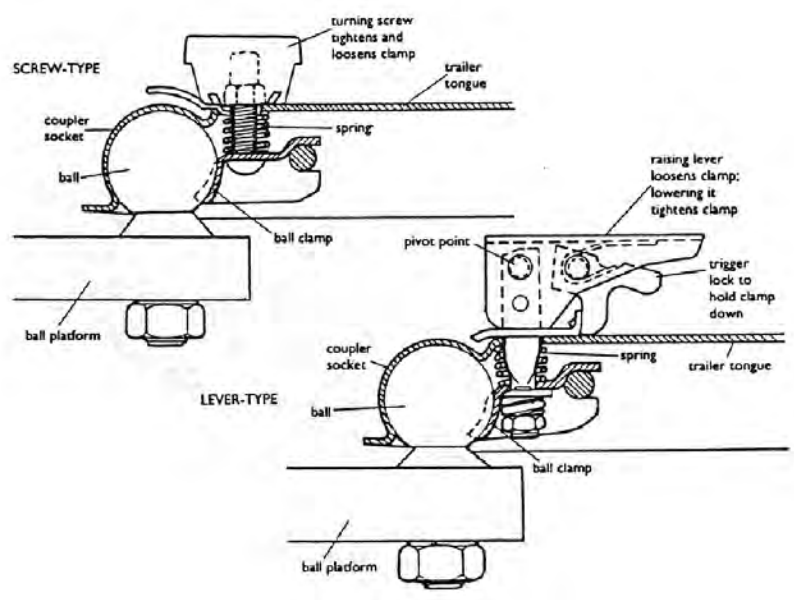
<u>Trailer and Hitch Classes</u>

Trailer and Hitch Class	General Category	Maximum Capacity: Towing Weight t.w. (lbs.)	Maximum Capacity: Tongue Weight (percent of t.w.)	Type of Hitch	Typical Tow-Vehicle Attachment Points
Class I	Light duty	2,000	10%	Fixed ball platform	Bumper plus two points on frame
Class II	Regular duty	3,500	10%	Fixed ball platform	Bumper plus two points on frame
Class III	Heavy duty	3,500 to 5,000	10%	Receiver type	Four or more points on frame
Class IV	Extra-heavy duty	5,000 to 10,000	10%	Receiver type	Four or more points on frame

Coupler

The coupler is what attaches the trailer to the hitch, and is generally either a latch or screw type coupler. The coupler should be of the same class as the hitch.

NOTE: The weight capacity and ball diameter are stamped on both the ball and the coupler.



Safety Chains

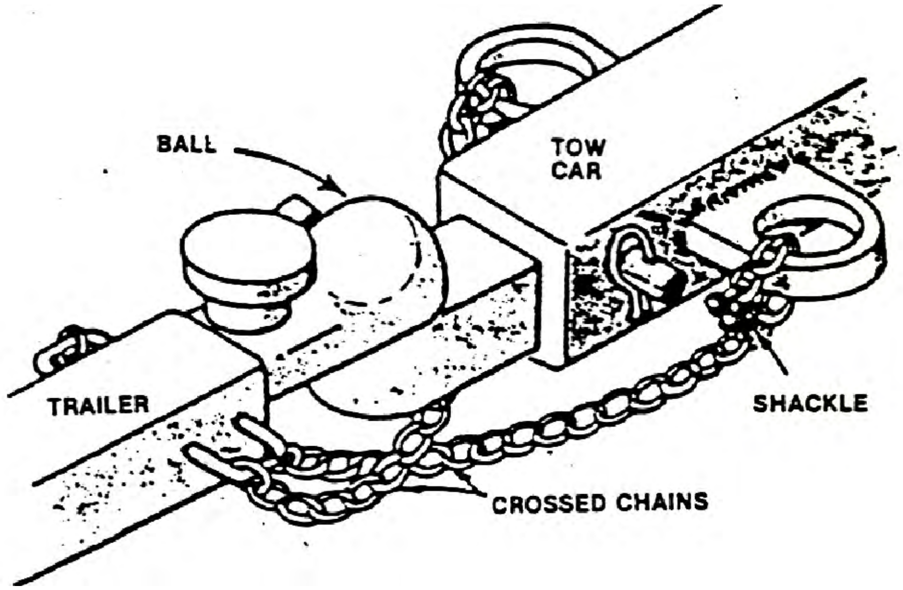
Safety chains are an important safety feature on trailer hitches and should be of proper size to carry the gross weight of the trailer. When the trailer is hooked to the tow vehicle the safety chains should be attached so as to CROSS under the trailer's tongue. Properly crossed chains will catch and hold the tongue off the pavement if the hitch or coupler should fail. The chains should be long enough to allow the rig to turn freely, but not so long that they drag on the pavement.

Shackles of the proper size are recommended to secure the safety chains to the hitch. If S hooks are used the open face must face the trailer, otherwise they will detach if the tongue becomes uncoupled and under rides the tow vehicle.

TRAILER CLASS	PROOF-COIL CHAIN SIZE (link thickness)	BREAKING STRENGTH**	SHACKLE SIZE
	1/8"	N/A	
I	3/16"	3,000	3/8"
II	1/4"	3,500	7/16"
III	1/4"	5,000	1/2"
IV*	5/16"	7,600	9/16"
IV*	3/8"	10,600	5/8"
IV*	7/16"	14,000	3/4"

* Chain can be used with trailer class shown provided gross trailer weight does not exceed breaking strength. Double chains are required.

** Steel welded chain or equivalent in strength.

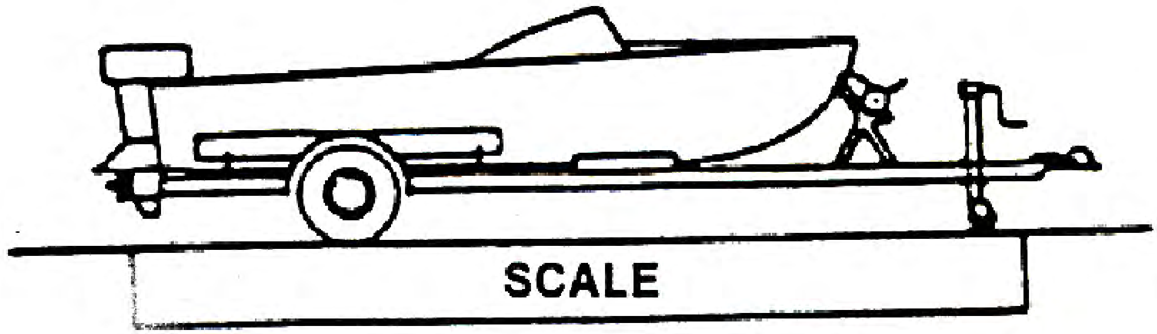


Trailer Weight

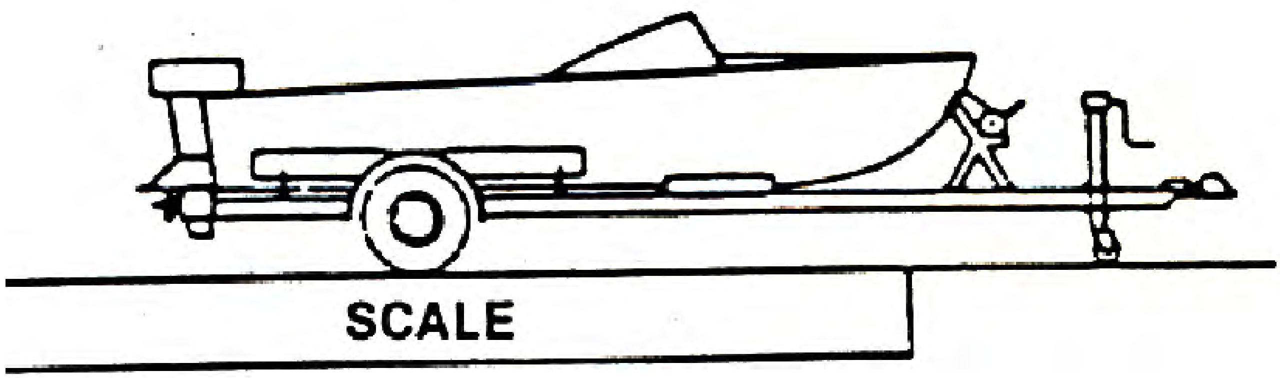
Safe trailering requires that the trailer be properly loaded and balanced. An overloaded trailer on the highway is a dangerous thing. All law enforcement vessels carry additional equipment, the weight of this must be considered when towing a boat on a trailer. In addition, when on the road this equipment should be properly distributed and secured to prevent shifting.

To get an accurate **Gross Vehicle Weight, Gross Axle Weight,** and **Tongue Weight** take the boat with all of its equipment to a truck scale.

Gross Vehicle Weight: Weigh the trailer unhitched with its wheels and jack stand on the scales.



Gross Axle Weight: Weigh the loaded trailer with only its wheels on the scales. The jack stand should be off the scales and adjusted to keep the trailer level. This is the Gross Axle Weight.



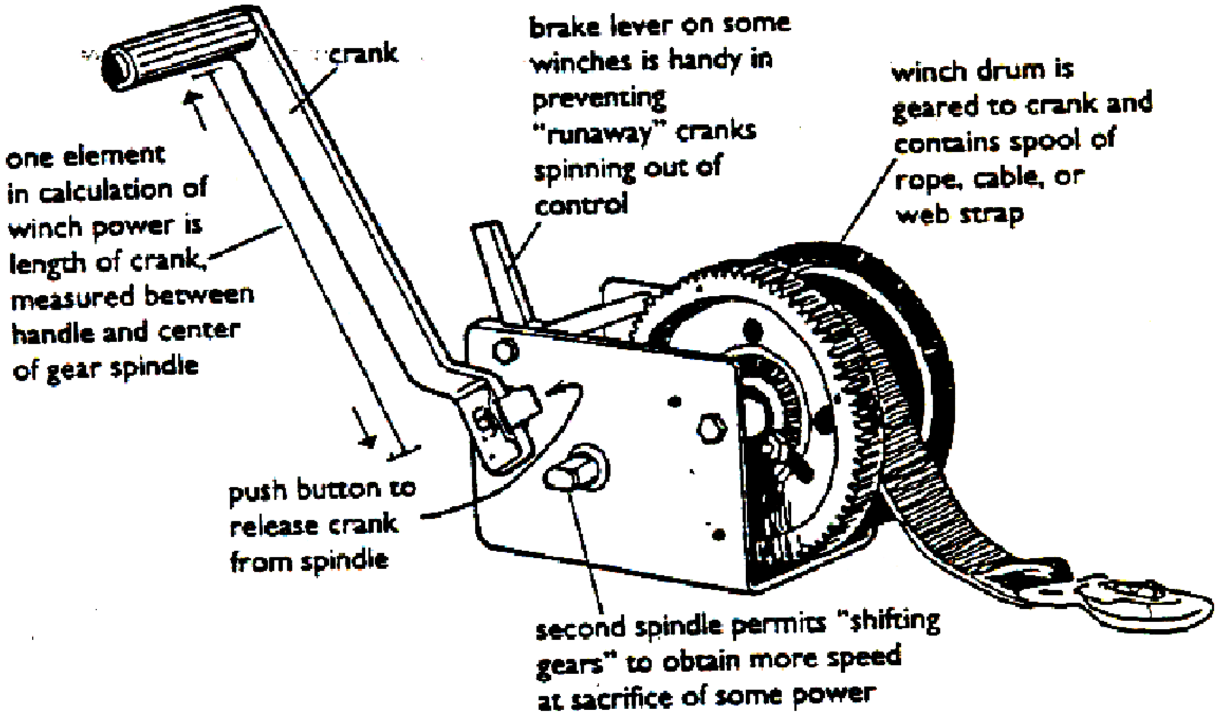
Tongue Weight: Weigh the loaded trailer with only its wheels on the scales. The jack stand should be off the scales and adjusted to keep the trailer level. This is the Gross Axle Weight. To obtain the Tongue Weight, subtract the Gross Axle Weight from the Gross Vehicle Weight.

Never load the trailer with so much equipment that the recommended gross vehicle weight and/or tongue weight is exceeded! Recommended tongue weight is 10% of gross axle weight.

Improper tongue weight may cause problems during towing. If the tongue is too light the trailer could fish tale or sway. Too much weight on the tongue can make steering quirky.

Trailer Winches

Most boat trailers come equipped with winches to assist in loading a boat. These can be either manually or electrically operated. Both types should be equipped with a safety brake to prevent back lash when weight is applied. Electric winches should be capable of manual operation if there is an electrical failure.



Pulling power of typical winches

Catalog Winch Capacity (lbs.)	Number of Speeds	Gear Ratio (xx:1)	Crank Length (Inches)	Pulling Power (lbs.)
600	1	3.1	6	372
800	1	3.2	6	384
1,000	1	4.1	7	574
1,200	1	4.1	8	656
1,400	1	4.1	9	738
1,700	2	5.5 + 10.5	9	990 + 1,890
1,800	1	5.1	9	918
2,000	2	5.5 + 12.5	9	990 + 2,250
2,200	2	4.1 + 9.8	10	820 + 1,960
2,500	2	5.1 + 12.2	10	1,020 + 2,440
2,500	2	5.5 + 17.0	10	1,100 + 3,400
2,600	2	5.1 + 12.2	10	1,020 + 2,440
3,500	2	6.0 + 12.0	12	1,440 + 2,880

Note: To calculate pulling power, friction is assumed to be 25%, drum diameter after line is wrapped is assumed to be 3", and pull on handle is assumed at 40 pounds.

Winches may be equipped with rope, strap, or steel cable for use in retrieving a boat. The minimum recommended breaking strength for these items is 150% of the rated "Straight Line" pull of the winch.

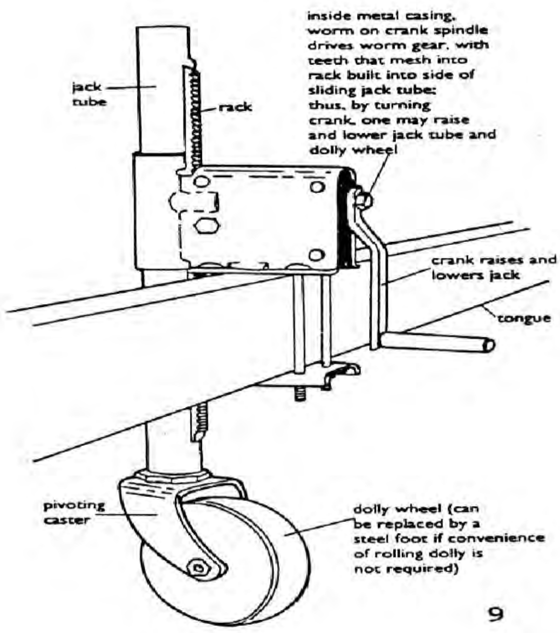
MINIMUM BREAKING STRENGTH (Pounds) FOR TRAILER WINCH ROPE* AND CABLE

DIA. OF ROPE	POLYETHYLENE		POLYPROPYLENE		NYLON		DACRON	DIA. OF CABLE	7x19 AIRCRAFT CABLE	
	TWISTED	SOLID OR DIAMOND BRAID	TWISTED	SOLID OR DIAMOND BRAID	TWISTED	SOLID OR DIAMOND BRAID			GALVANIZED OR TINNED PREformed	STANLESS STEEL PREformed
1/4"	1200	1100	1275	1100	1650	1200	1450	1/8"	2000	1760
5/16"	1750	1700	1900	1750	2500	2000	2200	5/32"	2800	2400
3/8"	2500	2500	2600	2450	3200	2750	3100	3/16"	4200	3700
7/16"	3400	3400	3250	3000	4650	4400	4200	7/32"	5600	5000
1/2"	4100	4000	4200	4000	6000	5000	5300	1/4"	7000	6400

Winch hooks should have a minimum breaking strength of not less than 150% of the winch rope or 125% of the winch cable. Any shackles used to attach the hooks to the winch rope or cable should have a minimum breaking strength at least equal to that of the rope or cable.

Jack Stand and Caster

Any trailer having a tongue weight exceeding 75 pounds should have a jack and caster assembly. This will facilitate mating a heavy trailer to the hitch. It allows raising, lowering or maneuvering the trailer tongue during hook up or when unhooking. It also allows the trailer's tongue to be elevated slightly so that rain water can drain out of the boat's transom scuppers.



Combination tongue jack and dolly

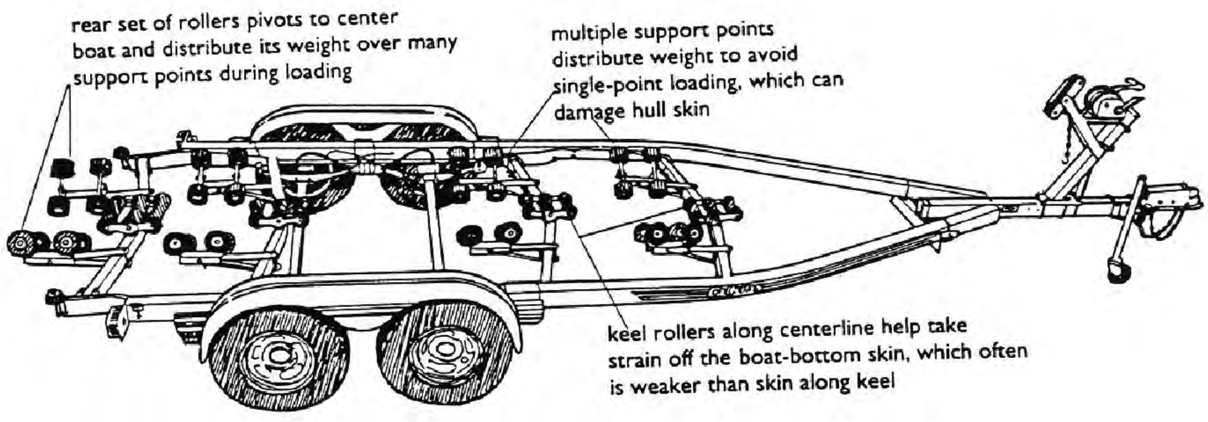
Hull Supports

A hull is designed to be supported over its entire hull surface by the pressure of the water. Even the best boat trailer can't duplicate this total support. However, it is important that a trailer give the hull as much support as possible. Improper support can cause splits in the hull's bottom or other hull failure.

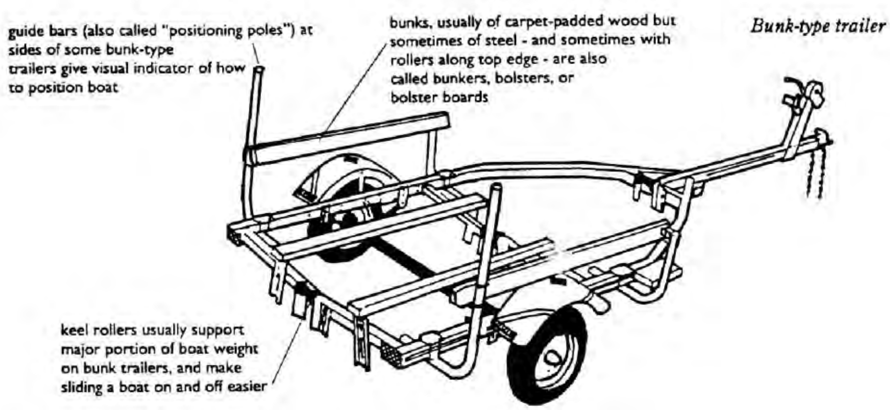
NOTE: DO NOT SKIMP ON BOAT TRAILERS!

There are two principal types of hull supports used on trailers, rollers and padded bolsters.

Rollers are the most efficient for launching and retrieving because they have minimum friction. Rollers are preferred if the trailer is the correct length for the boat and the trailer has sufficient rollers. The hull should correctly rest on all of the rollers. Assure that the boat is never overloaded when it is on the trailer.



Padded Bolsters, or bunks, are not as efficient for direct launching and retrieving because of friction. Padded bolsters are preferred if the boat is launched with sling or hook hoists unless the trailer is a float-on type.



Some trailers combine both rollers and bunks on one trailer in an effort to achieve optimum use.

When considering setting the boat on a trailer the most vital support points for it's' hull are the forefoot, the keel, the turn of the bilge and the transom

Rollers and bolsters should be able to be adjusted up, down, forward, and aft. They should be adjusted to the boat's hull to prevent warping, sagging or other damage. When making these adjustments, consider that Inboard/outboards and outboards need good transom support because of the weight on the transom be sure to make adjustments equally port and starboard to keep the support symmetrical.

Tie Downs

The use of tie downs is recommended, and generally required for both peace of mind and safety, to help keep the boat on the trailer while it is being towed. Bow and transom tie downs are most crucial. Use a tie down, from the bow eye to the trailer frame or to the lower part of the winch stand. Do not solely depend on the winch to hold the bow down. At the stern use the transom lifting eyes to secure the boat. A tie down strap across the gunnels at the stern is sufficient on lighter boats.

The use of a "transom saver", which is a device that transfers the weight of the lower unit directly to the trailer, will help prevent damage such as the transom delaminating or the hull hooking caused by the up and down bobbing action of the unit induced by uneven road surfaces.

Brake Lights and Turn Signals

Brake lights, tail lights, and turn signals are required by law on trailers. The addition of lights or reflectors on the rear and sides of the trailer beyond those required by law will greatly increase safety at night.

Detachable lights are preferred as they have greater useful life. If it is impractical to have detachable lights, the lights may be secured to a "guide-on". This accomplishes three things. It will reduce corrosion and water damage to the lights because they won't be submerged. The lights can be seen better at night due to their added height and retrieving the boat is made easier because the guide-on allows you to center the boat on the trailer.

Regardless of the type of lights that are mounted on the trailer, always disconnect the wiring harness plug before launching or retrieving to prevent short circuits. This action allows the bulb to cool before entering the water.

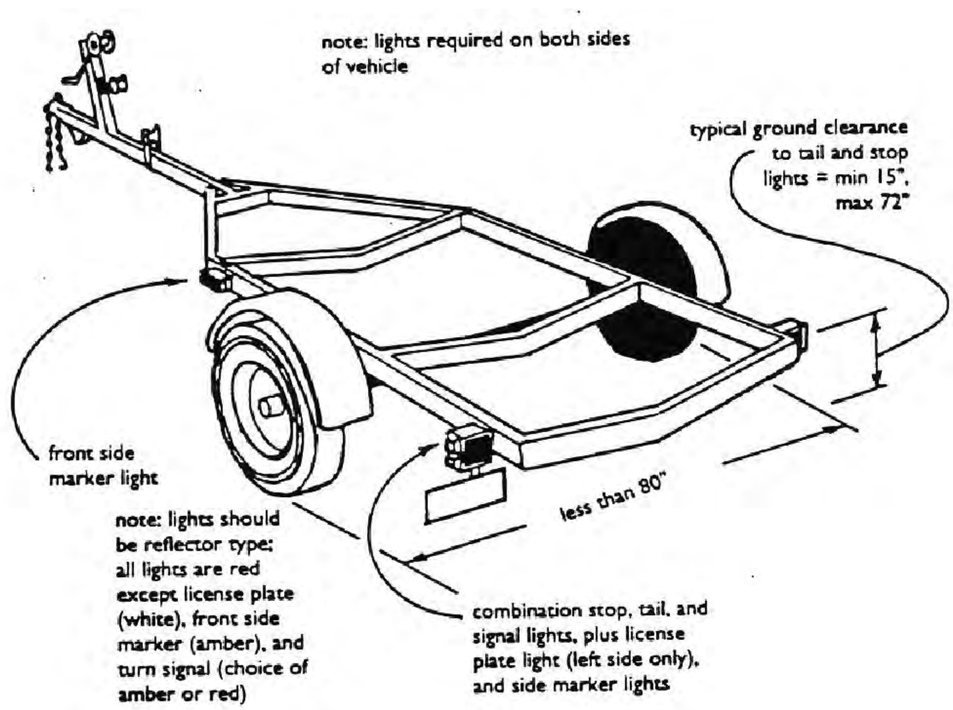
The tow vehicle should also be equipped with a heavy duty flasher unit to handle the additional load of trailer lights.

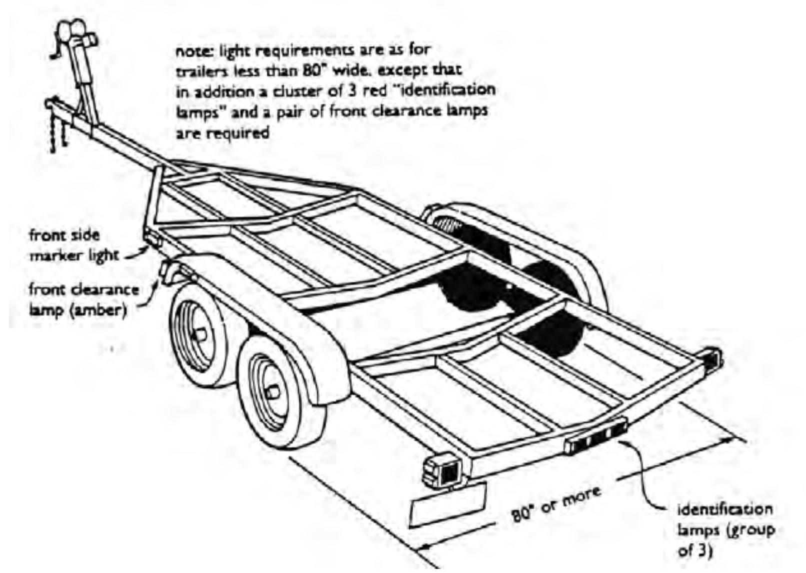
All wiring connections should be made correctly. Make sure there is a good ground between the trailer and the tow vehicle. The standard wiring color code for trailer lights is:

WIRE COLOR CODING

Wire Color	Function
White	Ground
Yellow	Left stop & turn signal
Brown	Running lights

Green	Right stop & turn signal





Tires and Wheels

The size and weight carrying capacity of tires will vary. , Federal law requires that load capacities be displayed on the sidewalls of tires. Trailer manufacturers will utilize different configurations and sizes of tires in an effort to match both the boat and the intended launch method.

Trailer tire inflation pressure versus capacity

SMALL TIRES

TIRE SIZE DESIGNATION	TIRE LOAD LIMITS (LBS.) AT VARIOUS COLD INFLATION PRESSURES (PSI)																	
	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
4.80-8	260	310	350	**390(A)**	430	465	495	530	560	**590(B)**	615	645	670	695	720	**745(C)**		
4.80-12	345	410	465	520	570	615	660	700	740	**780(B)**	815	855	890	920	955	**990(C)**		
5.30-12	395	465	530	590	645	700	745	795	**840(B)**	885	925	970	1010	**1045(C)**				
5.70-8	355	420	480	530	580	630	675	**715(B)**	760	800	835	875	**910(C)**	945	980	1010	1045	**1075(D)**
6.90-9	500	**590(A)**	670	750	820	**885(B)**	950	1010	1065	**1120(C)**	1175	1225	1280	1325	**1375(D)**	1420	1470	**1510(E)**
6.50-10	530	625	715	795	870	940	1010	1070	1135	**1190(C)**	1250	1305	1360	1410	1460	1510	1560	**1605(E)**
7.50-10	695	820	935	1040	1135	1230	1315	1400	1480	1560	1635	1705	1775	1845	1910	**1975(E)**		

LARGE TIRES

TIRE SIZE DESIGNATION	TIRE LOAD LIMITS (LBS.) AT VARIOUS COLD INFLATION PRESSURES (PSI)										
	15	20	25	30	35	40	45	50	55	60	65
6.50-13 ST	650	770	875	975	**1065(B)**	1150	1235	**1315(C)**			
7.75-15 ST	830	985	1120	1245	**1365(B)**	1475	1580	**1680(C)**			
8.55-15 ST	990	1170	1330	1480	**1620(B)**	1755	1880	**2000(C)**	2115	2225	**2330(D)**
"78 SERIES"											
A78-13 ST	600	710	810	900	**985(B)**	1065	1140	**1215(C)**			
B78-13 ST	650	770	875	975	**1065(B)**	1155	1235	**1315(C)**			
C78-13 ST	695	825	940	1045	**1145(B)**	1235	1325	**1410(C)**			
E78-14 ST	790	935	1065	1185	**1300(B)**	1405	1505	**1600(C)**			
F78-14 ST	845	1000	1140	1270	**1385(B)**	1500	1605	**1710(C)**			
G78-14 ST	920	1090	1245	1385	**1515(B)**	1635	1755	**1865(C)**			
H78-14 ST	1005	1190	1355	1510	**1650(B)**	1785	1910	**2035(C)**			
E78-15 ST	790	935	1065	1185	**1300(B)**	1405	1505	**1600(C)**			
F78-15 ST	845	1000	1140	1270	**1385(B)**	1500	1605	**1710(C)**			
G78-15 ST	920	1090	1245	1385	**1515(B)**	1635	1755	**1865(C)**			
H78-15 ST	1005	1190	1355	1510	**1650(B)**	1785	1910	**2035(C)**	2150	2260	**2370(D)**
"70 SERIES"											
F70-14 ST	845	1000	1140	1270	**1385(B)**	1500	1605	**1710(C)**			
H70-14 ST	1005	1190	1355	1510	**1650(B)**	1785	1910	**2035(C)**			

Note: "Load Range" is a measure of tire carcass strength as defined by the "ply rating." That is, Load Rating A is equivalent to a 2-ply rating, B to a 4-ply rating, C to 6-ply, D to 8-ply, and so on up to N, equivalent to a 24-ply rating. (Incidentally, under certain conditions, the actual number of plies may differ from the "ply rating," though this is of no consequence to the trailer-boater.)

Letters in parentheses denote Load Range for which bold-face loads and inflations are maximum. For example, a 5.70-8 tire rated for Load Range B can support a maximum of 715 pounds, for Load Range C 910 pounds, and for Load Range D 1,075 pounds.

Source: Tire and Rim Association

Replacement wheels and tires should equal or exceed the specifications listed on the trailer's certification plate. Load carrying ability varies with inflation pressure; check tire pressure often. The most common cause of tire failure on trailers is from under inflation. Under inflation can lead to tire separation and failure. Air pressure on trailers is much higher than on vehicle tires, sometimes as much as twice as high.

Before you start out towing a trailer consider that on tandem axle trailers, whipping and weaving can be reduced by having the rear tires inflated higher than the front. Check air pressure on tires before loading and again on the road after warm up.

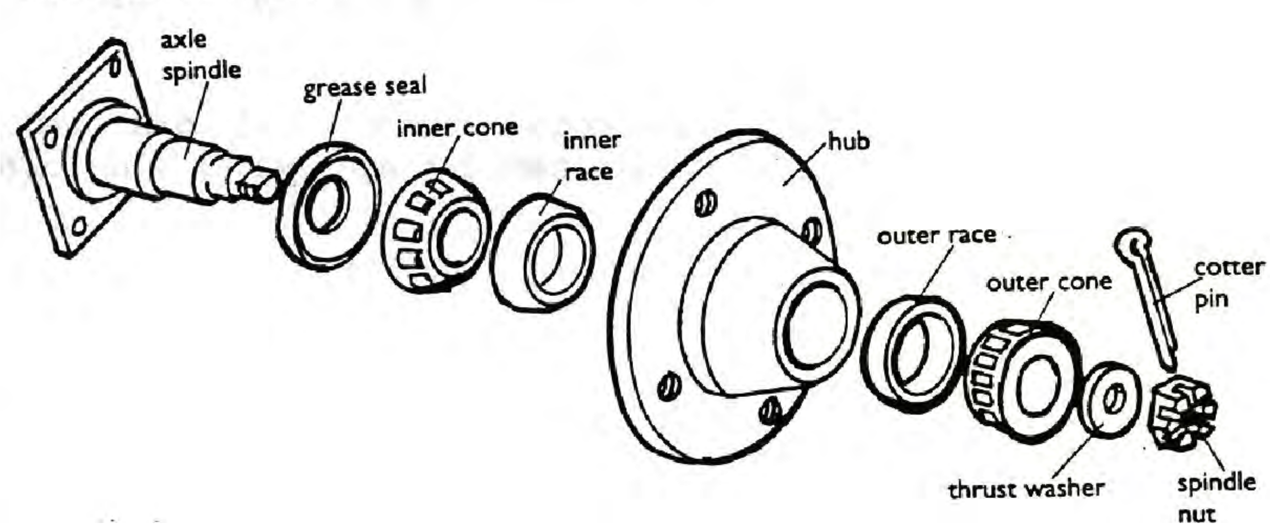
Trailers have flats too. Remember to carry a jack, lug wrench and spare tire suitable for your trailer. The use of safety flares is a good precaution when changing a trailer tire on the open road.

Bearings, Seals and Lubrication

Standard automotive hubs, bearings, seals and grease are often used on trailers. These do an acceptable job if the hubs are not submerged. If the trailer is to be submerged use only inner seals designed for boat trailers along with waterproof grease inside the hub.

Inspect the hubs, bearings and seals regularly. Check for water in the grease (it will look milky), and signs of rust, on, or pitting of the bearings. Examine the dust caps, seals and locking cotter pins to make sure each is functioning properly. Water entering the bearing around the inner grease seal is the cause of most bearing failures. When a hub is hot (normal use) the drop in air pressure caused by the cooling of air inside the hub will draw water into the hub. Squeaky hubs or hubs that are too hot to touch indicate a failure somewhere. Any trailer that is subject to having its hubs submerged should have protected or sealed bearings. Bearing protectors hold the grease under pressure which helps prevent water from entering the hub.

Wheel hub and bearings



Brakes

Most states require trailers over a certain gross weight to be equipped with brakes on at least one axle. These gross weight requirements vary from state to state. There are three basic types of brakes available: surge brakes, electric brakes, and electrically actuated hydraulic brakes. Brakes actuated by the tow vehicle's brake system are recommended. Most are adjustable to ensure proper timing, and order of, activation. They are also equipped with emergency braking in case of a hitch failure.

The braking system on a trailer should be inspected at regular intervals to ensure proper function at the required time. These inspections include testing the surge system and should include removal of the wheel and brake hub on a trailer that is put into the water. Periodic manual adjustment of the brakes is also recommended.

Investigate erratic brake performance at once. Inspect the brake units themselves for indications of failure or damage. If the trailer pushes the tow vehicle during a stop, adjust the brakes for earlier activation. If the trailer jack-knifes during a stop make sure that the brakes on both sides are adjusted the same. Brakes should release when the trailer is pulled forward. Surge brakes need to be pinned in order to prevent activation when backing. When brakes are submerged they will get wet. Excess moisture in can be reduced by applying the brakes a few times.

The Tow Vehicle

The most important factor to consider in a tow vehicle is its towing weight capability. There is a maximum load a given vehicle may pull. The towing capacity of a vehicle can be determined by the owner’s manual, contacting the dealer or searching the internet.

Other factors to consider are:

Engine - V-8 engines are the recommended engines for tow vehicles. A large displacement engine gives more power, acceleration and torque.

Transmission - an automatic transmission is more efficient than a manual because it shifts gears smoother than a manual transmission. It should have an oversized transmission fluid cooler.

Differential – a lower gear ratio is recommended for towing heavier loads. A positive traction differential or four-wheel drive will prevent wheel spin on slippery boat ramps.

Gauges - tow vehicles should be equipped with gauges to monitor oil pressure, engine oil temperature, transmission fluid temperature, RPM’s, and vacuum.

Cooling System - the cooling system on a tow vehicle should have a larger radiator, a more efficient cooling fan, and an engine oil cooler.

Hitch - should be of the appropriate size and type.

Tires - should be 6-8 ply rating with tire pressure up to 50 pounds.

Brakes - heavy duty, dual system brakes are recommended.

Suspension - the rear axle should have heavy duty leaf springs and heavy duty shock absorbers. Coil springs are not recommended. Adjustable air shocks will help level the unit.

Lights – a heavy duty flasher unit is recommended for the turn signals and for the hazard flashers.

Mirrors - most states require large mirrors on both sides of the tow vehicle. They should extend out far enough to provide good rear visibility.

EPO#2: Identify or demonstrate the proper methods of preventive maintenance involved with a trailer and tow vehicle.

Preventive Maintenance

Preventive maintenance is essential for trouble free towing. Things to include when performing maintenance are listed as follows:

1. Maintain proper tire pressure. Always check pressure when tires are cold.

2. Wash the boat's hull, trailer, and trailer hubs as soon as possible after recovery.

NOTE: Flush the engine as soon as possible also.

3. Make sure that ball and coupler are lubricated and kept free of dirt and grit.

4. Lubricate rollers.

5. Lubricate winch and check cable.

6. Lubricate tilt mechanism if applicable.

7. Lubricate jack and caster.

8. Check lights and spray connectors with CRC.

9. Inspect and repack bearings with grease a minimum of one time a year.

10. Clean trailer and check for corrosion.

EPO#3: Identify or demonstrate the correct procedures for safely towing, launching and retrieving a law enforcement vessel.

Trailer Towing and Maneuvering

To safely tow, or launch and retrieve a vessel, practice and prior planning are a must.

NOTE: Practice towing in a deserted parking lot before going on the road.

A trailer backs in the opposite direction of the tow vehicle. All moves should be made at a slow speed. Remember to not panic if things don't go right. Just pull ahead and try again.

NOTE: Place the hand at the six o'clock position of the steering wheel. To cause the trailer to back left then move the hand to the left. To cause the trailer to back right then move the hand to the right. Return the steering wheel to the neutral position as the trailer begins to swing.

When towing in forward direction, the trailer tires will track to the inside of the tires of the tow vehicle while in a turn. So remember to swing wide on all turns. Drive smoothly, avoid sudden jerks and stops. Anticipate and plan all actions well in advance. To avoid accidents remember that a vehicle towing a trailer can not stop as quickly or as controlled as a vehicle without a tow. Avoid quick turns or sudden swerves when towing. Don't tailgate and use extra caution when passing. Be sure to watch the mirrors on both sides. When on long trips be sure to stop and check the entire rig at regular intervals.

Launching

Launching a boat safely requires at least two people. Before attempting to launch be sure to check conditions on and around the ramp. Things to check include the slope of the ramp, the surface condition, tide height, current, depth, and wind direction.

NOTE: Watch a few other boaters launch their boats, especially on an unfamiliar ramp, and learn from their mistakes.

Take your time when preparing to launch. Let the wheel bearings cool prior to backing into the water. Prepare the boat before backing down the ramp. Remove boat covers, install drain plugs remove tie down straps, and disconnect trailer lights. Do not remove the winch strap until the boat is in the water. Be sure to prepare lines to control the boat once it is off the trailer.

There are several methods of getting the boat off the trailer safely. If the boat is to be launched by hand use two lines for control as the boat is launched. If launched under power, have a plan for the boat while the trailer is being recovered.

When launching, align the vehicle and trailer square with the ramp.   Back down slowly until the boat's transom is afloat, but with the rest of the boat still resting on the trailer. Set the parking brake and place the vehicle in park (or in forward gear if a manual transmission). Turn vehicle off and place a chock behind the wheels of the tow vehicle. Check depth of water at the stern. Lower outboard(s) or out-drive(s) if necessary.   Start engine(s) and allow for warm up. Remove the winch strap and either float or power the boat off the trailer. If the boat is floated off the trailer, use lines to control the boat until ready to get underway. After the launch is complete park and lock the tow vehicle.

Retrieving a Boat

Before retrieving a boat check the ramp condition. Back the trailer to the appropriate depth. Set the parking brake, place the vehicle in park (or in forward gear on a manual transmission) turn off the vehicle and chock the wheels. If the boat is to be loaded by hand center the boat on the trailer, using bow lines if necessary. Hook the winch strap to the bow eye of the boat. Set the anti-kickback pawl on the winch and wind the cable up. Keep the boat centered as it is brought forward.

If the boat is powered onto the trailer using the engines align the boat with the center of the trailer and apply power gently. When loaded, attach the winch strap to the boat's bow eye.

When the retrieve is completed drive away from the ramp to clear it for other boaters. Make sure the boat is sitting properly on the trailer. It may be necessary to lightly re-float the boat to adjust the alignment. Remove the drain plug and check the hull for leaks and other damage. Secure the boat to the trailer with straps and plug in the trailer lights. Before driving away be sure to lower antennas and tops and secure all gear to make the boat "road ready".

Trailed boats can add a great deal of flexibility to the marine enforcement unit. Matching the right trailer to the boat and the right tow vehicle to the trailer can make towing a trailer safe and easy. And remember, with practice, maneuvering a trailer or launching and retrieving your boat will be a breeze.

REFERENCES

Chapman, Piloting, Seamanship, and Smallboat Handling – page 242

Maloney, Elbert S. Chapman, Piloting, Seamanship and Small Boat Handling, 66th ed. Hearst Marine books, 2009.

Trailering Guide

Trans World Publishing Inc., 2006 Boating World, Atlanta, Ga, 2006.

Trailer Boats –2007 – Page 3

Ehlert Publishing Group, Your Guide to Towing, Maple Grove, MN, 2007.

A VIDEO TAPE –

Motorboat Trailering United States Coast Guard, 1999.

U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

STUDENT TEXT

BOARDING PROCEDURES

7512 APRIL/11

I. INTRODUCTION

A. RAPPORT AND OPENING STATEMENT

[redacted]

a. The courts have held that because of the exigent circumstances of most vessel boarding, obtaining a warrant prior to conducting a search is not practical. Most searches in the marine environment will not require a warrant but if time allows one should be obtained.

b. If marine enforcement officers do not exercise proper legal authority and professional demeanor in the conduct of a boarding, the courts could impose tighter restraints.

[redacted] (b)(7)(E)

II. **PRESENTATION**

A. **EPO #1: IDENTIFY THE RESPONSIBILITIES AND DUTIES OF A MARINE LAW ENFORCEMENT OFFICER WHILE PERFORMING A BOARDING.**

1. A vessel boarding is a systematic process used to ensure compliance with law enforcement laws and regulations (fisheries, immigration, customs laws, counter terrorism and marine safety). The boarding team should have a plan constructed before initiating a vessel boarding. The boarding team must assess the situation and determine a proper course of action.

[redacted] (b)(7)(E)

Note; Information is determined by communicating with suspect vessel and law enforcement information sources.

2) This recognized information will determine the level of risk involved (risk or high risk boarding.)

b. Marine law enforcement officers must be prepared for the unexpected. Officers must be mentally and physically prepared for risk and high risk boardings.

[redacted] (b)(7)(E)

2) Certain boardings involve unique procedures by virtue of the status, type, or activity of the vessel.

2. The marine enforcement team promotes a positive impression by appearance, professional conduct and competence.

a. All officers should conduct a vessel boarding in a polite and professional manner.

b. A professional appearance can be obtained by wearing a PFD when underway, due to the hazards posed in the marine environment, as well as the positive reinforcement to the public about the importance of wearing their PFD.

c. During the boarding, utilize effective communications, task direction and good officer presence.

[redacted] (b)(7)(E)

d. Be prepared to state the purpose and authority for the boarding. Be cautious not to limit the scope of the boarding by indicating a lesser level of boarding authority.

e. Confirm any information obtained during the stop and approach to the vessel (i.e. number of persons on board, presence of weapons and location of any valuables on board).

1) Ask for the vessel's official document or registration certificate.

2) Record all the pertinent information; time, geographical location, other vessels and their position in the area, weather and sea conditions, last departure point, destination, activity and what the vessel was engaged in before the boarding and other pertinent information made available during the boarding.

3) Maintain a professional demeanor at all times to minimize the potential of antagonizing the people on board and escalating the risk to the boarding team.

[redacted] (b)(7)(E)

[redacted]

1) The law enforcement vessel is equipped with blue lights and will be easily identified as a law enforcement vessel. Be prepared to show personal identification (i.e. badge and/or credentials).

[redacted]

Note: The master will invariably have better accommodations than the rest of the crew.

B. EPO #2: IDENTIFY TACTICS USED FOR CONDUCTING A VESSEL SECURITY SWEEP.

Vessel Security Sweep

a. The purpose of a vessel Security Sweep is for the safety of the marine enforcement team.

[redacted]

b. [redacted]

[redacted]

NOTE: Agency statutory authority provides for warrant-less inspections and procedures that are exempt from Fourth Amendment requirements. They are provided for under Administrative Inspections.

c. Outside:

[redacted]

(b)(7)(E) [redacted]

Note: Totality of the circumstance may dictate a high risk entry or a Special Response Team.

(b)(7)(E) [redacted]

C. **EPO #3: IDENTIFY PROPER TECHNIQUES FOR VESSEL AND CREW CONTROL DURING A SUSPECT VESSEL BOARDING.**

(b)(7)(E) [redacted]

c) The names and identification papers of each person on board should be obtained.

NOTE: The marine enforcement officer must remember that detaining a person to include restraining, is the temporary limitation of that person's freedom of movement. To be lawful, a detention must be reasonable in duration, method and location.

3) Depending on specific agency policy, the following steps should be taken when a weapon is located.

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

(2) All persons on board should be evacuated from the vessel.

(b)(7)(E) [redacted]

(b)(7)(E)

(b)(7)(E)

d) If no other marine enforcement unit is available as backup, follow or direct the suspect vessel to a dock and have a land based law enforcement unit provide backup.

(b)(7)(E)

f) Commercial fishing vessels and large recreational vessels, usually, have two or more persons on board.

g) Many of these vessels also routinely have firearms on board.

h) Both of these facts make a single officer boarding extremely risky.

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U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

STUDENT TEXT

MARLINESPIKE SEAMANSHIP

7513 **AUG/2011**

INTRODUCTION

Marlinespike seamanship is the art of handling line and wire rope. This includes tying knots and splicing. We will discuss different types of line and their characteristics. In addition, we will discuss knots, bends, hitches and common uses of lines on boats.

The term "marlinespike seamanship" comes from a tool used by sailors and riggers called a marlinespike. This tool is a pointed metal spike used in splicing line or wire rope. It can also be used to untie knots that are jammed after being under heavy load.

The knowledge and skills of marlinespike seamanship are valuable to have for any mariner. In certain situations, the ability to quickly and effectively handle lines or tie knots could save a life or prevent damage to the boat.

Enabling Performance Objectives

1: Identify terms used for knots, bends and hitches and their usage along with related equipment used on and around a vessel. Page 2

2: Through lecture and laboratory exercise, demonstrate the ability to properly secure a vessel to a dock or pier. Page 5

3: Identify the proper equipment and the procedures used to anchor a vessel under the prevailing wind and sea conditions. Page 7

4: In a laboratory exercise, demonstrate the ability to tie these four knots: Bowline, Cleat belay, Clove hitch and Sheet bend. Page 11

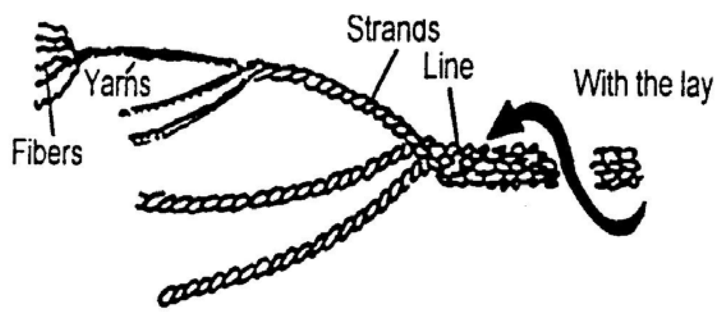
Types and Characteristics of Line

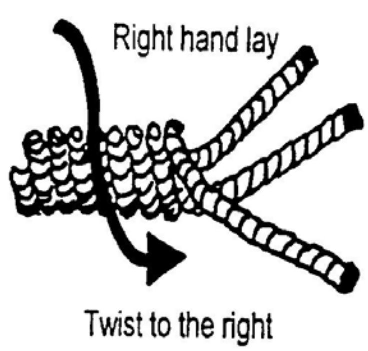
Line is used for pulling, holding or lifting/lowering. All of these uses put strain on the line. Under certain conditions this strain can be extremely DANGEROUS. When certain types and sizes of line under strain part, they can snap back with tremendous force. There are two basic types of line, synthetic fiber and natural fiber.

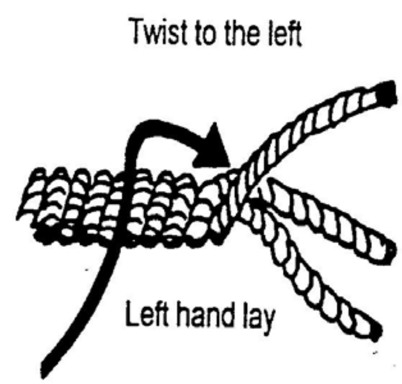
Three stand line

Nylon line is a relatively strong synthetic fiber. It is resistant to damage from rot and mildew. It is not as slippery as polypropylene and is much more flexible. For this reason it is easy to splice and holds a knot relatively well.

Strand or twisted line is the most common type of line used. In plain lay three strands are twisted together to the right in an alternating pattern. Because of the number of strands, this line is sometimes called "three stand" line. The direction of the twist determines the lay of the line. In the case of plain layed lines, the yarns are twisted to the right. They are then twisted together to the left to make the strands. The strands are twisted together to the right to make a line called right hand lay.







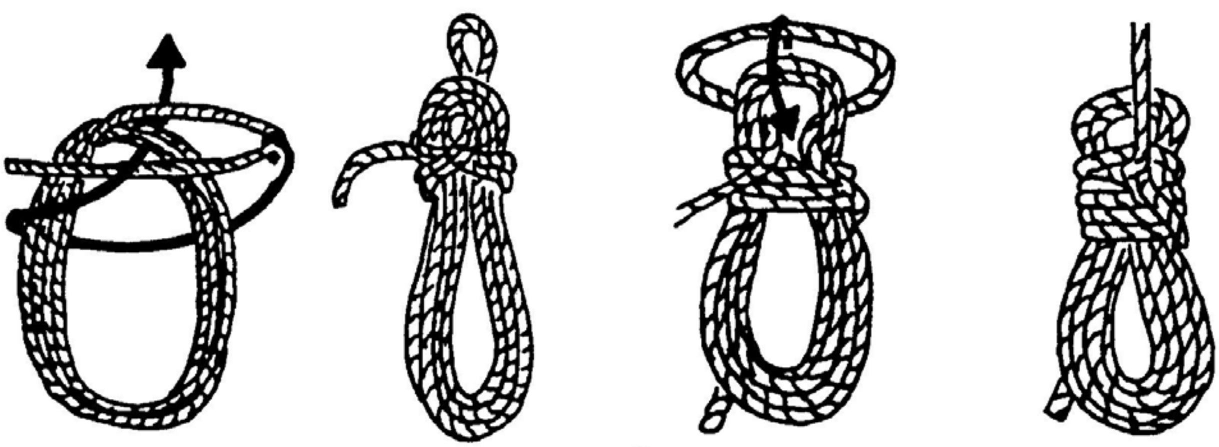
Braided line

The small fibers used to make line are generally twisted (layed or corded rope) or braided (single or double braided rope) together to make lines of various sizes. Nylon double braided line is relatively strong. It is well suited to use on boats, especially in load bearing situations. It is more expensive than layed or corded line. In addition, it also requires special tools and knowledge to splice double braided line. It is possible to buy double braided line already spliced for specific uses (mooring lines and anchor lines, for example).

Stranded nylon line is the second choice for use on boats. It is probably the most common type of line found on boats today. It has resiliency and relatively high tensile strength. It is less expensive than either Dacron line or nylon double braided line. With minimal care, stranded nylon line should give you years of wear.

Storing Line

All line on a boat must be properly stored so it is always ready for use. Nothing is more frustrating or potentially dangerous than reaching for a line and realizing that it is nothing but a mass of tangles. There are three basic methods of storing line when not in



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use: coiling, flemishing and faking. This makes the line neat and ready for use and is the proper way to stow the line. The line can be stowed by hanging it from a rail using a slip clove hitch for ready use or by securing it in hatch or compartment.

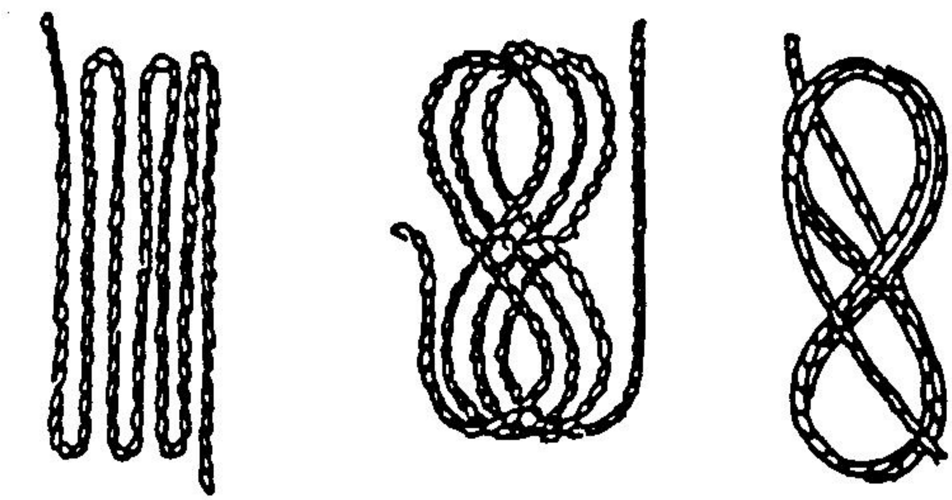
Coiling Line

If a line must be kept ready for emergency use, it is coiled down. This method simply means the line is layed down in circles one after the other. You should keep the circles as uniform as possible. Generally this coiling should start at the working end of the line and work back along the standing part when coiling a short line in your hands. If the line is extremely long or heavy, coil it on the deck. In this case, start at the non-working end (standing part) and coil back to the working end. When you finish the coil, the working end will be on top.

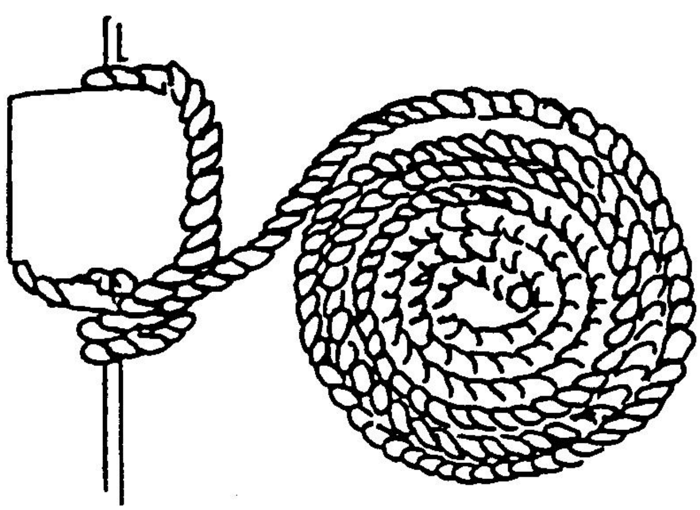
There are several ways to tie off a coil for stowing. Some methods are more complex than others. In general, the rule of thumb is to use the simpler method for coils of line used repeatedly or in emergencies. The more complex ones should be reserved for less critical lines stowed for long periods of time.

Faking Down

This means laying the line down in long flat bights, each slightly forward of the last instead of in round coils. This is useful for storing either very long or very heavy lines on very large vessels. A figure eight pattern is often used to prevent the line from tangling when it is being run out. This method is recommended for use on small boats when preparing a towline for immediate use.



Flemishing



This method coils the line in a tight spiral mat on the deck. Start your spiral from the bitter end and spiral it out in a clockwise direction. This method is used primarily for decorative purposes. The flush mat of a flemished line does reduce the possibility of trip hazards on the deck or on the dock.

Mooring Lines

One of the primary

uses of line on boats is that of mooring. Each time a boat leaves a dock and returns, lines must be handled. Small boats generally use four lines to moor to a dock, pier, or slip. The actual number will vary depending on the size of the boat, conditions of tide or current, availability of cleats and anticipated weather.

The four basic mooring lines are as follows:

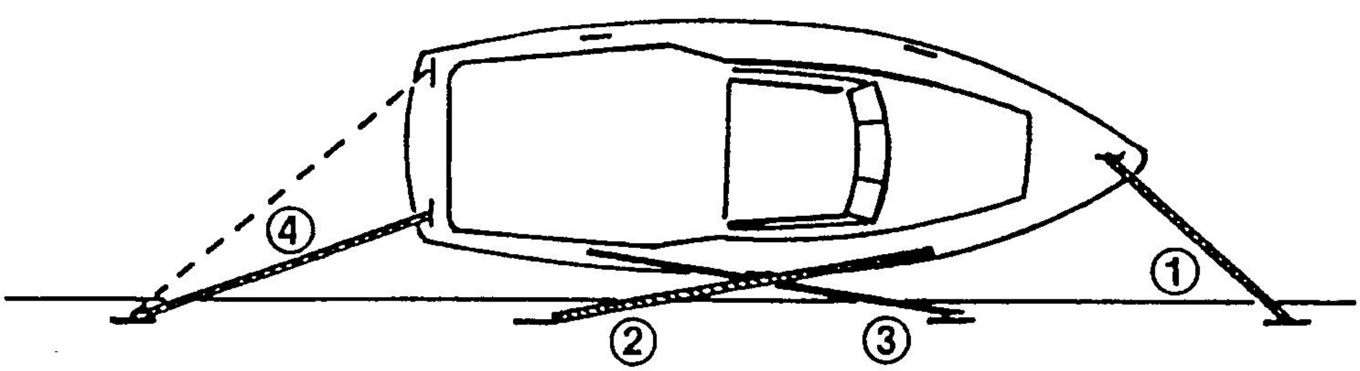
a. **The bow line** - Also called line number 1. This line leads from the bow of the boat forward to the pier or dock.

b. **The after bow spring -** Also called line number 2. This line leads from a side cleat located on the forward half of the boat aft to the pier or dock.

c. **The forward quarter spring -** Also called line number 3. This line leads from the quarter cleat forward to the pier or dock.

d. **The stern line -** Also called line number 4. This line leads from the boat's stern aft to the pier or dock. The line may be lead from either your boat's inboard or outboard stern cleats. The outboard cleat is generally preferred because it allows for a better leverage angle. The greater length of a lead to the outboard cleat also gives more shock absorbing capacity to the line.

As you can see, the lines are numbered to simplify commands during mooring. The lines are numbered starting at number 1 at the bow to number 4 at the stern.



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The Heaving Line

A heaving line is a light line thrown to the dock, another boat or a person in the water. It may be used to pass a larger diameter line. To properly prepare the heaving line before throwing it, you must coil it. Throwing a coiled heaving line allows you to throw it farther, with greater accuracy. A coiled line is less likely to foul when thrown.

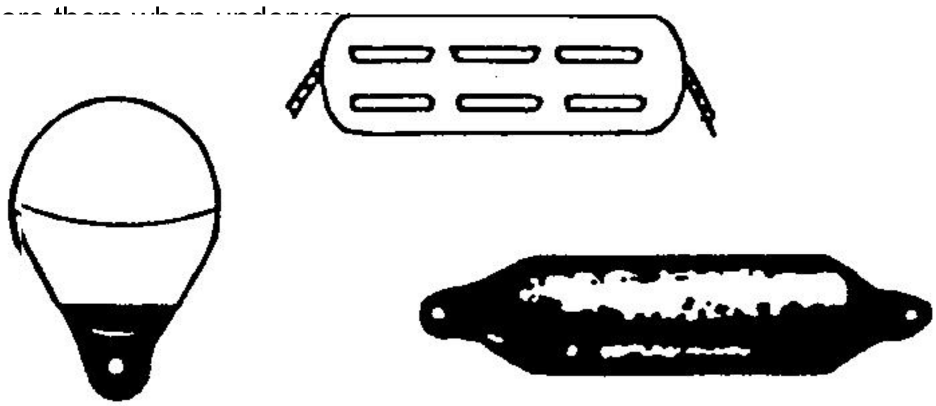
Coil the line starting at the end you are going to throw. Make the coils as even as possible. Divide the coils evenly. Place the half you plan to throw in your preferred throwing hand and the other half in the non-throwing hand.
Be sure to secure the bitter end of the line before you throw the line.
The throw should be underhanded, don't try to throw overhand. Half twist your body away from the target with your throwing hand away from the target. When throwing, twist your body back toward the target using your upper body to put more power into the throw. Release the coil of line in your throwing hand when your hand is pointing directly at the target. Your non-throwing hand should hold its coils palm up and point at the target. As the heaving line sails toward the targets it will pull the coils out of your non-throwing hand. If you took the time to properly coil the heaving line, it should sail straight and true to the target. It should also be free of any kinks, tangles or knots. Practice the technique and make it second nature. In an emergency, it could just save a life.

Fenders

Fenders limit the damage to the boat if contact should be made to docks, pilings or other boats. There are many different types and sizes of fenders available on the market. One type works as well as the next, as long as you have sufficient quantities of the right size for your boat.

Even the slightest movement of a boat as it rises and falls with the tide will mar the hull or rub rails. The boat also surges fore and aft with the current. Wind can also cause the boat to make contact with the pier. Most damage however, usually occurs from inconsiderate boaters causing a wake as they pass your moorings. Most, if not all of this damage can be avoided with properly placed fenders.

Fenders are made of rubber or a rubber-like plastic. They are filled with air under low pressure to provide shock absorption. They may be tubular or spherical. They have some means of attaching a line to suspend the fender over the side. This may be a grommet hole or an axial tube running through its center. Four to six fenders is the average number which should be carried on small boats. More would not hurt, if you have room to store them when underway.



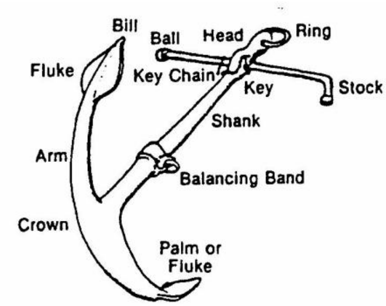
When using fenders, remember to place them at the points where contact is likely to occur. If mooring next to a low, floating dock, rig the fenders low, near the waterline. If coming alongside another boat, you probably will want to rig your fenders high along your rub rail. Spread your fenders apart along the sides of your boat to provide maximum protection along the hull.

Anchors

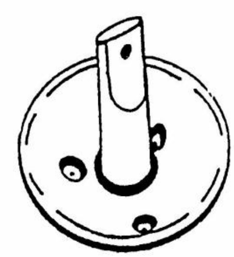
Another piece of nautical equipment related to marlinespike seamanship is the anchor. There are many reasons for using an anchor, not the least of which is preserving your safety. There are times when engine failure will happen at the worst possible place or time. You could risk drifting into a surf zone or into an inlet with a breaking bar. You may be dangerously close to rocks or jetties. Severe weather might require you to ride out the storm at anchor or on a sea anchor. From a law enforcement standpoint, you may have to drop anchor to maintain surveillance or a security zone.

There are a number of different types of anchors available to the boater today. Some of the more common types are:

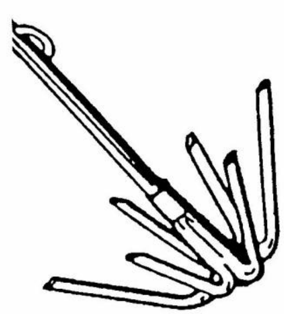
a. **Yachtsman or Kedge Anchor -** This was once the most common type of anchor used on both commercial and recreational craft. Recently (as of about twenty-five years ago), it has fallen out of favor. This is because of its relatively large size. This makes it cumbersome to stow when not in use.



b. **Mushroom Anchor -** This is an excellent anchor for long term or permanent moorings. It is not very useful for day to day, short term anchoring. Its efficiency for short term anchoring is at the lowest end of the scale. Over time, the mushroom anchor buries itself into soft bottoms.

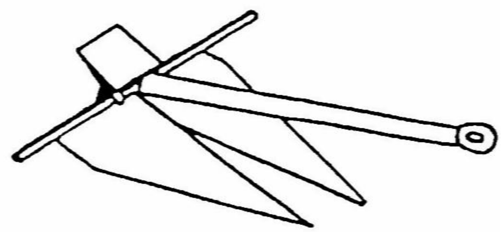


c. **Grapnel Anchor -** Commercial fishermen, especially in rocky or coral bottoms sometimes use a grapnel anchor. It usually consists of three to five curved prongs



symmetrically arranged around the crown end of the shank. When used to anchor in rocky or coral bottoms a trip line must be attached to the crown. A more common use for grapnels, especially in law enforcement, is to grapple for items thrown overboard.

d. **Danforth Anchor -** This anchor was developed during World War II for use by landing craft during beach assaults. Its lightweight and efficient holding power soon made it the most popular anchor among recreational boaters. It stows easily because of its flat profile. It is lightweight makes it easy to deploy and recover. The flat crown pieces force the long, wide flukes into soft bottom for maximum holding power. The Danforth anchor can also be used in rocky or coral bottom if a trip line is attached to the crown.



Anchoring Techniques

The first step in anchoring is to select an anchorage site. In an emergency situation you may not have the time to select a proper anchorage. In an emergency, the object is to get the anchor down to prevent your boat from drifting into a more hazardous position. For routine anchoring, selecting the right anchorage is critically important.

Shallow, sheltered water is preferred for anchoring. In shallow water, a given amount of scope on the anchor rode will provide better holding power. A shorter scope will reduce the diameter of the circle through which your boat swings when riding at anchor. Other factors you should consider in selecting an anchorage include: the bottom contour, quality of bottom, the tidal range and the presence of hazards. Always consult a chart and verify the water depth with your fathometer prior to anchoring.

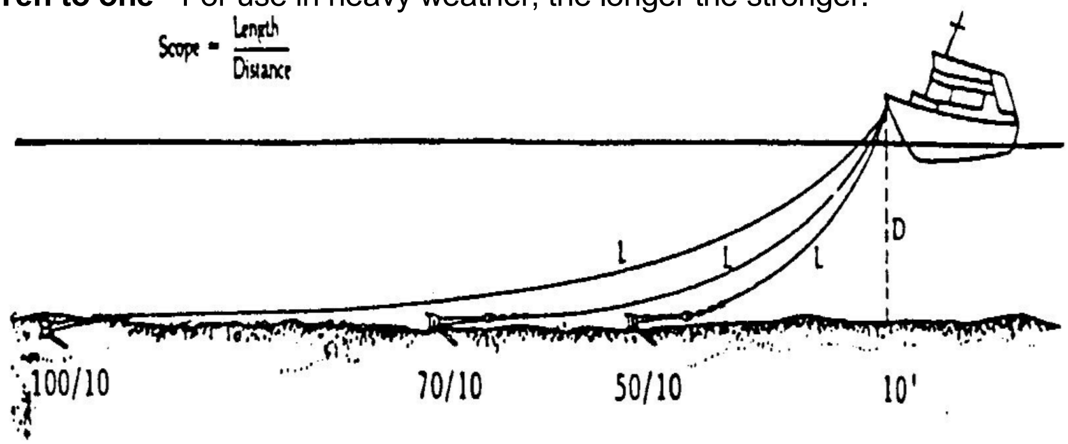
Scope

Proper scope must be determined prior to setting anchor. To do this, add the depth of water at the proposed anchorage site to the distance from the waterline to the cleat securing the anchor line. Add to this sum the anticipated rise of tide, if any. This total represents distance to the bottom. This total is now multiplied by a factor to obtain a suitable ratio of distance to bottom and length of anchor line. Generally, this ratio should be between 5:1 and 10:1 depending on wind and sea conditions.

a. **Five to one -** This is sometimes called a "lunch hook." This might be considered the minimum safe scope in calm, protected waters. With such a short scope, an anchor watch must be maintained at all times.

b. **Seven to one -** This would be an adequate scope for use in calm to moderate conditions for an overnight anchorage.

c. **Ten to one -** For use in heavy weather, the longer the stronger.



Letting Go the Anchor

Prior to approaching the anchorage, prepare the anchor and anchor line for letting go. Make sure you have enough anchor line faked out on deck to prevent fouling. Make sure the anchor is properly secured to the anchor line. Have a crew member standby at the bow to let the anchor go. Make sure he/she understands not to stand in the bight of the line.

Always approach the anchorage into the wind and/or current, whichever is strongest. Always overshoot the anchorage site, slightly upwind or up current. Prior to letting the anchor go, take all headway off by reversing engines and begin moving astern. Do not let the anchor go with forward way on, you may foul the line in your screw(s). Do not throw or heave the anchor, instead, lower it slowly, crown first hand over hand. This minimizes the possibility of fouling the anchor. Lowering a heavy anchor is best accomplished by taking a round turn on the cleat and paying the line out slowly.

When the anchor touches bottom, continue backing. Pay out the anchor line (also known as veering) until the desired amount of scope is paid out. Secure the anchor line to the cleat and apply slow power astern to set the anchor firmly into the bottom. Check that the anchor is in fact holding. To do this, rest your hand on the anchor line outboard of the chock. If the anchor is not holding, you will feel the line vibrate or jerk as the anchor drags along the bottom.

While at anchor, you should take frequent bearings on various landmarks to insure you are not dragging anchor. If anchoring at night, make sure your anchor light is turned on.

Weighing Anchor

Before weighing anchor, work out a system of hand signals with your crew. The signals will allow the crewmember on the bow to relay information about the direction the anchor rode is tending. This is extremely important on larger boats where communication may be more difficult. You should use full arm signals for best visibility.

a. Arm straight out, fingers extended - the anchor rode is tending in the direction the arm and hand is pointing.

b. Arm held aloft with fist clenched - take all way off, stop.

c. Arm held aloft with fist clenched and thumb extended - the anchor is at short stay.

As you prepare to weigh anchor, start your engines. Have a crewmember stand at the bow. Slowly apply power to move up the anchor rode. The crewmember can unhitch the anchor line from the bow cleat. Have the crewmember take up the slack as he can. It is much safer for the boat operator to maneuver the boat up the anchor rode than for a crew member to pull the boat toward the anchor. The crewmember must continually give the boat operator hand signals as to where the anchor rode is tending.

When the anchor rode is at short stay (the anchor line tends straight up and down), take all headway off. The crewmember can make the anchor line fast to the bow cleat. The natural rolling of the boat should be enough to break the anchor free of the bottom. If the anchor fails to break free, come ahead slowly on your engines. This should cause the anchor to trip and break free. If the anchor refuses to break free, maneuver slowly in a circle around the anchor. This action should break the suction on the anchor. In addition, if the anchor was snagged on the bottom, the changing angles might pull it free.

Knots Bends and Hitches

In general, line is used for pulling, holding, lifting or lowering. When put to such uses, it is often necessary to tie the line to itself, another line or an object. Knots, bends and hitches are used to accomplish this. A knot is formed when a line is bent back on itself (as in a bowline). The term knot is also used as a generic term for bends and hitches as well. A bend is used to tie two lines together or to tie a line to an anchor (as in the sheet bend). A hitch is used to secure a line to an object or to a stationary line (as in a cleat hitch or a stopper hitch).

In making knots, bends or hitches, it is useful to know some basic terms used in marlinespike seamanship.

a. **Belay -** To secure a line using Figure 8 turns around a cleat, bitt or other object.

b. **Bight -** An open, half loop formed by turning a line back on its self.

c. **Bitter end -** The running end (or free end) of a line or rope.

d. **Cast off -** To let go a line or to untie a knot.

e. **Ease -** To slack off a line slowly.

f. **Eve -** A loop in a line that has been seized, spliced or knotted.

g. **Ground tackle -** A general term used to describe anchors, anchor rods and various fittings used in anchoring a boat.

h. **Lash -** To tie down an object with line.

i. **Lead -** The direction of a line (pronounced "leed").

j. **Line -** A general term for a piece of rope put to a specific use on a boat.

k. **Loop -** A bight that forms at least a half circle. It may be an open loop, closed loop, over hand loop or underhand loop.

l. **Make fast -** To secure a line to an object.

m. **Reeve -** To pass a line through a hole or opening as through a fairlead.

n. **Rigging -** Lines or wire fitted to masts or spars for control and support.

o. **Rode -** An anchor line.

p. **Rope -** The term rope is seldom heard on board boats. It generally refers to new stock in unbroken coils. Once rope is cut and put to use on a boat it becomes line. The term "learn the ropes" is derived from apprentice seaman learning the forty to sixty or so "ropes" found on old sailing ships. (For example, bellrope, manrope, etc.)

q. **Round turn -** Two rounds of a line around an object.

r. **Snub -** To quickly check by making fast to a cleat a line that is running out.

s. **Standing part -** The long, unused, or belayed (secured) end of a line.

t. **Take a turn -** To pass a line once around an object.

u. **Turn -** One round of a line around an object.

v. **Veer -** To pay out or let out a line or chain.

w. **Working end -** The manipulated end of a line.

Useful Knots for the Mariner

All knots, bends and hitches are basically combinations of bights, loops and/or turns interwoven together. There are thousands of other knots for various applications. The best source of information on how to tie these knots is Ashley's Book of Knots written by Clifford Ashley.

The following are four common knots you will find most useful on small boats:

a. Bowline
b. Cleat belay
c. Clove hitch
d. Sheet bend (single & double)

Bowline

This knot is the - "King of Knots." This knot is not prone to slipping or jamming when properly tied. In fact, the Bowline is very unlikely to capsize before the lines breaking point is reached. It is so good sailors seldom use any other type of knot to form an eye in the end of a line. In spite of its incredible holding power, the Bowline can easily be untied. A Bowline can be used to hitch a line to an object. Two Bowlines can be linked together to form a hawser bend. To tie the Bowline:

a. Hold the bitter end of the line in your right hand. Hold the standing part with your left hand. Leave enough slack between your hands to form the size loop you want.

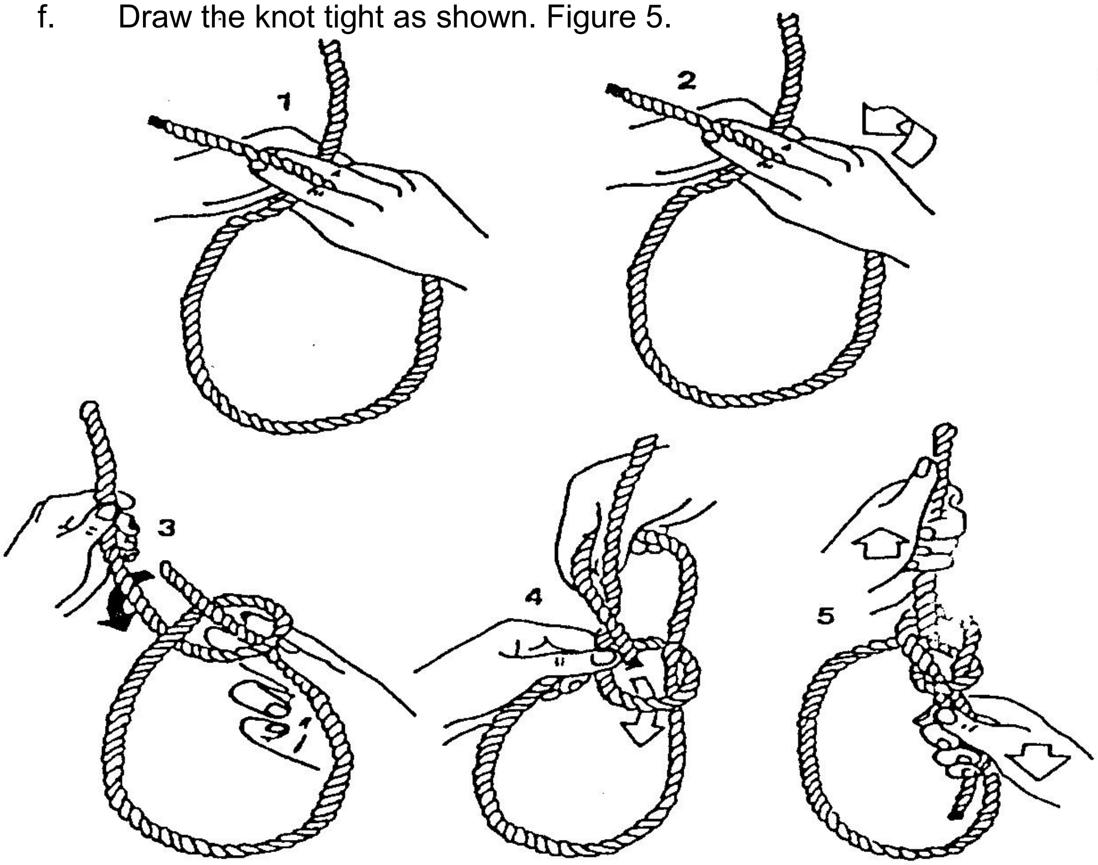
b. Place the bitter end over the standing part grasping the two parts of the line between your first two fingers and thumb of your right hand. Figure 1.

c. Roll the wrist of your right hand away from you, forming an overhand loop in the standing part. Figure 2.

d. The bitter end is brought up through the center of the loop at the same time the loop is formed. Figure 3

e. Run the bitter end behind and around the standing part and back down through the loop. Figure 4

f. Draw the knot tight as shown. Figure 5.



Cleat Belay

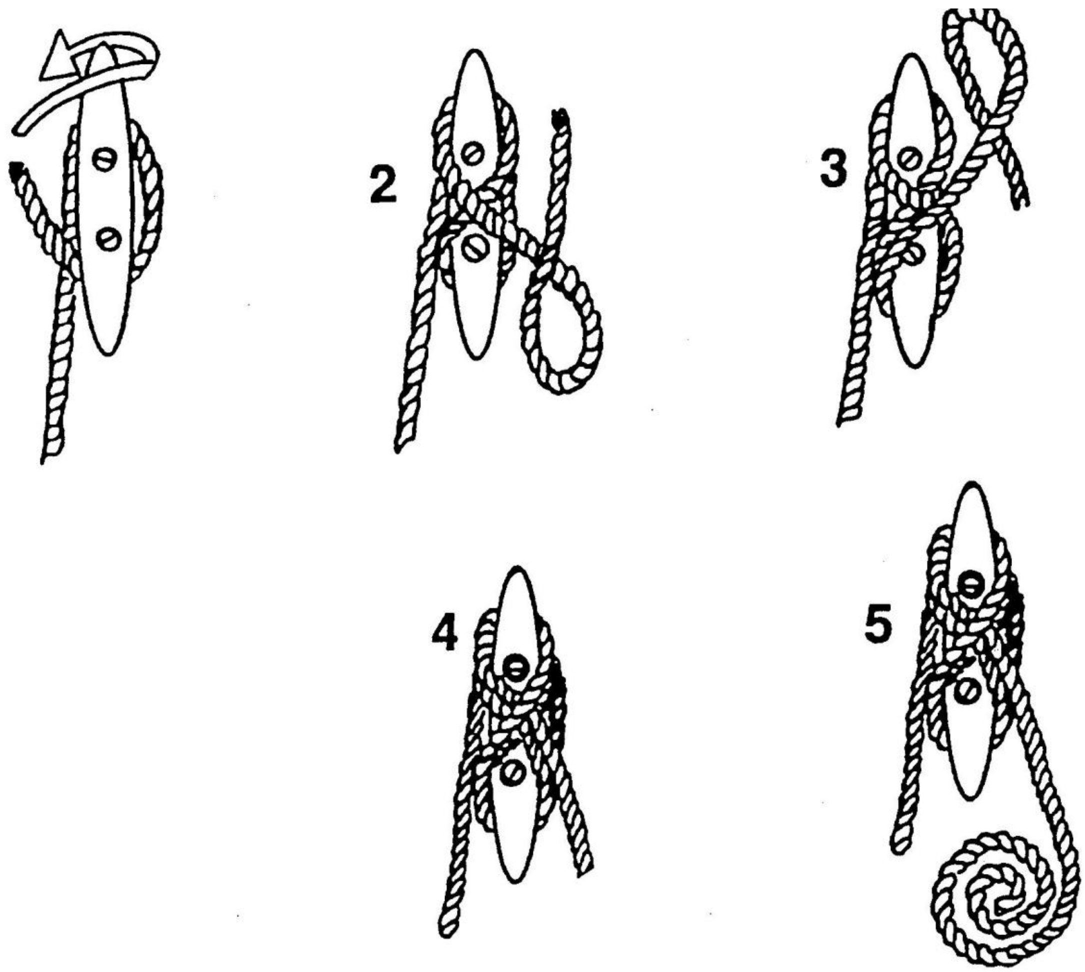
To belay a line to a standard cleat

a. Take a turn around both lugs of the cleat. (Figure 1

b. Make a figure eight around both horns of the cleat. (Figure 2

c. Make the line fast with a single hitch (half hitch). To do this forms an underhanded loop in the bitter end. (Figure 3

d. Place the underhanded loop over the horn of the cleat and pull.



If the cleat is on a dock, flemish the bitter end. This last touch will reduce the potential of having a passerby tripping on the line.

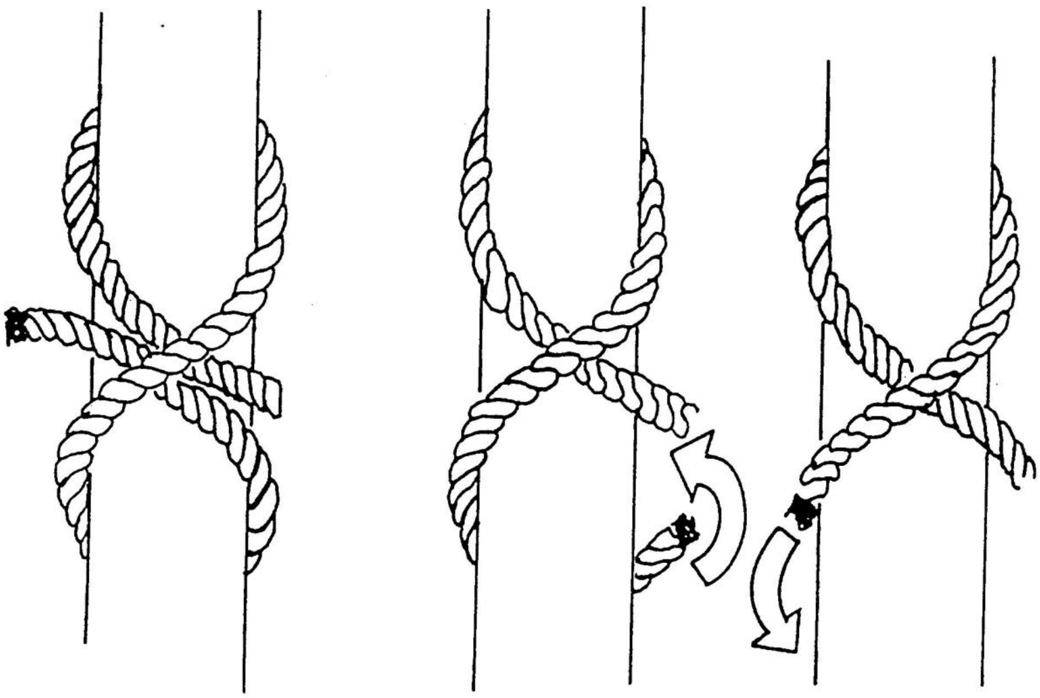
Clove Hitch

The Clove hitch is a quick and simple method of tying a line to a post or rail. It is also known as the "Builder's knot" because of its extensive use in erecting scaffolding (Another common name is the "Waterman's knot"). To prevent the hitch from slipping out, the Clove hitch can be finished off with a Half hitch. To tie a Clove hitch:

a. Take a round turn over a rail (or around a post) with the bitter end.

b. Cross the bitter end over the first turn and take another turn around the rail.

c. Pass the bitter end under the second turn. Make sure the bitter end lies parallel to the standing part. Tighten by pulling the bitter end and standing part at the same time.



Sheetbend

The Sheet bend is used in tying two lines together. It has many names: the bend, the simple bend, the ordinary bend, the common bend, the single bend and the flag bend. A common error is to call this knot the Becket bend NOTE: The Becket bend is a similar knot but it is tied with a bitter end on an eye splice instead of with two bitter ends.

a. To tie the Sheet bend, take two bitter ends. Cross the left-hand end over the right-hand end.

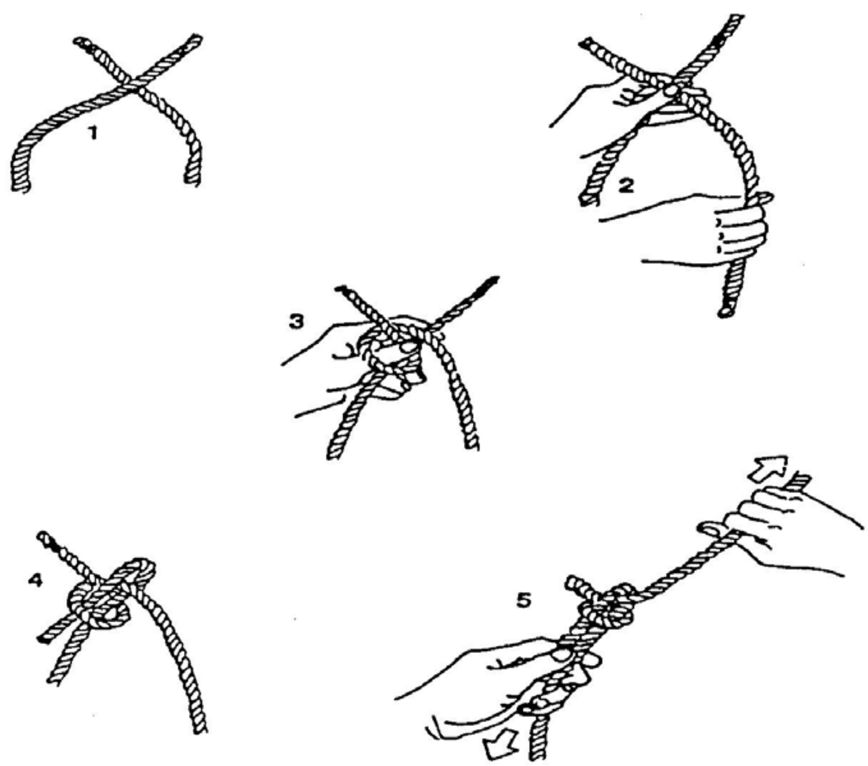
b. When tying two lines of different diameters, always cross the thicker (or larger) line over the thinner (or smaller) line.

c. Pinch the crossover point with the left hand and slide the right hand down the right-hand standing part about ten inches.

d. Form a loop by bringing the right hand standing part clockwise around the ends and leave the right hand standing part hanging down between the two bitter ends.

e. Then tuck the right-hand end into the loop.

f. With the left hand holding the left-hand standing part and the right-hand bitter end, tighten the knot by pulling on the right-hand standing part with the right hand.



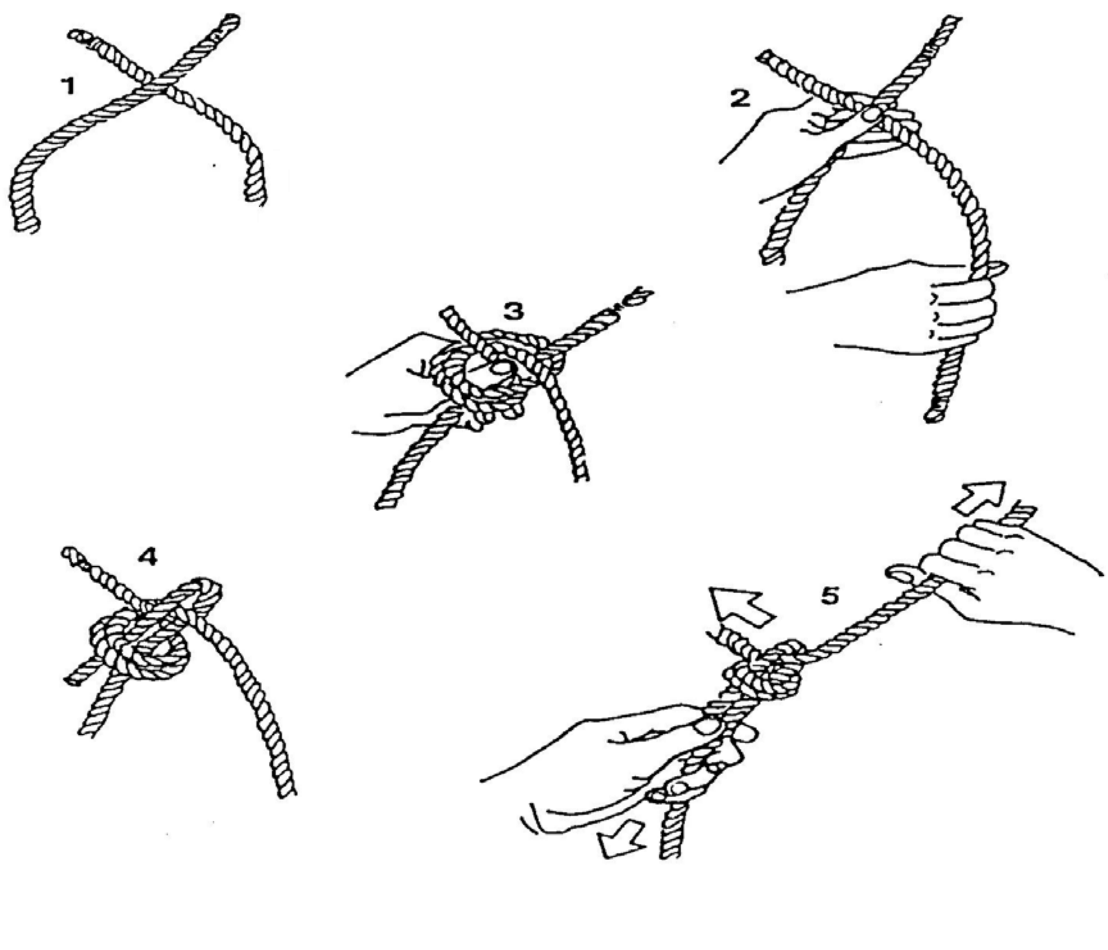
The double Sheet bend is a more secure form of the single Sheet bend. As with the single Sheet bend, when tying lines of unequal diameters, always cross the thicker (or large) line over the thinner (or smaller) line. To tie the double Sheet bend:

a. Take two bitter ends and cross the right-hand bitter end over the left-hand bitter end.

b. Pinch the crossover point with the left hand and slide the right hand down the right-hand standing part about ten inches.

c. Form a double loop by bringing the right-hand standing part around both bitter ends and once more around the left bitter end (Passing it clockwise around both bitter ends and then once more around the left bitter end) and leave the right-hand standing part hanging down between the bitter ends.

d. Then tuck the right bitter end into the double loop



U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

STUDENT TEXT

MARINE COMMUNICATIONS

7515 **DEC/2011**

~~WARNING~~

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TERMINAL PERFORMANCE OBJECTIVE (TPO):

Given scenarios requiring the use of marine radios, protocols for use , the student will identify these systems and procedures according to Federal Communications Commission (FCC) regulations.

PERFORMANCE OBJECTIVES

INTRODUCTION

Before the invention of the radio, mariners communicated by waving flags, flashing lights, shining mirrors or by smoke signals. Sometimes communication required putting a sailor in a small boat, where they sailed or rowed, often in the heat of a pitched battle, from one ship to another. Today we rarely use these methods to send a message except in an emergency, since nearly all vessels have a two way radio on board.

With the advent of transistorized circuits, transceivers (radios that contain both transmitter and receiver) have become available that are both inexpensive and reliable. With modern radios anyone can use them to communicate without the need for technical training.

By law, the primary function of regulated electronic communication at sea is **safety**, with other purposes being secondary.

As marine law enforcement officers, we use radios to keep in contact with our own agency. However, by taking advantage of other marine communication systems, we gain access to the world around us and tap a valuable source of information. These systems provide a method of communication that is not agency specific. This provides a convenient way to contact personnel from other agencies and the general public.

In an environment where 'back up' can be hours away, it is imperative to have access to more than one method of requesting assistance.

EPO #1: Identify the three marine communications systems

Marine Radio Systems

There are three radio systems that are generally found aboard vessels; Marine Very High Frequency (VHF), High Frequency Single Side-Band (SSB) and Frequency Modulated 2 meter (FM). Of these systems VHF is the most prevalent with SSB running second.

There are differences in the characteristics of each system with the use and usefulness of each being determined principally by the needed operating range.

1) VHF - No FCC license required. Their effective range is 20-30 miles, with a maximum allowable power output of 25 watts. These radios operate on a band width between 156 163 MHz with 104 channels being available. The calling channel is #16 and it is monitored by the Coast Guard.

2) SSB - Licensed by the FCC. SSB radios are more complex and are used in long range communications. These radios can have a power output up to 400 watts. They operate on a series of 7 frequency bands from 2-22 Megahertz (MHz). The Coast Guard monitors the calling frequency at 2182 kHz. (This frequency is always referred to as 2182 kHz.) The 7 bands have different range capabilities at different times of the day. Given the right conditions you can talk around the world on a SSB radio.

3) FM - Licensed by the FCC. These radios share similar characteristics with VHF, but are capable of greater range. This range is enhanced by, output power and the use of "sky waves" unlike the VHF which uses "ground Waves" the FM "sky waves" bounce off of the ionosphere and return to the earth's surface with sufficient power to continue this process world wide.

NOTE: **The FCC no longer requires a Restricted Radio Operator's License for operation of marine VHF within the U.S on "voluntarily equipped" vessels operating that do not travel to foreign ports. It is still required for operation of the radio in International waters.**

FCC 47 CFR §§ 80.148, 80.310 states In general, any vessel equipped with a VHF marine radiotelephone (whether voluntarily or required to) must maintain a watch on channel 16 (156.800 MHz) whenever the radiotelephone is not being used to communicate.

EPO #2: Identify features and channels on marine VHF radios

Radio Usage and Applicability

Monitoring the public access airways will tell a law enforcement officer a lot about what goes on in the marine environment. This may be a useful way of obtaining law enforcement intelligence.

Law enforcement agencies have a wide variety of radio equipment, with each agency usually having its own frequency and dispatcher. The marine VHF radio gives those officers working in the marine environment an alternate method of communicating with other marine enforcement and/or rescue units.

In addition the marine VHF gives law enforcement officers the ability to:

1) Manage vessel traffic.

2) Listen for distress, safety incidents and call for assistance.

3) Receive up to date weather information.

4) Tie into the ship to shore telephone system.

5) Contact civilian boaters and the Coast Guard.

Features On Marine VHF radios

Features available on VHF radios

1) One button selection of channel 16.
2) Switchable power output from high power (25 watts) to low power (1 watt or less).
3) Capable of being tuned to all marine VHF channels
4) Sea or Dual Watch - This feature automatically monitors channel 16 and any other one channel selected.
5) Scan - This feature will monitor a series of channels and is generally programmable.
6) Loud Hailer - Allows the unit to be used as a megaphone.
7) Direction Finder - This feature determines the direction a radio signal is coming from.

Channel Usage

There are 104 VHF channels designated for marine service. Fifty-four (54) of these are reserved exclusively for use in the waters of the United States. The rest are used in international waters near other countries.

In most cases International and USA channels are identical. There are however seventeen (17) channels were the frequencies are different. In those cases the USA channels are designated with the letter A, e.g. 22A. Radios will generally display USA or have the A marking when those channels are selected, and often have a switch to allow automatic selection of A channels.

The International Telecommunications Union (ITU) has established three VHF marine radio stations to be recognized worldwide for safety reasons.

1) Channel 16 (156.800 MHz) is the distress, safety, and calling frequency, monitored continuously by the U.S. Coast Guard. It is reserved for emergency traffic and for contact calls. Once initial contact is made, both parties must switch to a working channel. **A listening watch must be maintained on channel 16**.

2) Channel 13 (156.65 MHz) is the bridge-to-bridge or "piloting" channel, used for communicating navigational information between vessels. Contact with locks and bridges as well.

3) Channel 70 is the channel reserved and designated as the Digital Selective Calling channel.

The remaining channels are grouped as to usage, with certain channels within each group being used primarily.

1) U.S. Coast Guard and U.S. Government - 21A, 22A, 23A, 81A, 82A, 83A (Ship to ship/ship to shore.)

NOTE: Channel 22A is the primary channel used by the Coast Guard to communicate with the marine community. It is also used to broadcast severe weather warnings, Notices to Mariners and other safety information.

2) Noncommercial (recreational) - 09, 68, 69, 71, 78A, 80A (Ship to ship/Ship to shore.) 67, 72 (Ship to ship only.)

NOTE: Channel 68 is the primary "yacht" channel.

3) Marine Operators - 24, 25, 26, 27,28,84, 85, 86, 87, 88 (Ship to shore only.)

4) Commercial Vessels - 07A, 09, 10, 11, 18A, 19A, 79A, 80A (Ship to ship/Ship to shore.) 08, 67 (Ship to ship only.) 88A (Ship to ship/Ship to airplane.)

NOTE: The FCC has recently made channel 9 available for use as a hailing channel. This use has been adopted by some Coast Guard Districts.

4) Port Operations/Vessel Traffic Systems - 01A, 05A, 12, 14, 20, 63A, 65A, 66A, 73, 74 (Ship to ship/Ship to shore.) 77 (ship to ship only.)
5) Intership Safety- 06

6) Environmental - 15 (Receive only). Environmental information such as sea conditions, weather and notice to mariners.

7) State Control - 17 (Ship to ship/Ship to shore.) Communicating with state and local authorities on matters dealing with marine activities, regulations, control and assistance.

8) Weather - WX 1 - WX 9 (Receive only)

NOTE: Shore stations such as those at marinas have limited licenses with restricted channel availability. They will generally have channel 9 or 68.

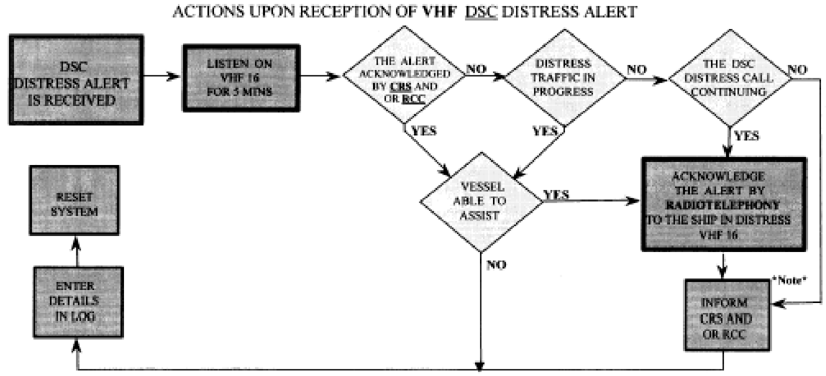
EPO #3: Identify Digital Selective Calling (DSC) features and requirements.

DSC (Digital Selective Calling).

DSC is a semi-automated method of establishing a radio call, it is to become mandatory in the near future.

FIG 1

ACTIONS UPON RECEPTION OF VHF DSC DISTRESS ALERT



REMARKS:
Note : Appropriate or relevant RCC and/or Coast Radio Station shall be informed accordingly. If further DSC alerts are received from the same source and the ship in distress is beyond doubt in the vicinity, a DSC acknowledgement may, after consultation with an RCC or Coast Radio Station, be sent to terminate the call.

CRS = Coast Radio Station RCC = Rescue Co-ordination Center

DSC has been designated by the International Maritime Organization (IMO), as an international standard for establishing maritime MF, HF, and VHF radio calls. It has also been designated part of the "Global Maritime Distress and Safety System" (GMDSS). DSC will eventually replace aural watches on distress frequencies, it will be used to announce routine and urgent maritime safety information broadcasts.

Coast Guard Groups and Communication Stations (COMMSTAs) are responsible for maintaining radio distress watches:

Digital Selective Calling (DSC) automatically monitors calling frequencies and signals when a communications link is established between marine radios (ship/shore ship/ship); for distress calls and routine operational communications, thus simplifying this process.

The advantages of DSC include faster alerting capabilities and automatic transmission of information, such as: the nature of distress, situation, and the identity and location of the caller.

Furthermore, in a non-distress situation, DSC minimizes the time necessary to establish communications, and increases spectrum efficiency.

DSC uses a DIGITAL signal to send a specific set of information. The information that can be passed by a DSC call includes:

The caller's Maritime Mobile Service Identity or MMSI is a number that uniquely identifies the caller, similar to a telephone number. The MMSI of the unit being called can be a specific unit, or a group of units, (for example all Coast Guard units).

DSC will enable the caller's location and time to be identified by all DSC capable VHF's. This can be derived directly from an interface to a GPS/Loran/Sat/Nav receiver, or it can be entered manually. Location and time of location are normally only transmitted with a distress alert.

The requested working frequency & mode is the frequency and mode of emissions that will be used to transact business.

DSC is only used for Call Set-Up.

Once the call is established, the two parties change to a working frequency and mode to continue the call.

For distress calls, the DSC can indicate the type of emergency and the priority of the call (Distress, Urgent, Safety, and Routine).

DSC can be used for anything from distress calls, to setting up a routine phone patch through a commercial coast station.

DSC calls are SELECTIVE unlike traditional voice radio calls; a DSC call can be addressed to a certain user or to a set of users.

When a DSC receiver "hears" a DSC call, it looks at the address, geographic information, etc; it then alerts an operator only if the call is intended for that unit. This eliminates the need for a watch stander to constantly monitor the receiver. For Example:

DSC calls can be addressed to:

a.) Specific vessel or shore station,

b.) Receivers in a specific geographic region,

b.) A specific set of DSC receivers, such as all Coast Guard receivers.

c.) All receivers in radio range, when the individual identity of the ship being called is unknown.

d.) As stated before, DSC is primarily designed to establish a radio call.

When a DSC call is received, the receiving station will use the DSC protocol to acknowledge the call. At this point, the two parties will move to a working frequency and a different mode (voice, fax, RTTY) to complete the call. Generally, a DSC radio will "ring" when called, as would a telephone.

a.) How will the Coast Guard use DSC?

b.) The Coast Guard will use DSC to listen for: Distress calls.

c.) To initiate radio communications with other vessels.

d.) To announce urgent maritime information broadcasts.

e.) To track vessels.

Instead of a radio operator maintaining an aural watch on a voice channel, a computer built into the radio will listen for DSC calls on an internationally designated radio frequency (channel 70). Eventually, the Coast Guard will be able to discontinue the current aural watch on 2182 kHz and other voice channels, as mariners convert to DSC equipped radios.

Distress Calls

The DSC system will alert an operator when a distress call is received.

The DSC system will provide the operator with the distressed vessel's MMSI (DSC's nine-digit "phone number"); and if available: location, time of location, and type of distress (fire, taking on water, etc).

The DSC radio operator can acknowledge the call, move to the designated working frequency, establish voice contact, and work the call.

Safety Broadcasts

Before sending an unscheduled maritime broadcast, Coast Guard units will send a DSC safety message indicating that a broadcast is about to be made, and designate the frequency on which it will be made.

Other than the initial DSC announcement on the designated frequency, broadcasts will continue on the current working frequencies.

The Coast Guard units will also use DSC to initiate radio telephone calls to ships for a variety of purposes.

This can include asking a vessel which has sent a distress alert to verify it is in distress, or to request a vessel to assist in another vessel's distress.
The system can also be used to communicate with a vessel for law enforcement purposes.

Calling Procedures

There are a number of general rules to apply and actions to avoid anytime you use a radio. Some examples of each are listed below.

(a) Be certain the transmitter is on the proper channel or frequency.

(b) Keep the receiver gain (squelch control) turned high enough to hear weak signals through static and other interferences.

(c) Listen before transmitting, to avoid unauthorized break-in on established communication lines.

(d) Speak slowly, concisely and clearly and in a normal tone.

(e) Keep the microphone approximately 1 to 2 inches from your lips.

(f) Protect the microphone from wind or noise generating sources while transmitting.

(g) End every transmission with either the "over" or "out" (not both) to let the receiving parties know you are finished.

Actions to avoid in radio communication.

Do not key the microphone unless you are ready to transmit.

Do not use profane or obscene language.

Emergency Signals and Procedures

There are three different voice signals used over the radio to denote urgent or emergency calls.

Distress signal "MAYDAY". This is the distress signal that requests immediate assistance for a boat in grave and imminent danger. MAYDAY takes priority over all other traffic. It is reserved for true emergencies in which there is a real and immediate danger to life and property.

Urgent signal "PAN-PAN". (Pronounced pahn-pahn.) This signal is used when the safety of a person or boat is in jeopardy. Man-overboard reports use this signal.

Safety signal "SECURITÉ". (Pronounced say-cure-e-tay.) Proceeds - navigation messages where safety is involved; severe weather alerts; etc.

Each signal should be transmitted on VHF channel 16, with the appropriate signal word(s) being repeated three times, e.g. "MAYDAY, MAYDAY, MAYDAY". The actual safety message following "SECURITÉ" should be transmitted on VHF channel 22A. When you hear these signals, keep off the air, unless you can help.

NOTE: The radio signal SILENCE (SEE LONCE) MAYDAY has been adopted internationally to control transmissions on the distress frequency. This signal may be used <u>only</u> by the vessel in distress or the station controlling the distress traffic. Stations hearing this signal <u>must</u> cease all transmissions. SILENCE FINIS (SEE LONCE FEE NEE) ends the restriction.

If you hear a Distress Message from a vessel and it is not answered, then YOU must answer. If you are reasonably sure that the distressed vessel is not in your vicinity, you should wait a short time for others to acknowledge.

NOTE: Do not respond "Vessel Calling MAYDAY", use "Vessel in DISTRESS" this is....

After you acknowledge receipt of the distress message, allow a short interval of time for other stations to acknowledge receipt. When you are sure of not interfering with other distress-related communications, contact the vessel in distress and advise them what assistance you can render.

Make every effort to notify the Coast Guard of the situation. You may use the wording "MAYDAY RELAY" repeated three times with the message following to relay the information.

PHONETIC ALPHABET

Letter	Phonetic Equivalent	Pronunciation
A	ALPHA	AL FAH
B	BRAVO	BRAH VOH
C	CHARLIE	CHAR LEE
D	DELTA	DELL TAH
E	ECHO	ECK OH
F	FOXTROT	FOKS TROT
G	GOLF	GOLF
H	HOTEL	HO TELL
I	INDIA	IN DEE AH
J	JULIETT	JEW LEE ETT
K	KILO	KEY LOH

L	LIMA	LEE MAH
M	MIKE	MIKE
N	NOVEMBER	NO VEN MER
O	OSCAR	OSS CAH
P	PAPA	PAH PAH
Q	QUEBEC	KEH BECK
R	ROMEO	ROW ME OH
S	SIERRA	SEE AIR RAH
T	TANGO	TANG GO
U	UNIFORM	YOU NEE FORM
V	VICTOR	VIK TAH
W	WHISKEY	WISS KEY
X	XRAY	ECKS RAY
Y	YANKEE	YANG KEY
Z	ZULU	ZOO LOO
0	ZERO	ZERO
1	ONE	WUN
2	TWO	TOO
3	THREE	THUH REE
4	FOUR	FO WER
5	FIVE	FI YIV
6	SIX	SIX
7	SEVEN	SEV EN
8	EIGHT	ATE
9	NINE	NIN ER

Radio Procedure Words

(Pro-words)

When communicating by radio certain words called "pro-words" have particular meaning and importance. The most common pro-words and their definitions are contained in the following list:

Pro-word	Meaning
AFFIRMATIVE	What you have transmitted is correct.
ALL BEFORE	Used to call reference to a particular part of a transmission.
ALL AFTER	Used to call reference to a particular part of a transmission to follow.
BREAK	Term used to indicate the end of one message prior to commencing the transmission of a second.

	Also used to indicate certain information is to be separated from the message text.
ETA	Estimated time of arrival.
ETD	Estimated time of departure.
ETR	Estimated time of return.
FIGURES	Indicates that figures or numbers follow. Used when numbers occur in the middle of a message.
MESSAGE FOLLOWS	A message that requires recording follows.
NEGATIVE	What you have transmitted is incorrect.
OUT	Used following the last line of the message transmitted. Signifies the end of the transmission and nothing follows. No answer is required or expected.
OVER	Used following a line of transmission when a response is necessary. It may be omitted when the context of a transmission makes it clear that it is unnecessary. That is, when it is clear that a response will follow.
ROGER	Indicates a transmission has been received satisfactorily.
SAY AGAIN	Repeat
SILENCE	(Pronounced SEE LONCE) Cease all transmissions immediately. Silence will be maintained until instructed.
SILENCE FINIS	(Pronounced SEE LONCE FEE NEE) indicates the end of an emergency and resumption of normal traffic.
WORDS TWICE	Communication is difficult, give every phrase twice.

Channel Number	Ship Transmit MHz	Ship Receive MHz	Use
01A	156.05	156.05	Port Operations and Commercial, VTS. Available only in New Orleans / Lower Mississippi area.
05A	156.25	156.25	Port Operations or VTS in the Houston, New Orleans and Seattle areas.

6	156.3	156.3	Intership Safety
07A	156.35	156.35	Commercial
8	156.4	156.4	Commercial (Intership only)
9	156.45	156.45	Boater Calling. Commercial and Non-Commercial.
10	156.5	156.5	Commercial
11	156.55	156.55	Commercial. VTS in selected areas.
12	156.6	156.6	Port Operations. VTS in selected areas.
13	156.65	156.65	Intership Navigation Safety (Bridge-to-bridge). Ships >20m length maintain a listening watch on this channel in US waters.
14	156.7	156.7	Port Operations. VTS in selected areas.
15	--	156.75	Environmental (Receive only). Used by Class C EPIRBs.
16	156.8	156.8	International Distress, Safety and Calling. Ships required to carry radio, USCG, and most coast stations maintain a listening watch on this channel.
17	156.85	156.85	State Control
18A	156.9	156.9	Commercial
19A	156.95	156.95	Commercial
20	157	161.6	Port Operations (duplex)
20A	157	157	Port Operations
21A	157.05	157.05	U.S. Coast Guard only
22A	157.1	157.1	Coast Guard Liaison and Maritime Safety Information Broadcasts. Broadcasts announced on channel 16.
23A	157.15	157.15	U.S. Coast Guard only
24	157.2	161.8	Public Correspondence (Marine Operator)
25	157.25	161.85	Public Correspondence (Marine Operator)
26	157.3	161.9	Public Correspondence (Marine Operator)
27	157.35	161.95	Public Correspondence (Marine Operator)
28	157.4	162	Public Correspondence (Marine Operator)
63A	156.175	156.175	Port Operations and Commercial, VTS. Available only in New Orleans / Lower Mississippi area.
65A	156.275	156.275	Port Operations

66A	156.325	156.325	Port Operations
67	156.375	156.375	Commercial. Used for Bridge-to-bridge communications in lower Mississippi River. Intership only.
68	156.425	156.425	Non-Commercial
69	156.475	156.475	Non-Commercial
70	156.525	156.525	Digital Selective Calling (voice communications not allowed)
71	156.575	156.575	Non-Commercial
72	156.625	156.625	Non-Commercial (Intership only)
73	156.675	156.675	Port Operations
74	156.725	156.725	Port Operations
77	156.875	156.875	Port Operations (Intership only)
78A	156.925	156.925	Non-Commercial
79A	156.975	156.975	Commercial. Non-Commercial in Great Lakes only
80A	157.025	157.025	Commercial. Non-Commercial in Great Lakes only
81A	157.075	157.075	U.S. Government only - Environmental protection operations.
82A	157.125	157.125	U.S. Government only
83A	157.175	157.175	U.S. Coast Guard only
84	157.225	161.825	Public Correspondence (Marine Operator)
85	157.275	161.875	Public Correspondence (Marine Operator)
86	157.325	161.925	Public Correspondence (Marine Operator)
AIS 1	161.975	161.975	Automatic Identification System (AIS)
AIS 2	162.025	162.025	Automatic Identification System (AIS)
88A	157.425	157.425	Commercial, Intership only.

U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

Homeland Security

STUDENT TEXT

HEAVY WEATHER

7518 **JULY/2013**

DESCRIPTION:

This course covers common situations involving heavy weather operations and decisions that confront the mariner. The course includes recommendations and procedures for safely operating vessels in inclement weather. It also identifies sources of weather information and conditions associated with different weather systems and weather advisories. It describes methods of anticipating weather trends and mission feasibility.

TERMINAL PERFORMANCE OBJECTIVE (TPO):

Given a marine weather scenario, the student will utilize different sources of weather information associated with marine weather advisories and conditions to coincide with mission planning in accordance with standard maritime practices and procedures.

ENABLING PERFORMANCE OBJECTIVES (EPO):

INTRODUCTION

The marine environment surrounds the mariner with powerful and often fickle elements including sky, water, and wind.

Boat operators must develop their weather eye, an eye quick to observe coming changes in the weather.

They need to be aware of approaching fog banks, swiftly moving currents, rising winds, and building seas.

Even with all the weather information readily available to mariners, hundreds lose their lives each year because of bad weather or poor judgment in assessing the dangers posed by bad weather.

The mariner who battens down for a severe storm and then only meets a gentle rain and modest seas has erred on the side of safety.

The mariner who optimistically expects the best weather and underestimates it may pay the ultimate price.

Manufacturers design small powerboats to be seaworthy in normal weather and sea conditions with a margin of safety. However, marine enforcement officers routinely must operate their vessels in adverse or heavy weather conditions.

Through training and experience, officers can develop the knowledge and skill needed to operate a vessel in adverse conditions.

Lesson Plan overview

Given a marine weather scenario, the student will utilize different sources of weather information associated with marine weather advisories and conditions to coincide with mission planning in accordance with standard maritime practices and procedures.

ENABLING PERFORMANCE OBJECTIVES (EPO)

EPO #1: Identify sources of weather information.

EPO #2: Identify the conditions associated with marine weather advisories and warnings in concurrence with mission planning.

EPO #3: Identify the characteristics of various weather systems.

EPO #4: Identify the recommended safety procedures associated with heavy weather operations.

I. PRESENTATION

EPO #1: Identify sources of weather information.

1. The mariner can obtain weather information from a variety of sources including:

a. **Recorded marine weather reports** available by telephone from the National Weather Service (NWS)

b. Weather broadcasts on Very High Frequency (VHF) marine radio

1) Usually, the NWS updates these broadcasts every three to six hours.

2) Most VHF marine radios have from one up to nine weather channels (WX 1 - 9). Monitor each channel to determine the channel appropriate for your area

3) In addition, the U. S. Coast Guard broadcasts severe weather bulletins on VHF marine channel 22A. These broadcasts begin with the safety pro-word "SECURITE" transmitted on channel 16 and then advise the mariner to switch to 22A for details

c. Commercial radio or television stations routine broadcast weather reports.

d. Local **newspapers** print weather forecasts

2. **Barometer** – A barometer is an instrument for determining atmospheric pressure.

a. Mariners use barometers to help them forecast weather.

b. The **aneroid barometer** typically used on small boats, measures atmospheric pressure by its affect in bending a metallic surface to move a pointer

1) It is a rugged instrument and generally very accurate

2) It has a reference pointer to help the mariner track changes in atmospheric pressure.

c. Barometers **measure changes in atmospheric pressure** as either inches of mercury or millibars (the aneroid barometer uses both scales).

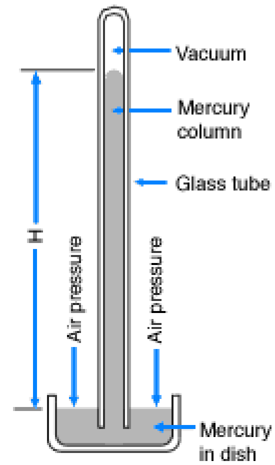
d. It is not the actual barometric pressure but the **direction and rate of change of pressure** that is important in forecasting weather.

1) **Falling barometer** usually forecasts that bad weather is approaching.

2) **Rising barometer** usually forecasts clear and fair weather.

3) **Rapidly falling barometer** generally forecasts the strong winds

(below) Aneroid barometer



EPO # 2: Identify the conditions associated with marine weather advisories and warnings in concurrence with mission planning.

The NWS issues these advisories and warnings through a variety of means and the prudent mariner should regularly check these sources to receive them in a timely manner.

1. SMALL CRAFT ADVISORY: To alert mariners to sustained (more than two hours) weather or sea conditions, either present or forecast, that might be hazardous to small boats. If a mariner notices a Small Craft Advisory pennant displayed he should determine immediately the reason by tuning his radio to the latest marine broadcast. Decision as to the degree of hazard will be left up to the boatman, based on his experience and size and type of boat. There is no legal definition of "small craft". The Small Craft Advisory is an advisory in Coastal Waters and Nearshore forecasts for sustained winds, frequent gusts, or sea/wave conditions, exceeding defined thresholds specific to geographic areas. A Small Craft Advisory may also be issued when sea or lake ice exists that could be hazardous to small boats.

    a. Eastern (ME, SC, Lake Erie, Lake Ontario) - Sustained winds ranging between 25 and 33 knots (except 20 to 25 knots, lower threshold area dependent, to 33 knots for harbors, bays, etc.) and/or seas/waves 5 to 7 feet and greater, area dependent.

b. Central (WI, OH) - Sustained winds or frequent gusts between 22 and 33 knots inclusive, and/or seas/waves greater than 4 feet.

c. Southern (GA, TX and Caribbean) - Sustained winds of 20 to 33 knots, and/or forecast seas 7 feet or greater that are/is expected for more than 2 hours.

d. Western (WA, CA) - Sustained winds of 21 to 33 knots. A Small Craft Advisory for Hazardous Seas is issued for seas 10 feet or greater.

e. Alaska (AK) - Sustained winds or frequent gusts of 23 to 33 knots. A small craft advisory for rough seas may be issued for sea/wave conditions deemed locally significant, based on customer needs, and should be no lower than 8 feet.

f. Pacific (HI, Guam, etc) - Sustained winds: northwest through east/southeast winds of 25 to33 knots for the coastal waters (30 to 33 knots for the channels between the islands); southeast through west winds of 20 to 33 knots for both coastal waters and channel winds. Swells: open ocean swells 10 feet and greater; swells 6 feet and greater with short periods (6 to 8 seconds); south swell 4 feet and greater with long periods (13 seconds and greater); north and northeast swells 5 feet and greater with long periods.

g. "Frequent gusts" are typically long duration conditions (greater than 2 hours).

h. For a list of NWS Weather Offices by Region, refer to the following website: http://www.nws.noaa.gov/organization.php

i. The NWS defines small craft "small boats, yachts, tugs, barges with little freeboard, or any other low-powered craft

j. The prudent mariner should not ignore small craft advisories when displayed even if it is a clear, sunny day.

“Taki-Tooo” Tillamook Bar Oregon June 2003

2. GALE WARNING – The NWS uses the following criteria when issuing gale warnings. Sustained winds of 34 – 47 knots (39 – 54 miles per hour).

Gale warning

3. STORM WARNING or WHOLE GALE WARNING – The NWS uses the following criteria when issuing storm warnings

   a) Sustained winds equal to or greater than 48 knots (55 miles per hour) from a non-tropical system

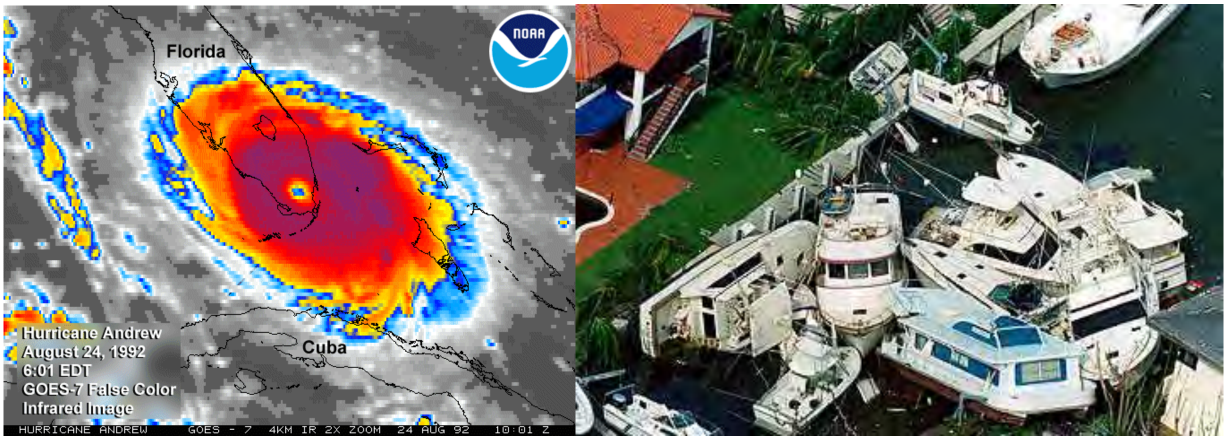
   b) If associated with a tropical storm, sustained winds of 48 – 63 knots (39 – 73 miles per hour) within 24 hours.

4. HURRICANE WARNING – The NWS uses the following criteria when issuing hurricane warnings:

   a) Implies a dangerous storm surge

   b) Although Sustained winds equal to or greater than 64 knots (74 miles per hour) within 24 hours.

   c) Not part of the criteria used by the NWS, mariners can expect high waves over 46 feet (14 meters)



Hurricane Andrew August 1992

A. EPO #3: IDENTIFY THE CHARACTERISTICS OF VARIOUS WEATHER SYSTEMS.

1. One method used to **classify clouds** is by whether they are layered (flat looking) or built up (clouds with great vertical height).

   a. Layered clouds are stable and indicate good weather or no immediate change in the current weather conditions.

   b. **Built-up clouds** are unstable and indicate that the current weather conditions may rapidly change

2. Cloud classification index

   a. **Cirrus - Ci**

   "*Long foretold, long to last, Short notice, soon past."* Long foretold, refers to warm fronts or large isolated lows in general, which are slow moving. Look for cirrus in a clear sky expect rain in 12 hours.

The longer it takes to build the longer it will rain. Short notice refers to fast moving cold fronts.

1) **Characteristics**

High white delicate cloud. Cirrus is composed of ice crystals and is always white (except possibly after sunset or before sunrise). It looks great in photographs, makes a nice daytime backdrop and excellent sunsets but is often a sign of a change in the weather**.**

2) **Weather prediction**

Small amounts of cirrus are OK but lots of dense cirrus is often a sign of storms to come

3) **Precipitation (rain/snow etc)**

None

b. **Cirrocumulus – Cc**

"*Mackerel skies and mare's tails make tall ships set low sails*". Mackerel skies are waves (billows) in cirrocumulus indicating strong winds and shear aloft and mare's tails are fall streaks from cirrus clouds. Again, the fall streaks indicate strong winds with distinct wind shear aloft.

1) **Characteristics**

Very small, white cloud elements. Sometimes produces a 'mackerel sky' but this is more often formed with altocumulus. Signifies convection in the upper atmosphere - not good.

2) **Weather prediction**

Real cirrocumulus is a bad sign as there is convection high up - a sign of storms on the way.

3) **Precipitation (rain/snow etc)**

None

c. **Cirrostratus – Cs** This halo signifies cirrostratus. In most instances the halo is the only evidence that there is any cloud at all. The halo has a 22° - an angle approximated by the ends of your forefinger and thumb at arms length. But NEVER look directly into the sun

1) **Characteristics**

Thin white cloud, very high in the atmosphere. It can be difficult to see at first - a 'halo' around the sun is often a giveaway. Again all cirrus is composed of small ice crystals.

2) **Weather prediction**

Not storms this time but an almost certain predictor of a warm front. That's lots of continuous rain in a few hours, but not generally stormy.

3) **Precipitation (rain/snow etc)**

d. **Altocumulus - Ac**

1) **Characteristics**

Medium level convective 'lumps' of cloud. Great for sunset photography. Often forms a 'mackerel sky'.

2) **Weather prediction**

Convection is never good - altocumulus again means unsettled and possibly stormy weather to come. Varieties of altocumulus, namely floccus and castellanus, are very accurate predictors for thundery activity in a day or two. Altocumulus can form 'sun pillars'.

3) **Precipitation (rain/snow etc)**

Very rare (at least in reaching ground level).

e. **Altostratus**

1) **Characteristics**

Light grey formless sheet of medium level cloud. The sun will sometimes appear as through ground glass. The loss of the halo signifies altostratus has replaced cirrostratus as the warm front approaches yet nearer.....

2) **Weather prediction**

Approach of warm front imminent. Get the brolly ready.

3) **Precipitation (rain/snow etc)**

Precipitation sometimes in the form of continuous light rain.

f. **Nimbostratus -**

1) **Characteristics**

Dense grey-blue cloud, without form.

2) **Weather prediction**

Too late for predictions - sorry.

3) **Precipitation (rain/snow etc)**

Heavy continuous rain associated with passing warm front

g. **Stratocumulus** "*Red sky at night, sailor's delight*"- Stratocumulus no weather to the west to block the sun so you will have clearing weather over night

1) **Characteristics**

Low level, almost continuous layer of cloud, but 'lumpy'. Can be formed as cumulus or sometimes cumulonimbus dissipates (usually in the evening).

2) **Weather prediction**

Normally a dull period. There are different forms of stratocumulus which makes forecasting difficult without a lot of knowledge. It can accompany 'high pressure' in the winter, but instead of weak winter sunshine, can give an extensive cover of cloud for days on end.

3) **Precipitation (rain/snow etc)**

Not normally rain - but drizzle sometimes (a word of warning - drizzle relates to the size of droplet). Heavy drizzle (lots of small diameter bits of precipitation) can get you wet on occasion.

h. **Stratus -**

1) **Characteristics**

Fog and mist are examples of this low level cloud - no form.

2) **Weather prediction**

Cold if it persists in Winter - Otherwise not a reliable predictor.

3) **Precipitation (rain/snow etc)**

None. (But beware - there may be something else above you can't see!).

i. **Cumulus -**

1) **Characteristics**

Low level 'lumpy' cloud.

2) **Weather prediction**

Small cumulus (with a height to width ratio less than 1:3 is sometimes called 'fair-weather' cumulus. If the ratio starts to exceed 1:2 convection can turn cumulus into cumulonimbus, with thunder etc..

3) **Precipitation (rain/snow etc)**

Showers sometimes (but more extensive rainfall in the tropics).

j. **Cumulonimbus -**

1) **Characteristics**

Large towering cloud, often with an 'anvil'. Other characteristics: Thunder, lightning, rainbows.

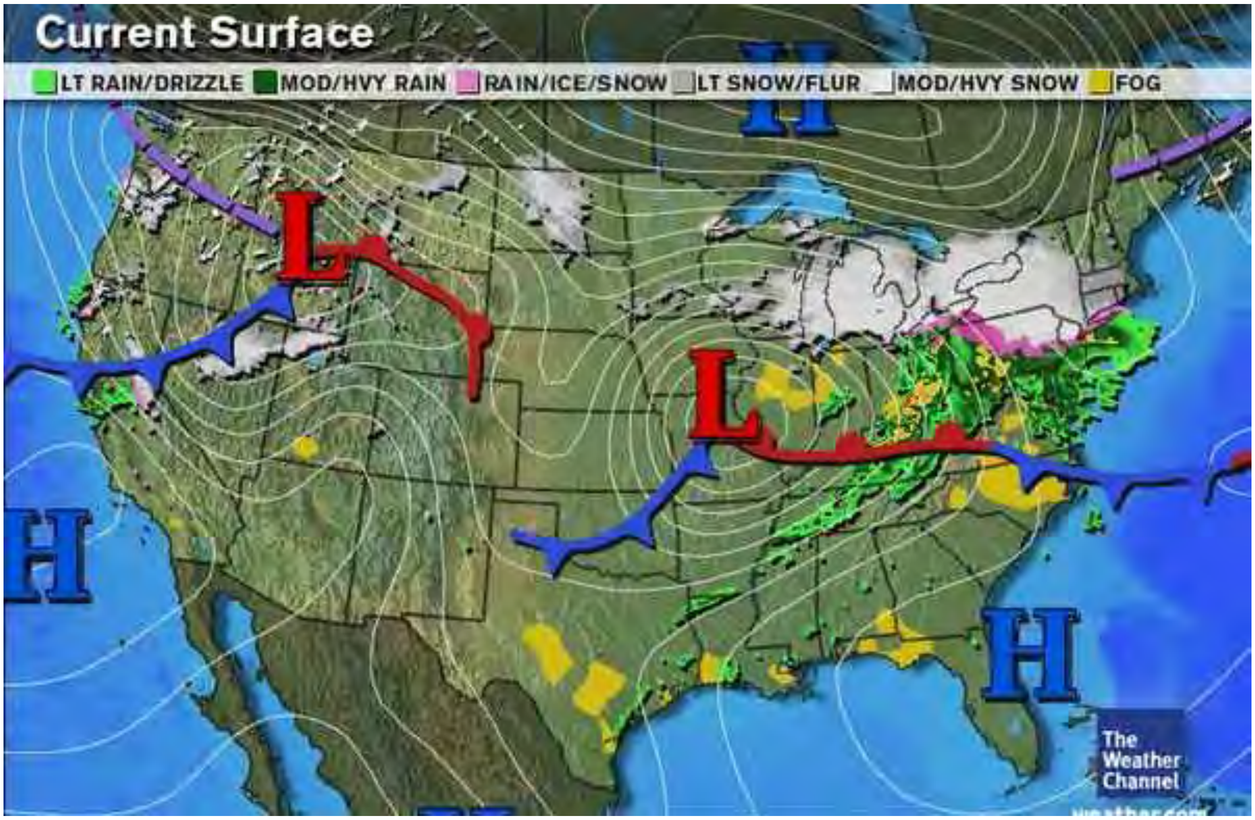
2) **Weather prediction**

Time to get indoors

3) **Precipitation (rain/snow etc)**

Rain, hail etc.

3. **Fronts** develop when cold and warm air masses meet.



Passing fronts cause changes in the current weather conditions, usually for the worse. The conflicting air masses do not mix but move in relation to each other Meteorologists classify air masses as either cold or warm

1) Characteristics of **cold air masses** include:

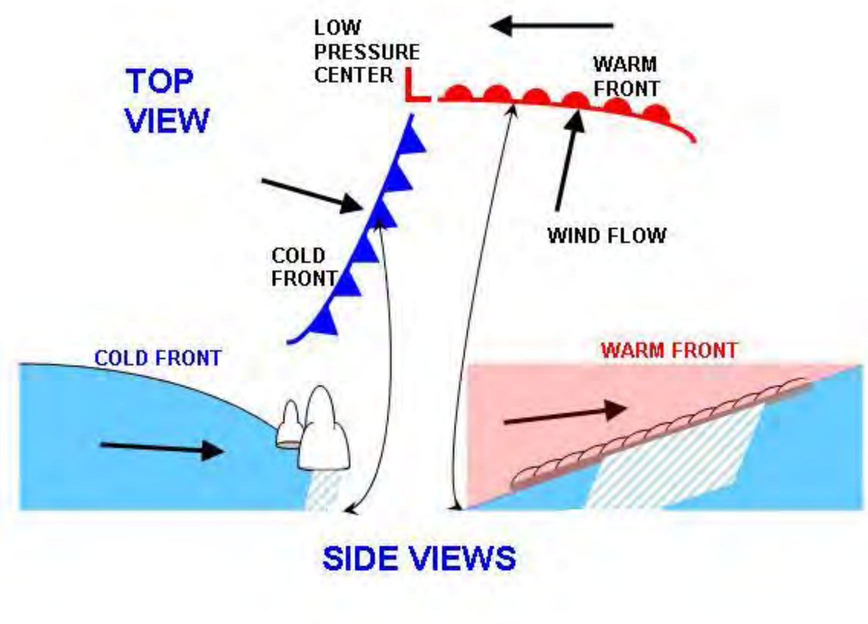
a) Instability because as the air near the surface warms it moves upward through the overlying layers of cold air

b) Good visibility

c) Gusty winds

d) Cumuliform clouds (e.g., cumulous, cumulonimbus, and alto cumulous

e) Showery precipitation



2) Characteristics of **warm air masses** include:

a) Stability because the air near the surface cools and sinks while the warm air above remains undisturbed

b) Poor visibility

c) Steady winds

d) Stratoform clouds (e.g., nimbostratus, altostratus, and cirrostratus

e) Steady precipitation

3) As a **warm front advances**, it moves slower than a cold front

a) The warm air mass rides over the cold air mass and moves

b) The resulting clouds may extend for several hundred miles ahead of the front.

c) When a warm front approaches, the barometer falls but at a slower rate than with an approaching cold front, clouds build, and steady rain or drizzle falls.

d) As the warm front passes, the winds will shift clockwise (in the Northern Hemisphere), the rain will diminish, and fog may form.

b. **Cold fronts advance rapidly**, often taking mariners by surprise (300 – 500 statute miles per day – faster in winter and slower in summer

1) For the mariner, an approaching cold front can be more dangerous than an advancing warm front. They may produce squalls, lightning, and thunderstorms

2) As a cold front approaches

a) The barometer will fall rapidly

b) The winds will shift toward the south and then the southwest

c) The clouds will lower and build up

d) Rain starts slowly but increases rapidly

e) As the cold front passes, the wind will continue to veer to the west, then the northwest, and, finally, to the north

f) After the cold front passes, the sky clears quickly, the temperature drops, the barometric pressure rises quickly, and the wind may continue to veer to the northeast

c. Stationary fronts occur when two air masses lie side by side with a distinct frontal line between them and no interaction

1) Stationary fronts have little or no movement

2) Stationary fronts produce weather similar to a warm front.

3) Indicators of deteriorating weather conditions include

a) Lowering and thickening clouds

b) Increasing cloudiness

c) Clouds moving rapidly across the sky

d) Veils or sheets of gray cloud increasing on the western horizon

e) Clouds moving in different directions at different altitudes

f) Clouds moving from east or northeast towards the south

g) Barometer steadily or rapidly falling

h) Static on an amplitude modulation (AM) radio.

i) Strong winds in the morning

j) Winds shifting from north to east and, possibly, on through east to south (a veering wind)

k) Temperatures far above or below normal for that time of year

4) Indicators of strong winds approaching include

a) Light, vapory clouds alone in a clear sky

b) Sharp, clearly defined edges to clouds

c) A yellow sunset

d) Unusually bright stars at night

5) Indicators of impending precipitation include

a) Distant objects seem to stand above the horizon.

b) Sounds are very clear and heard for great distances.

c) Transparent, veil-like clouds thickening and lowering.

d) A halo around the sun or the moon.

e) Increasing south winds, with clouds moving in from the west.

f) Winds, especially north wind winds, shifting to the west and then to the south (backing winds).

g) Steadily falling barometer

h) A pale sunset.

i) A red sky at dawn (red sky at morning, sailors take warning

j) No dew after a hot day.

6) Indicators of clearing weather include:

a) Wind shifts to west, especially shifting from the east on through to the south

b) Rising cloud bases.

c) Quickly rising barometric pressure.

d) A gray, early morning.

e) Morning fog or dew.

7) Indicators of continuing fair weather include:

a) Morning fogs that lifts early.

b) Gentle winds from the west or the northwest

c) Steady or slightly rising barometric pressure

d) Red sunsets (red sky at night, a sailor's delight)

e) A bright moon and light breezes

f) Clear blue morning skies

B. EPO #4: IDENTIFY THE RECOMMENDED SAFETY PROCEDURES ASSOCIATED WITH HEAVY WEATHER OPERATIONS.

1. A **marine VHF radio** may be your most important piece of safety equipment

   a. With it, one can receive weather bulletins and warnings in a timely manner.

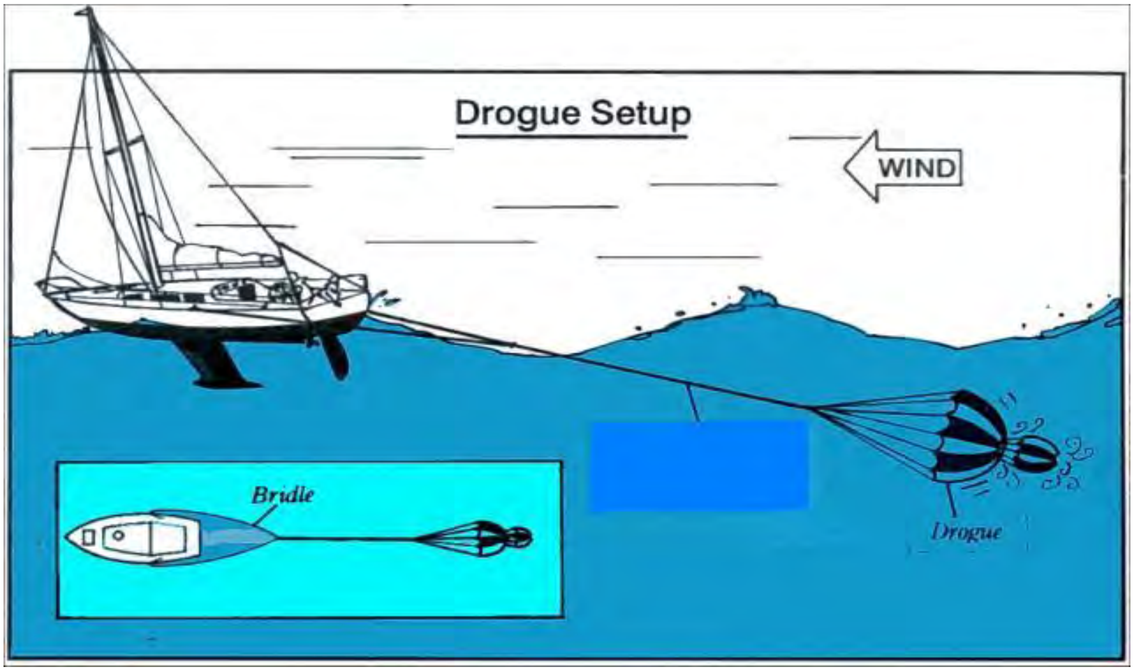
   b. When a vessel is in danger of sinking or foundering in heavy weather, one can use the radio to call for emergency assistance

2. A **drogue** (usually an open-ended canvas cone) can assist the mariner steering a vessel in heavy seas.

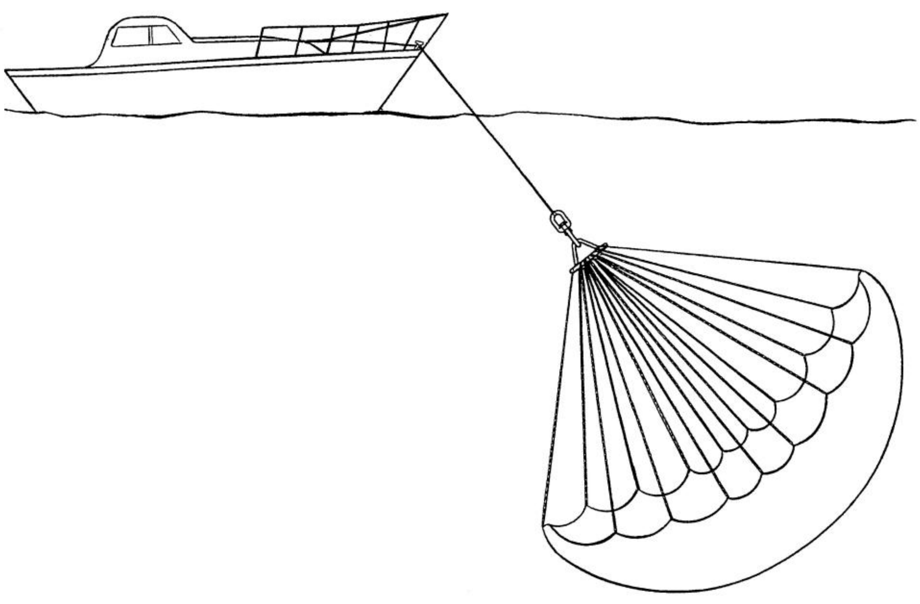
   a. Heavy following seas make steering a vessel difficult because the seas exert force on the stern that can cause broaching

   b. To prevent broaching, the mariner can stream a drogue astern of the boat while under power

   c. This practice counteracts the force (i.e., it increases drag) of the following seas on the stern and prevents the boat from sheering off course



3. A **sea anchor** (usually a canvas parachute-like device) provides the mariner with a means to keep the bow of a vessel to the seas in open water too deep to anchor
   a. It reduces the drift of a vessel
   b. The mariner streams the sea anchor from the bow of the boat.



NOTE: Although a mariner may use drogues and sea anchors interchangeably, their functions are distinct. The mariner deploys a drogue while making way using the propulsion system of the vessel whether sail or power. However, a mariner deploys a sea while the vessel is adrift and not making way. In either case, the mariner must realize that the drag created by drogues and sea anchors is considerable. The mariner must make to fasten these devices to fixtures able to withstand the strain.

4. **Bilge pumps** are essential safety equipment for operating in heavy weather.
   a. Most vessels come equipped with installed electrical or mechanical bilge pumps but these are subject to failure in emergencies
   b. Therefore, each vessel should carry some type of manual pump.
   c. In addition, plastic buckets are effective for bailing water
5. If your vessel has **radar**, you can use it to locate, and track dangerous weather systems like squalls, thunderstorms, and waterspouts
6. The **prudent mariner takes precautions** before getting underway including making sure that all required equipment is onboard
7. Additional consideration should be given to the following procedures for operating vessels in heavy weather
   1) Taking a position fix and updating your plot on a navigational chart
   2) Altering course for sheltered waters
   3) Notify the dispatcher center about your situation, position, and proposed course of action.
   4) Secure all hatches, port holes, windows, and loose gear.
   5) Checking the operation of the **bilge pump**(s) and pumping the bilge dry
   6) Making sure everyone has a personal flotation device (PFD) on
   7) Breaking out the emergency gear (e.g., hand operated bilge pumps, bailing buckets, sea anchor, drogue, etc
   8) Reviewing emergency procedures with your crew and passengers
   9) Making sure the navigation lights of your vessel are on.
   10) In cold climates or when operating on seas with water temperature below 70 degrees Fahrenheit (21 degrees Centigrade), donning additional clothing or exposure suits
   11) Assess the need to have crewmembers rig lifelines.

8. The following procedures are critical skills every mariner must master to safely operate a vessel in heavy weather and seas

   a. **Head seas** – Manufacturers generally design boats to meet moderate head seas without any difficulty

      1) In heavy weather, however, the seas become larger and steeper – the boat will begin to pound you, your crew, and itself to pieces

      2) One also runs the risk of "over-revving" the engine or spinning a propeller hub when the screw "ventilates."

      3) The prudent mariner, therefore, slows a vessel when meeting steep head seas.

         a) Reducing the speed of the vessel allows the buoyancy of the bow to lift the boat and ride over the each wave

         b) The consequence of not reducing speed is that you may crash the bow into a wave breaking ports or windows, or damaging the hull or superstructure.

         c) Always match the speed of your vessel to the prevailing sea conditions – slow until you are barely making headway, if necessary

      4) In addition, one can use the following techniques when meeting head seas:

         a) Steer at an angle. Take the seas slightly off the bow, preferably an angle approaching 45 degrees this "lengthens" the wave and gives the vessel a smoother ride

         b) Adjust trim One can swamp the boat if the boat is improperly trimmed

            (1) Too much weight forward increases the chance of stuffing the bow into an oncoming wave.

            (2) Too much weight aft increases the chance of water coming in over the transom.

            (3) Use the trim tabs or tilt the drive units (on outboard or inboard-outboard boats).

            (4) One can also shift weight inside the hull to trim the boat.

         c) Meet **each wave** as it approaches

            (1) Take each wave as a separate maneuver

(2) Adjust the speed of the vessel or its approach angle as one interprets each wave.

(3) If a particularly big wave is approaching, alter the course of the vessel to avoid it, if possible

d) Avoid ventilating the screw(s).

(1) Slow down to match the sea conditions

(2) Angle the approach and take the seas at a 45-degree angle.

b. **Beam seas** (i.e., "in the trough") is in heavy weather conditions

(1) When running with the beam to the seas, the waves push against the large surface area of the side of the boat.

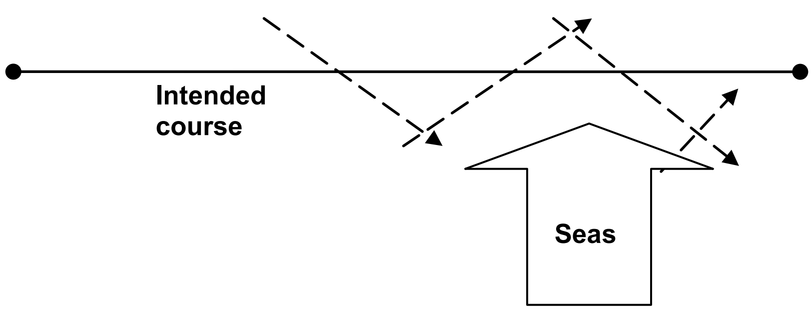
(2) In rough water, this much force could roll the boat on its side or capsize it.

(3) To avoid running in beam seas, one should tack the course like a sailboat tacks against the wind.

(a) Take the seas broad on the bow at a 45 degrees in the general direction of destination

(b) Then alter the course to take seas broad on the vessels quarter.

c. **Running before the seas** (i.e., in following seas) is also dangerous in heavy weather conditions.



a) This produces a zigzag course

2) If the boat is traveling faster than the speed of the waves, the boat may come off the face of one wave and stuff the bow into the back of the next wave.

3) If the boat is traveling slower than the speed of the waves, the waves may swamp the boat if they come over the transom (i.e., “being pooped”).

a) Additionally a vessel may broach as it comes down the face of the wave

(1) Broaching occurs when a wave lifts the stern of a vessel, which causes the bow to plow

(2) The combined effects of increased friction at the bow and decreased friction at the stern causes the stern to try to overtake the bow (i.e., it swings or “yaws” to the port or starboard

(a) The result is that the vessel now has the sea on its beam and it could capsize

(b) In larger seas, there is the possibility of **“pitch poling”**

(c) As the wave lifts the stern and the bow buries itself, the force of the wave pushed the stern up and over the bow

(d) A poet once wrote”If you pitch pole down a big hole, despair and give up hope”

4) To reduce the potential of broaching, pitch poling, or pooping

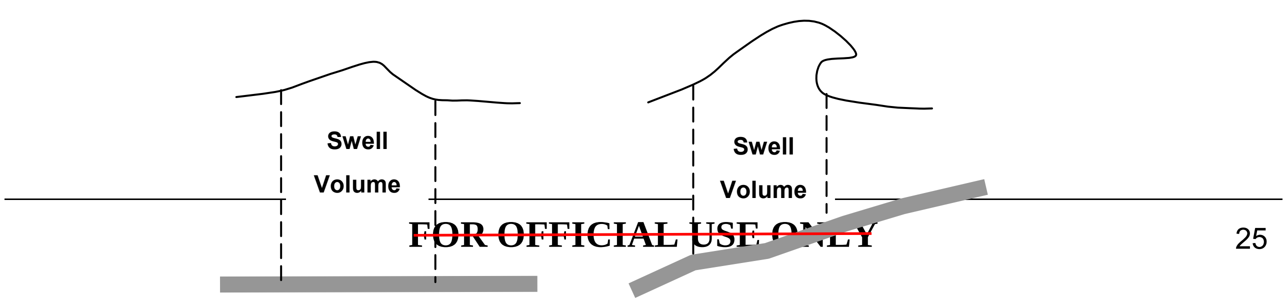
a) **Adjust the speed** of the vessel so that it rides just behind the wave crest (i.e., on the shoulder of the wave).

b) **Tack** (i.e., zigzag) to take the waves off the port and starboard quarters alternatively. However, this can lead to considerable yawing.

c) A **drogue** is extremely useful in helping control the stern for easier steering here.

5) One of the most dangerous things to attempt in heavy weather is **running an inlet**.

HOW SWELLS BUILD INTO BREAKERS IN SHOALING WATER



a) As offshore swells approach shallow water, their height increases rapidly. These swells are especially dangerous when an onshore wind drives them against a tidal current pouring out of the inlet.

b) **Breakers** form over the shallow areas, showing the location of sandbars.

c) **Before entering an inlet** in heavy weather, stop and observe the prevailing conditions.

(1) **Watch** the waves as they cross the bar.

(2) **Look** for where the waves pile up indicating shallow water.

(3) **Prepare** your boat by closing all hatches and ports, securing all loose gear, and briefing your crew.

(4) When one is ready to cross**, look** for the largest wave in the set and follow it in.

(5) Match the speed to that of the wave and stay on its shoulder.

(6) Watch the waves both in front and behind the vessel.

(7) If it appears that a following breaker may overtake the vessel, quickly turn the vessel to meet it bow on.

d) **Leaving an inlet** in heavy weather is safer than entering.

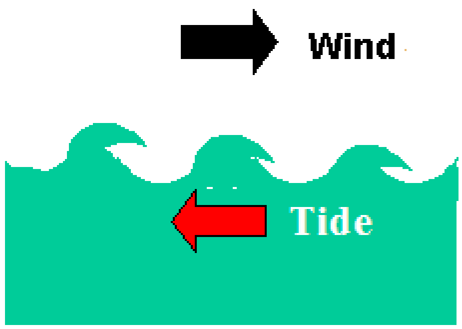
e) If deciding to cross, spotting dangerous waves is easier

f) Heading into the seas will offer better control than a vessel running with the seas

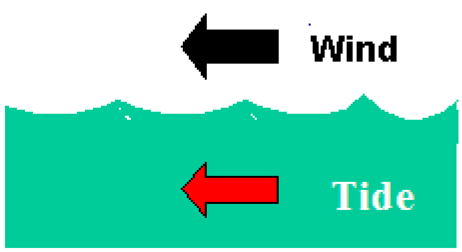
6) When conditions become so bad that you cannot make headway, **heave to**.

a) Bring the bow into the seas and maintain bare steerageway.

b) One may also deploy a **sea anchor**.

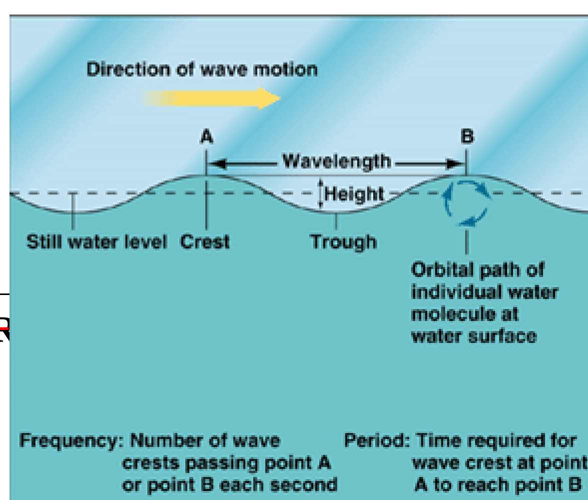


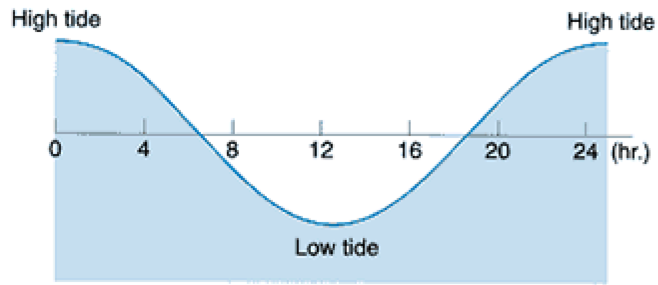
Sea roughest with wind against tide



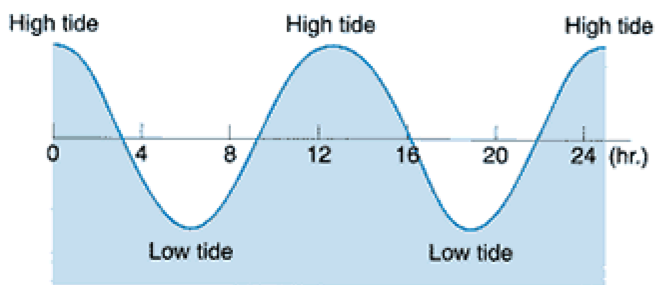
Sea calmest if the wind is with the tide

Measuring Wave Height

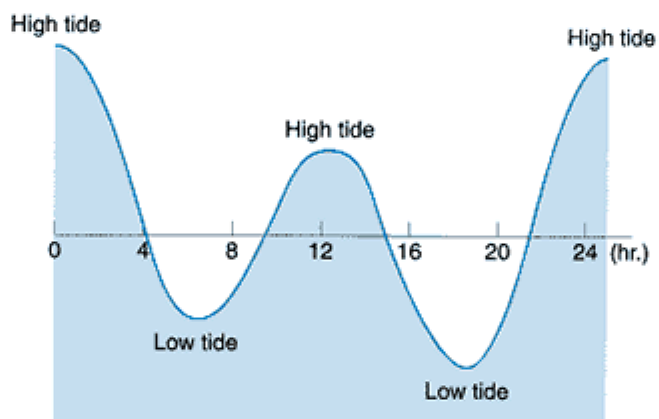




Diurnal tide



Semidiurnal tide



Mixed tide

d. A Glossary for Tidal Currents

1) **Current** - horizontal movement of water

2) **Tidal current** - horizontal movement of water caused by gravitational interaction between the sun, moon, and earth. Tidal currents are a part of the vertical rise and fall of the sea which we refer to as tide.

3) **Non - tidal current** - horizontal movements of water

that are not the result of tidal effects. Examples include river currents, ocean currents, and wind-driven currents.

4) **Set** - the direction toward which a tidal current flows.

5) **Drift** - the speed of a tidal current, which is normally expressed in knots and measured to the nearest 10th of a knot. River currents are measured in mph.

6) **Ebb** - tidal current moving away from land or down a tidal stream.

7) **Flood** - tidal current moving toward land or up a tidal stream.

8) **Slack, or Slack Water** - the state of a tidal current when its speed is near zero, prior to reversing direction. The term is also applied to the entire period of low speed prior to and after the turning of the current when it is too weak to be of any practical importance in navigation. Not to be confused with stand.

9) **Stand** - the point when vertical movement stops at both high and low tide.

C. REVIEW OF PERFORMANCE OBJECTIVES

1. EPO #1: Identify sources of weather information.
2. EPO #2: Identify the conditions associated with marine weather advisories and warnings in concurrence with mission planning.
3. EPO #3: Identify the characteristics of various weather systems.
4. EPO #4: Identify the recommended safety procedures associated with heavy weather operations.

D. REVIEW OF TEACHING POINTS

1. Use good common sense when deciding whether to operate your boat when wind and sea are building
2. Know your own limitations and the limitations of your boat
3. You can safely ride out heavy weather if you take the necessary precautions, use good seamanship, and do not panic.
4. The prudent mariner will periodically check the latest weather while underway.

References

A Mariner's Guide to Marine Weather Services, Coastal, Offshore and High Seas. National Oceanic and Atmospheric Administration, National Weather Service, 2010. NOAA PA 94058, http://www.nws.noaa.gov/pa/94058

Husick, Charles, B. *Chapman Piloting & Seamanship*, 66th edition. New York: Hearst Communications, 2009

National Oceanic and Atmospheric Administration, National Weather Service. 2010 http://www.nws.noaa.gov/pa/

U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

STUDENT TEXT

SAFETY AND EMERGENCY EQUIPMENT

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INTRODUCTION

The safety and well being of every employee is, and should be, a prime concern of the employer/agency. Injury or death is a high price to pay for getting the job done. During the years from 2000 to 2007, 21 law enforcement officers nationwide died in water related incidents. 18 of the officers drowned, while 2 died from exposure to hypothermia and another died from injuries sustained from falling of a boat.

Having the proper safety, emergency, and personal protective equipment available should substantially reduce job-related injuries and deaths. Safety equipment has no life saving value if it is not cared for and utilized. In addition, the user must identify and rehearse the proper use of all the equipment. It is the recommendation of the FLETC Marine Training Branch staff that all agencies draft individual check-off sheets for each vessel, while assigning specific locations for the storage of all equipment on board. Every vessel should be checked off at the beginning of every shift to assure that the operator is aware of what equipment is on board, as well as its condition. In addition, safety and emergency equipment must be routinely inspected and serviced to ensure that it is ready when needed.

It is the responsibility of the agency to equip the vessel and employees with the proper equipment to perform the mission. The Occupational Safety and Health Administration states: “The employer is responsible for providing personnel with protective equipment”. This includes protection for the eyes, face, head, and extremities. The United States Coast Guard prescribes minimum requirements for safety equipment aboard recreational vessels according to the vessels length. Agencies should operate with the understanding that law enforcement vessels, due to the nature of the work, should be equipped above and beyond the requirements for recreational boats.

TERMINAL PERFORMANCE OBJECTIVES (TPO):

Given an on-water situation and the type of vessel to be employed, the student will identify the required and recommended Safety and Emergency equipment for safe vessel operation and tactical law enforcement practices to ensure survival during emergency situations.

ENABLING PERFORMANCE OBJECTIVES (EPO):

EPO #1: Identify the essential safety and emergency equipment needed aboard all vessels.

EPO #2: Identify additional safety and emergency equipment to be carried on board marine law enforcement vessels.

EPO #1: IDENTIFY THE ESSENTIAL SAFETY AND EMERGENCY EQUIPMENT NEEDED ABOARD ALL VESSELS

Personal Flotation Devices (PFDs) are a necessity for law enforcement vessels. Agencies should ensure that officers wear PFDs while underway. In addition, extra PFDs should be on board every vessel, including child sizes, so that they are available to officers when needed. All PFDs should be approved by the U.S. Coast Guard, which means that the PFD has met certain standards of buoyancy and construction. However, there are many PFDs available that exceed the buoyancy requirements. PFDs are tested in calm water without additional gear and tools that officers typically carry. Therefore, agencies should provide officers with the most buoyant PFDs that are practical for their job.

Performance Type:

1) TYPE I: Designed to turn an unconscious person face up to a vertical, slightly backward position. An adult Type I PFD has a minimum of 22 pounds of buoyancy, and is the most suitable for all boating waters. It is especially suited for rough or open waters, when there is a probability of delayed rescue.

2) TYPE II: Designed to turn a person face up to a vertical, slightly backward position, though the turning action is not as a Type I. A Type II PFD has a minimum of 15.5 pounds of buoyancy and is designed for calm inland waters, where there is a good chance of quick rescue. **TESTS HAVE SHOWN THAT TYPE II PFDs DO NOT PROVIDE ADEQUATE SAFETY IN ROUGH WATER.**

3) TYPE III: Designed so the user can maintain a vertical, slightly backward position. It has no turning force, and it requires the user to help maintain a vertical position. Like Type II PFDs, Type III PFDs also have a minimum of 15.5 pounds of buoyancy. Additionally, they are also intended for use in calm, inland waters where the probability of a quick rescue is high. While Type III PFDs are most comfortable, the limitations associated with them should be taken into account when choosing them for use.

4) TYPE IV: A Type IV PFD is a throwable device and is not intended to be worn by the user. The device is meant to be thrown to a person in the water and grasped. This type of PFD can be obtained in various forms, including a ring, yoke, or seat cushion.

5) TYPE V (Hybrid): These are inflatable PFDs, which allows more comfortable use for the user. These devices have become increasingly more popular for use among law enforcement agencies in recent years. When they are inflated, some newer models contain buoyancy that far exceeds the minimum requirements for a Type I. While some models can be inflated automatically or manually, others may only be inflated manually. Read the label for intended use.

NOTE: It is extremely important that users conduct proper maintenance and inspections on inflatable PFDs to ensure that they remain functional. After use, the inflatable PFD should be rearmed immediately.

Fire Extinguishers are an extremely important piece of equipment aboard any vessel. Law enforcement vessels, in particular, should be equipped with excess fire extinguishers, as they may be needed aboard agency vessels or other vessels in distress. Like PFDs, all fire extinguishers should have a Coast Guard approval number located on them. Additionally, they should be regularly inspected and maintained.

Fire extinguishers are classified by letters and roman numerals. The letter indicates the class or classes of fire that the extinguisher can effectively utilized to extinguish. The classes of fire are as follows:

1) Combustible material
2) Flammable liquid
3) Electrical components
4) Flammable metals

The Roman numeral represents the amount of extinguishing agent a fire extinguisher holds.

Types of extinguishers: The two types of extinguishers commonly accepted on vessels are dry chemical, and carbon dioxide (CO_2).

Dry Chemical- These extinguishers contain powder placed under pressure and are most effective on Class B fires. Those manufactured after June 1965 must have a visual or pressure gauge indicator. The gauge will indicate the charged propellant weight. False readings on the gauge will occur if the gauge cover is depressed against the needle. Mount dry chemical fire extinguishers horizontal. This position prevents packing of the powder.

Carbon Dioxide (CO_2) - These extinguishers contain pressurized gas and are most effective on class C fires.

NOTE: Some vessels may contain fixed halon systems installed for extinguishing fires. Halon is a gas that is toxic to humans. If on board, these systems will be installed in enclosed spaces. Users should be aware of the fact that they should not enter these spaces when halon has been activated.

Visual Distress Signals (VDS) should be carried on all law enforcement vessels. These devices, like all safety and emergency equipment, should be regularly inspected to ensure that they are not expired or damaged. In addition, they should be stored in a location that makes them readily accessible to the operator. VDS are generally designed for either day or night use, and both types should be carried onboard. When conducting operations at night, it is a good idea for the operator to carry VDS on his or her person.

Pyrotechnic devices: may be designed for day (orange smoke) or night (flares). Flares may be hand-held, meteor, or parachute type. Parachute types typically burn longer and are more likely to be seen.

Non-pyrotechnic devices: range from special flags to a variety of signaling lights.

Sound Producing Devices should be carried onboard every vessel. Law enforcement vessels typically have loud hailer systems installed on them that adequately meet the need of a sound producing device. However, it is recommended that vessels be equipped with additional sound producing devices in case the unit fails or the operator ends up in the water. Vessel operators should carry a whistle with them.

EPO #2: IDENTIFY ADDITIONAL SAFETY AND EMERGENCY EQUIPMENT TO BE CARRIED ON BOARD MARINE LAW ENFORCEMENT VESSELS

ADDITIONAL EQUIPMENT FOR SAFETY AND MISSION RESPONSE

Having the minimally required equipment, on board your patrol vessel, is just the beginning of a properly outfitted vessel. The enforcement vessel must be able to respond to its own safety needs as well to the missions assigned by its parent agency.

The Federal Law Enforcement Training Center's training vessels carry the following equipment. Some or all, of this equipment, will apply to your operational and safety needs.

Anchor and line - Have an appropriate size anchor with an adequate length of line and chain for your size vessel and the depth of water in your area of responsibility.

Tow line and bridle - Pre-made bridles and towline with quick release attachments will simplify most small craft towing needs. The size and length of the bridle and towline is governed by the size of the patrol vessel and the average distance of the tow.

Fenders - Two to three fenders will adequately protect a vessel mooring alongside a bulkhead, dock, or another vessel. Proper placement will insure the most protection. Use fenders to fend off object, not hands or feet.

Mooring lines - Have adequate number and line size to secure the vessel. Mooring lines are stowed aboard the patrol craft when underway. This allows mooring at other docks and provides lines for alongside towing.

Boat hook - A telescoping boat hook is recommended. The boat hook allows the operator to reach and remove objects from the water. In shallow water it can be used as a sounding pole.

Skiff kicker hook - This is a self-attaching hook attached to a towline. The hook is fitted into the bow eye of a disabled vessel. The skiff hook has an attachment fitted to a boat hook. This rig allows the operator to reach the bow eye without reaching over the side and between the vessels.

Paddle - A disabled small craft can be paddled for a short distance. Size of the vessel will dictate if paddling is an option. A law enforcement officer may find other reasons to silently propel his vessel in this manner.

Personal flotation devices - Carry additional PFDs in excess of personal use. Often the marine enforcement officers will encounter a recreational boater without any PFDs or insufficient PFDs. It will be necessary to provide PFDs for safety and provide escort to a safe mooring.

Bilge pumps - Electric bilge pumps provide ease of de-watering automatically. If electrical power is lost, manual pumps or bailing buckets always work.

Rescue line - A rescue line is thrown to a conscious person in the water. It has a padded throwing object attached to a floatable line. Use a rescue line to bring a victim alongside the rescue vessel.

Hand held light - Hand held lights will provide illumination for identifying objects during night operations. Smaller flashlights with red lenses are used for chart reading and other task directed inside your vessel. Remember that a white light will destroy your night vision capabilities.

Compass - This is standard equipment for any professional boater. Calibrate compasses at minimum annually. Marine enforcement work, especially accident investigation, will require accurate compass bearings.

Tool kit - A simple tool kit is all that is necessary to make adjustments or simple repairs.

Navigation kit - Charts and/or maps of the assigned area of responsibility and adjacent areas - simple navigation tools for bearing taking and measurement of coordinates and distances.

Ignition kill switch - A switch tethered to the operator, which will interrupt the ignition system. It will shut down the engines if the operator is thrown or knocked away from the helm controls. Kill switches are highly recommended, especially on single officer boats.

Radios - The need for an agency radio is obvious. A marine band VHF-FM radio is necessary to develop communications with the boating public and keeping abreast of the changing weather conditions. The marine band radio provides a link between you and other marine enforcement agencies.

Marine electronics - Refer to the "Marine Electronics" student handout provided with this course.

First aid kit - It is a necessity for your personal care, if injured, and first aid to victims, as a first responder. The size and the amount of equipment are according to departmental policies and personal first aid training.

DRAG DEVICES

A disabled vessel and the approach of heavy weather can spell disaster for a vessel at sea. The results and eventual outcome can be minimized by the proper use of a drag device. These devices are designed to maintain stability and reduce the drift a vessel. The use of sea anchors and drogues have been around a long time. There is evidence that early mariners dating back to 1200 AD used a form of sea anchor on their double ended voyaging canoes. This was done by attaching stone ground anchors to sennit (coconut fiber) ropes and lowering them from the bows of the canoe hulls. Today's sea anchors and drogues are manufactured to provide a parachute effect through the water. This will permit stability and the controlled movement of the vessel.

Testimonies from mariners that have found themselves in severe weather conditions reveal readiness and preparations are two of the most important considerations. It does not make sense to invest large sums of money in sea anchors and drogues and not be prepared to properly deploy them. Reading instructions on how to deploy a sea anchor or drogue in heavy weather may be impossible.

Sea anchor - A sea anchor is a large device deployed over the ***bow*** of a boat to hold the bow into the wind and the waves. The sea anchor has to be large enough to prevent the bow from falling off and allowing the boat to lie broadside to the waves. A boat riding to a sea anchor should have some leeward drift depending on the relative size of the sea anchor, the boat and the fury of the storm. A proper sea anchor deployed correctly will hold the backward drift under 1 to 2 knots. The sea anchor is used when a boat is disabled or to maintain a relatively safe position and attitude to the seas.

Sea anchor deployment - Deposit the sea anchor in its deployable storage bag along with the trip line, float line and float into the water off the windward side of a drifting vessel to avoid the possibility of line entanglement with underwater gear on the vessel. If control can be maintained of the vessel the sea anchor can be deployed over the stern, but the rode is still attached to the bow. The rudder should be secured amidships to prevent side force and possible breakage. Allow the boat to drift away from the parachute, paying out rode off the deck slowly, snubbing up occasionally to help the parachute open and rotate the bow of the boat into the wind. Continue paying out rode until the required length of rode is deployed.

The length of rode should be determined by wave duration. The sea anchor should be positioned to be in step with the vessel. This will eliminate unnecessary stress on the vessel and the rode. Make the line fast and install proper chafing gear.

Retrieval - To retrieve a parachute sea anchor, haul in on the trip line. The initial load may be heavy and require the use of a winch. Care should be exercised when hauling a trip line; these are normally smaller/weaker lines than the tow line. The weight of the water and the stress exerted by the sea condition could part the line and cause injury to the crew. An easier way to retrieve a sea anchor with a trip line is to secure the trip line and then ease out on the tow line. This will cause the sea anchor to collapse and can be hauled in by the trip line.

Drogue - A drogue is a smaller drag-producing device that is deployed over the ***stern*** of the vessel to slow its forward progress when running downwind and to hold the stern to the seas. The forward speed of a vessel towing a drogue will be considerably greater than the backward drift of a sea-anchored vessel. When using a drogue, rudder control must be maintained, this requires compatible speed to be preserved. This speed could be as high as 10 to 15 knots and never less than 3 knots.

PERSONNEL PROTECTIVE EQUIPMENT 29 CFR 1910.132

29 CFR 1910.132: States the employer is responsible for providing personnel with protective equipment for eyes, face, head and extremities; as well as protective clothing, respiratory devices, protective shield and barriers.

The marine enforcement officer's working environment is an inherently hazardous occupation. In addition to normal dangers involved in boating and law enforcement, the officer is continuously and directly exposed to the elements. Volumes of information have been written about exposure to ultraviolet rays, noise, and hypothermia. This information is continuously presented in journals, advertisements, and on the warning labels of the products we buy. There is no excuse for the marine enforcement officer to be without the necessary personal safety equipment.

The following is a list of safety equipment and supplies you may need to safely perform your job.

Footwear - Select shoes with non-skid and non-scuffing soles. Softer compounds with very narrow slits in the sole offer the best traction on wet decks. Unfortunately, this construction also wears out rapidly when worn ashore. The construction of this footwear must also allow for quick drying and be made of non-shrinking material. When the potential for foot injury exists, i.e., aboard fishing or trawling vessels, use a boot with similar sole construction and a steel toe insert. Boots do not let your feet breathe. Do not wear for extended periods.

Eye protection - Eye protection prevents a number of eye injuries. Goggles or sunglasses are used to prevent sand, spray or debris from entering the eye. They act as a windscreen preventing drying of the eye. Ultraviolet light, either direct or reflected, is the most dangerous element of daylight operation. The protective glasses selected for marine use should offer 100% UV protection and be impact resistant.

Hearing protection - Hearing protection is available in many forms. Exposure to loud engine noises and wind while operating your vessel creates fatigue.

Anti-exposure suits - A suit designed to combat hypothermia and provide floatation. If properly donned, this suit will greatly enhance the survival rate of its wearer. The Coast Guard requires the mandatory wearing of exposure suits, for its boat crews, when the water temperature lowers to sixty degrees.

Consider the type vessel you'll be operating. Consider the present and forecasted weather. Don an anti-exposure suit before you lose precious body heat. Your agency can provide you with the equipment, but if you do not use it, it will serve no purpose. Read labels and care for your personal protective clothing. Create Standard Operating Procedures. Define the conditions, which will dictate utilizing this specialized safety equipment.

Personal distress lights - A person in the water with an emergency light attached to a life jacket or anti-exposure suit will becomes more visible at night. A personal strobe light will give off an even higher intensity pulsating light.

Retro-reflective material for PFDs - Just like a distress light, the addition of retro-reflective material will make the wearer more visible in the water at night. Retro-reflective tape is installed front and back on the shoulder areas of a flotation device. This is not a requirement for PFDs used on recreational boats.

Signal mirrors - For daylight rescue the reflective mirror is most successful device for attracting attention. Keep this device affixed to your PFD or anti-exposure suit.

Whistles - Often your rescuer can't visually detect you. Whistles can audibly alert them to your position. Attach personal distress equipment to your personal flotation device.

NOTE: Safety equipment for the commercial fishing industry, port activity and other marine industry, is regulated and requires the additional devices such as retro-reflective tape and PFD lights. When the weather warrants it; the wearing of exposure or survival suits. The marine officer is a professional. Their duties require them to be in their boats during inclement weather. A reasonable standard of care obviously exceeds minimum requirements.

SUMMARY

Law Enforcement vessels, due to the nature of the working environment that they are operated in, must be equipped with adequate gear. It is the responsibility of the employer to provide employees with the proper gear. However, it is the responsibility of everyone on a boat crew to ensure that they and the vessel are properly outfitted prior to leaving the dock. This includes being proficient in the use of all gear and ensuring that it is properly maintained. Without the knowledge and experience no amount of money will keep you safe.

Several officers may operate the same vessel as you do. Before each patrol or sortie, thoroughly check the condition of the vessel, motor, and each piece of safety equipment. Create a maintenance schedule for taking care of your personal protective clothing and equipment. Know how to use each item and have them with you each time you get underway.

MINIMUM FEDERAL REQUIREMENTS FOR RECREATIONAL BOATS

Recreational vessels 65 feet and less in length are categorized into four classes. Each class of vessels has minimum equipment requirements. The larger the vessel, the greater the equipment requirement will be.

The four classes of vessels are:

1. **Class A:** Vessels under 16 feet in length.

2. **Class 1:** Vessels 16 feet to less than 26 feet.

3. **Class 2:** Vessels 26 feet to less than 40 feet.

4. **Class 3:** Vessels 40 feet to not more than 65 feet.

> **NOTE**: 46 CFR 24-26 describes equipment requirements for motor vessels greater than 65 feet.

Vessel lengths are often described in meters verses feet.

METRIC CONVERSION TABLE

200mm = 7.9 inches
300mm = 11.8 inches
1M = 3.3 feet

5M = 16.4 feet
8M = 26.2 feet
12M = 39.4 Feet
20M = 65.6 feet

In addition to overall length, construction is another consideration when determining the need for certain safety equipment.

Equipment meeting federal requirements, for marine application, is required to have Approval Numbers. The manufacturer is required to label that equipment with a Coast Guard approval number.

For a vessel to be in compliance with minimal federal requirements it must carry certain Coast Guard approved equipment. Sufficient quantities for all personnel will be carried and spares for possible rescues and/or arrest of suspects. Some equipment will be **READILY ACCESSIBLE**, (easily accessed), or some equipment must be **IMMEDIATELY AVAILABLE**, (within arms reach of the operator).

Legal Requirements for Personal Flotation Devices

When equipping your vessel, or inspecting the PFDs on a recreational boat, the following requirements must be met:

1. Coast Guard Approved. Approval No. 160.xxx

2. Correct size for the wearer.

3. Good condition and serviceable.

4. Readily accessible - Type I, II, III.

5. Immediately available - Type IV.

6. On boats less than 16 feet in length there must be one Type I, II, III, IV or V PFD for each person on board (POB).

7. On boats 16 feet in length and over there must be one Type I, II, III, or V PFD for each POB PLUS at least one Type IV.

> **NOTE:** Effective May 1, 1995, the Type IV PFD - - a flotation device that can be thrown to a person in the water can no longer be used as a substitute for a wearable flotation device. To meet the PFD requirements for recreational vessels under 16 feet in length, a wearable PFD is required for each person on board the vessel.

FIRE EXTINGUISHER (46 CFR 25.30)

An approved extinguisher is marked by the following method:

Marine Type U.S.C.G.
Type B: C Size I
USCG Approval Number 162.028
Valid only with bracket supplied by the manufacture

Legal Requirements for Fire Extinguishers

A recreational vessel's length and/or construction will determine the number and size of approved fire extinguisher it is required to have on board.

All recreational boats, which have compartments, wherein explosive or flammable gases or vapors can be trapped, require extinguishers.

A boat must carry the appropriate number and type of fire extinguishers when any of the following conditions exist:

1. It is carrying passengers for hire.

2. It is of a "Closed" construction.

3. The vessel has living spaces.

4. It has unsealed double-bottoms not completely filled with flotation.

5. It has permanently-installed fuel tanks. (A portable tank is permanent if it requires a tool to remove a restrictive device, or in your judgment it is too heavy to jettison.)

All recreational boats must carry at least the **MINIMUM** number of hand portable fire extinguishers required for its length.

1. Boats less than 16 ft. in length must carry one B-I extinguisher. If the boat has a fixed fire extinguisher system in the machinery space, no portable extinguisher is required.

2. Boats 16 ft. to less than 26 ft. in length must carry one B-I extinguisher. If the boat has a fixed fire extinguisher system in the machinery space, no portable extinguisher is required.

3. Boats 26 ft to less than 40 ft in length must carry two B-I fire extinguishers or one B-II fire extinguisher. If the boat has a fixed fire extinguishing system in the machinery space, one portable B-I fire extinguisher is still required.

4. Boats 40 ft to 65 ft in length must carry three B-I fire extinguishers. Or, carry the combination of one B-II and one B-I extinguishers. A vessel with a fixed fire extinguisher system in the machinery space is still required to carry portable fire extinguishers equivalent to one B-II or two B-I.

Like any other piece of safety equipment, not only is there a requirement to have an extinguisher on board; there is a requirement which determines if it is acceptable for use. In order for an extinguisher to be acceptable, it must be:

1. Readily accessible and installed in a bracket.

2. Good condition and serviceable.

3. Coast Guard Approval Number 162.XXX

Dry Chemical extinguishers are required to have a 6 month valid inspection tag.

A valid 12 months or less inspection tag is required for **halon systems**. A professional performs maintenance on this extinguisher.

NOTE: 46 CFR 25.30-20(a) Recreational boats, less than 26 feet in length, propelled by outboard motors, and not carrying passengers for hire, need not carry portable fire extinguisher. This applies only if the construction of such recreational boats will not permit the entrapment of explosive or flammable gases or vapors.

Backfire Flame Arrester (46 CFR 25.35)

All recreational vessels, using gasoline for fuel, must be equipped with an acceptable backfire control. Outboards are exempt. Outboard engines are mounted outside the transom and open to the atmosphere.

There are three types of backfire flame controls. The most commonly used device is the backfire flame arrester. The only purpose of a flame arrester is to suppress (cools) flames. According to basic fire fighting theories, there can be no fire without heat. In order for a flame arrester to perform the function of cooling flames, it must be constructed of metal that has the capability of absorbing heat as the flame passes through. The two most commonly used arresters have a fine wire mesh, of soft non-ferrous metal, construction. For a backfire flame arrester to be acceptable it must be:

1. In good condition and serviceable.

2. Have a Coast Guard Approval Number # 162.041.

3. Securely mounted to the carburetor.

Ventilation (33 CFR 175.201)

The Motor Boat Act of 1940 established ventilation criteria and responsibilities. The operator must maintain the system as designed. The manufacturer must construct and install ventilation in accordance to standards.

All vessels having engines for propulsion, generators, or mechanical power, and use gasoline for fuel; must ventilate enclosed engine and fuel tank compartments.

An enclosed compartment is any compartment, which has less than 15 square inches of opening, per cubic foot of compartment space. Compartments with fuel tanks made of non-permeable material with natural vents to the outside of the vessel are exempt.

Legal Requirements for Ventilation

Boats built after April 25, 1940, and before August 1, 1980, require natural ventilation to the fuel and engine compartments. There shall be at least one intake and one exhaust duct. Each properly installed atmosphere and extended to the mid and lower levels of the bilge respectively.

Boats built after August 1, 1980, require natural ventilation in fuel and engine compartments (As previously described). In addition to natural ventilation, inboard gasoline engines must have a mechanical powered blower system to provide a positive means of exhausting vapors. This system is separate from the natural ventilation system and the mechanical blower must be of a non-sparking type.

1. Acceptability requirements.

    a. Good condition and serviceable.

    b. Ducts must have a two-inch minimum diameter.

    c. Sealed mechanical blowers are used to prevent sparking.

    d. Intake hoses must extend below the carburetor.

    e. Discharge hose must extend to the lower 1/3 of bilge. It cannot be so low in the bilge that accumulated water blocks the opening.

f. Cowls must be properly faced, separated to prevent recirculation of fumes, and have an opening of three square inches.

Visual Distress Signals (33 CFR 175.110)

All boats, of any type, 16 feet or more in length; and all craft of any size carrying six of fewer passengers for hire, must be equipped with approved visual distress signals. This requirement is in effect at all times when operating on coastal waters and the high seas.

> **NOTE:** Coastal waters are defined as the U.S. waters of the Great Lakes, territorial seas (out to three miles) plus connected waters to a point where the waters are less than two miles wide.

Boats less than 16 feet in length must carry signals suitable for night use when operating on coastal waters between sunset and sunrise.

Legal Requirements for Visual Distress Signals

All visual distress pyrotechnic signals must be Coast Guard approved, and legibly marked with an approval number. Distress signals for boats will have the approval number **U.S.C.G. No. 160.066**. An expiration date, 42 months after manufacture, must also appear on the signal.

Some signals require use in combination with a suitable launching device, approved under 46 CFR 160.028. Some states consider a pistol launcher a firearm, and may be subject to licensing and other restrictions.
The Coast Guard certifies non-pyrotechnic devices such as, distress signal flag or an electric light, which continuously emits an "**SOS**" signal. **C.G. Certified 160.xxx**.

Acceptability requirements:

a. Must be readily accessible.

b. Must be in good condition and serviceable.

c. Devices suitable for day, night, or day and night use; must be on board and of the number required.

   1) **Non-pyrotechnic type-** required to have one day and one night device on board.

   2) **Pyrotechnic type-** required to have either: three day (orange smoke), and three night (flares), or three day/night parachute flares.

3) **Any combination of-** three pyrotechnics and one non-pyrotechnic device are acceptable, i.e., one day SOS FLAG and three night hand held flares.

SOUND PRODUCING DEVICES: (33 USC 2033/COLREGS RULE 33)

The Inland Rules of the Road Rule 33 states a vessel of 12 meters or more in length shall have a whistle and a bell. A vessel of less than 12 meters in length shall not be obliged to carry the sound signaling appliances prescribed, in this rule, but if it does not, it shall be provided with some other means of making an efficient sound signal.

For vessels less than 12 meters, an efficient sound signal is defined as a device that can produce a four to six second blast, i.e. a police whistle. Vessels less than 12 meters in length are still bound by Rule 33 to sound the appropriate signals as required.

Acceptability requirements:

a. A vessel less than 12 meters must have some means of making an efficient sound signal.

b. A vessel 12 meters to less than 20 meters will carry a bell and a whistle, which is audible for 1/2 mile.

c. A vessel 20 meters to less than 75 meters will have a bell and a whistle, which is audible for 1 mile.

U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

Homeland Security

STUDENT TEXT

PREVENTIVE MAINTENANCE

7520	APR/11

INTRODUCTION

The law enforcement officer must be able to depend on his/her patrol vessel, not only for normal patrol, but also, also for immediate response to call-outs and emergencies, at a moments notice. The vessel must also be able to return the officer safely to base at the end of the patrol. What many boat operators are failing to understand is the unforgiving marine environment and its' effects on the vessel. A law enforcement vessel is susceptible to both electrical and mechanical problems when exposed to these conditions. The problems may be minor but they can be a nuisance and affect the vessel's working ability.

1. The constant pounding of a vessel can cause wires to break or become frayed.
2. Nuts, bolts, and screws become loose. Vibration causes wires to chafe through.
3. Salt spray causes corrosion that affects wiring, battery cables, and other marine components.
4. Hoses deteriorate, sparkplugs become fouled, carburetors and filters become contaminated with water and debris.

There are simple preventive maintenance practices that can keep the vessel ready for use. A poorly maintained vessel is not dependable and has a shorter service life expectancy. An operator should be able to diagnose minor mechanical and electrical problems and take the necessary steps to correct them.

The reading assignment for this course includes this handout. In addition, read the sections on electrical and mechanical problems in <u>Chapman's</u>.

ENABLING PERFORMANCE OBJECTIVES (EPO):

EPO #1 Identify the three major component groups and major parts of an outboard engine. P2

EPO #2 Identify the methods used for proper preventive maintenance of an outboard engine. P4

EPO #3 Identify and demonstrate the ability to perform pre and post operation checks of an assigned vessel. P9

EPO #1 Identify the three major component groups and major parts of an outboard engine
OUTBOARD ENGINES:

For ease of service and engineering, outboard engines are divided, by the manufacturer, into three major component groups:

1. Power head: Includes engine, ignition system, carburetors/fuel injection, fuel system, lubrication system, and controls.

2. Center Section: Houses the drive shaft, shift shaft, and various transfer tubes for cooling and exhaust. It also has the mounting bracket, the steering bracket, and the power trim unit.

3. Lower Unit: contains the forward and reverse gears, the gear oil, water pump, the drive shaft, propeller shaft and propeller, and the sacrificial anodes.

Each of these component groups must be matched with each other to function properly on a boat.

<u>POWER HEAD</u>:

Until recently, the most common outboard engines were of the two-stroke design. But, due to increasingly strict environmental regulations four-stroke engines, in the higher horsepower range, are becoming more popular. There will be a lot of change in designs over the next decade. Even the two-stroke engines are significantly different from previous engines. They are much more fuel, and environmentally, efficient. Unlike a four-stroke engine that has a crankcase for the oil the two-stroke outboard engine gets it's lubrication from a fuel/oil mixture. Two-stroke engines produce power on every descending movement of the piston. Four-stroke engines only produce power on every other downward stroke. Two-strokes have 1/2 to 1/3 the moving parts of a four-stroke engine with a similar number of cylinders.

Without getting into too many details, the reason outboards have traditionally been two-stroke powered is that they are lighter, more compact, and more powerful at a high RPM range than a comparably sized four-stroke engine. Most planing hull boats require the engine to turn at high rpm's to maintain planing speed. In the past, two-stroke engines were more fuel consumptive and produced less torque at lower RPM's than a comparably sized four-stroke. They also often had a shorter service life expectancy, which was primarily attributable to poor maintenance, owner ignorance, and infrequent use. As marine law enforcement operators our jobs, and maybe our lives, depend on keeping our outboards operational.

<u>Ignition:</u>

Ignition on an outboard is generated and controlled by a rotor and stator located under the flywheel at the top of the power head. As magnets in the flywheel pass copper windings wrapped around iron bars (an electrical armature), electricity is made in a similar manner to the alternator in your car. On older engines, the electricity is routed through a series of electrical switches called a power pack. The power pack directs the electricity to the spark plugs, performing the same function as the distributor in your car. On late model engines the electricity is routed a computer similar to the electrical system on a late model fuel injected car. Some of the electricity is directed to other functions such as charging batteries and running gauges. With the exception of changing plugs and checking wires for breaks and positive connections, the outboard ignition system is not commonly serviced in the field.

Fuel Systems:

In the past, most outboard engines had carburetors and a set of reed valves. The reed valves act as one-way doors, letting fuel pass from the carburetor into the outboard crankcase but not back through the carburetor. An outboard that is back firing, may need reed valve replacement.

Currently, most of the larger outboards use electronic fuel injection to meter and deliver fuel to the cylinders.

Unless the engine is operated regularly, fuel systems may gum up, closing tiny but critical air and fuel orifices. There are fuel additives that delay fuel gumming and prevent gaskets from drying out. Additives are effective if the boat is going to sit idle for prolonged periods.

Fuel flows through rubber fuel lines to an engine mounted fuel pump or to a combined fuel/oil pump. Rubber fuel lines should be checked for cracks and replaced on a regular servicing schedule.

Lubrication Systems:

Early two-stroke engines used oil mixed in prescribed proportions directly into the gasoline. This was, and remains a very effective way to ensure proper lubrication for a two-stroke outboard. Unlike engines in cars, two-stroke outboards rely on oil mixed with gas for all power head lubrication. For convenience and economy, most outboard manufacturers now equip outboards with automatic oiling pumps commonly called VRO's (variable ratio oiler). VRO's meter oil into the gas stream at a ratio of about 100 parts of gas to 1 part of oil at idle and at about 50 to 1 at speed. Oil is pumped from a reservoir tank into the fuel system and then mixed with the gas.

Four-stroke engines have a crankcase similar to a car that contains the lubrication oil. A dipstick is used to check the oil level on a four-stroke engine.

CENTER SECTION:

The center section can be defined as the portion of the outboard between the power head and the lower unit. It is an engine mounting point where the brackets and steering heads connect. It also contains the power trim/tilt unit.

The center section has tubes inside it for transfer of exhaust and water along with a space for the drive shaft to pass through. The length of the center section is determined by the intended use of the boat. A 200 hp outboard mounted on a racing hull might only have a 15" center section. The same engine intended for use on an ocean going sport fisherman might have a 30" center section. With the exception of mounting brackets, steering heads, and power trim, there are no moving parts in the center section.

LOWER UNIT:

The lower unit (also called a foot) is the drive unit of an outboard. The drive shaft, forward and reverse gears, gear oil, and water pump, propeller shaft, propeller and sacrificial anodes are housed in the lower unit. With the exception of changing lubricants, the water pump impeller, the propeller, and sacrificial anodes, the lower unit is not serviceable in the field. Lower unit components are responsible for a large percentage of outboard engine failures. In spite of their apparent simplicity, careful maintenance of the lower unit is the only way to prevent related catastrophic failures.

EPO #2 Identify the methods used for proper preventive maintenance of an outboard engine.

PREVENTIVE MAINTENANCE:

Regular preventive maintenance should be scheduled in accordance with the manufacturer's recommendations. Yamaha recommends replacement of the lower unit gear lube every 100 hours or every six months. Water pump impellers should be replaced every 200 hours or annually, whichever comes first and more often when the engine is operated in shallow areas consisting of sand or mud. Water pump kits commonly cost around $70.00. That is cheap insurance when compared to a $4000.00 power head.

The first step in a good preventive maintenance program is to **READ THE OWNER'S MANUAL.** This is often overlooked by novices. Owner's manuals contain important information specific to each engine. It will contain important break in procedures. These are critical to the longevity of the power head and lower unit. Owner's manuals also contain fuel/oil mixture ratios and a service schedule that should be adhered to. Power head or lower unit failures are expensive. One of the main reasons for outboard engine repairs is simple neglect of maintenance. Other servicing information such as changing lower unit lube, replacing water pump impellers, and replacing hoses is equally useful in reducing down time and repair costs.

GETTING BACK TO THE DOCK

It seems like most boat breakdowns occur at the farthest possible point away from homeport. Many times, there is nothing to do but call (or wait) for help. The following are common failures with engines and suggestions on how to get the boat back to the dock.

Outboards (and I/O's) often 'spin' propellers. The prop has a rubber sleeve inside the hub that is supposed to give when the engine strikes an underwater object. Often, for no discernable reason, the prop will suddenly start to spin freely around the hub. The engine will rev wildly and the boat will come off plane. The boat can often be nursed back to the dock at idle speed to keep the prop from freewheeling. Remember, every time the prop freewheels around the hub there is less and less material left grabbing inside the hub of the prop and eventually the prop will freewheel even at idle speed, so go slow when this happens.

If the boat acts like there is a spun prop, turn the **engine off** and trim the engine up. Try to rotate the prop by hand with the engine in gear. If the prop turns by hand, try to watch the shaft inside the prop to see if it is turning, too. If the prop shaft also turns, suspect a broken drive shaft. Trim the engine down and start the boat. Check the telltale stream. If there is no telltale and the boat acts as if it has a spun prop, shut the engine down; the drive shaft is broken. The drive shaft turns the water pump impeller and if the engine is operated for more than a few seconds, especially when the engine is hot, it will seize the power head.

Power trim units occasionally will malfunction while trimmed or tilted up. The engine must be returned or lowered into the water before it can be used. All current trim units have an emergency relief valve on the trim unit. Locate the relief valve on the trim unit and with the use of the proper wrench or screwdriver to open the relief valve. This action will allow the engine to return to the run position.

A two-stroke engine has an oil alarm that sounds when the VRO oil level is low or the VRO system is malfunctioning. If alerted, bring the engine down immediately and switch it off. Check the VRO tank to see if there is adequate oil. Add oil to the remote tank if needed. If there is adequate oil, check for cracks in the tank or for water in the bottom of the oil reservoir. Also, check for cracks in the oil lines. If the tank is out of oil or no there is no obvious quick fix, continued operation of the engine, without oil, could cause the bearings or pistons in the power head to seize. A solution would be to, either, use spare oil that is on board or use the oil in the reservoir and mix it with the gasoline in the fuel tank. Try to calculate the oil mixture at a ratio of 50:1. That is fifty parts fuel to one part oil.

Water pumps are the hearts of outboard engines. If circulation fails, your engine will overheat and die. If it fails, stop the vessel and check to see if water is streaming from the telltale on the engine. If there is no telltale water, run a piece of wire up the telltale tube. If wire is not available, a paperclip will usually work to dislodge debris. If the telltale starts streaming water, it's OK. If not, look at the above water exhaust port, while the engine is idling, to see if there is any water being discharged from the port. If water is observed then it could be a defective alarm. If not then, shut the engine down, trim the engine up, and check for an obstruction of the water intake. If it is determined that the engine is actually overheating, then shut it down and call for assistance. Continued use could ruin an expensive power head. Many of the newer outboards have an overheat protection circuit built into their computer controls. If the engine starts to overheat, the engine will automatically shut down half its cylinders. The effective RPM limit will be around 2500 rpm's. This is allows the vessel to return to a safe mooring without further damage to the engine. If attempts to cool the engine are successful, shut the engine off to allow the computer to reset itself. The will allow the engine to function normally again. Many of the newer engines have smart gauges that will display water pump pressure. Check the gauge to determine if there is sufficient pressure.

It is a fallacy that engine temperature can be determined by touching the water being emitted from the telltale stream. The telltale water may or may not have circulated through the block. It depends on the type and model of engine. Don't try to second-guess overheat alarms by feeling telltale temperature.

There are two separate systems in a boat's electrical system. They are the engine electrical system, and the electrical support, or house, system. When troubleshooting either system, always start with the likeliest possible cause and work toward the least likely.

Corroded battery cables or a weak battery may cause low voltage. Check the cable ends and clean or recharge the battery if necessary.

The engine electrical system has all the parts for starting, running, and stopping the engines. It also has the generator/alternator that charges the batteries. If the gauges seem to be functioning normally and the tachometer suddenly fails, suspect a blown stator. This circuit charges the battery(s) and runs the tachometer and engine computer. If the battery power is drained below nine volts, the engine will not run. Turn off all of the electronics and head for the dock at a comfortable speed. Too slow may run the battery out of juice before reaching the destination, too fast requires too much power from the battery to jump a spark across the increased resistance of the sparkplugs.

The starting circuit is a source of potential wiring problems.

The starting system includes:

1. The battery (source).

2. The starter motor (load).
3. The starter solenoid.
4. Any neutral start or kill switches.
5. The ignition switch.

If the starter switch is activated and the starter does not engage, follow these steps:

1. When troubleshooting the starting system one of the first things to check is also the easiest to check. Make sure that the engine shift mechanism is in the neutral position. To check it, turn the key to the start position and move the lever in both directions through the neutral position. If the engine does not start move to next likely possible cause and work toward the least likely cause:

2. Check the fuses located under the cowling on the power head.

3. Check the battery. If discharged, charge the battery. Check the cables for loose or corroded connections. Clean or tighten as needed.

4. Turn the ignition switch to the start position and listen for the distinctive click a solenoid makes when it is working properly. If there is no click, check the wiring from the ignition switch to the ignition solenoid for possible broken wiring. Also, if there is no click, the solenoid may need replacing. If there is a click of the solenoid, troubleshoot it by using a jumper cable to bridge over the solenoid.

5. If the engine turns but will not fire, check the ignition safety/kill switch. Assure that the kill switch is on run position. If it still will not start check both sides of the switch for continuity with a circuit tester or multi-meter. The tester will verify if the switch is good.

NOTE: The safety switches may be bypassed in an emergency. However, they are safety switches and bypassing them could lead to an accident. Have them replaced as quickly as possible.

If a defective starter switch is suspected, check all connections for tightness. Also, check the ignition wiring harness from the switch to the engine. If a broken wire is found, an emergency repair can be made by twisting the ends of the wire together and taping them tightly with electrical tape. Always, cover any bare wire or connection exposed to moisture with tape. Remember to have the wire properly repaired as soon as possible.

Occasionally an ignition switch will go BAD due to age or water intrusion. On a pre 2000 outboard motor that is carbureted (not fuel injected) disconnect the wiring harness at the engine and then jump across the starter solenoid. If the motor runs, the problem is in the wiring harness between the engine and the helm station.

Late model outboard engines have a solid-state electronic ignition system that consists of a series of diodes and rectifiers. It also has a magnetic pick up and a trigger (or a light source and photocell) and a capacitive discharge unit. The newest engines are controlled by a computer. These electronic ignition systems are sealed units. They are very reliable units but, when they malfunction they must be replaced. The basic principle of an electronic ignition system is the same as for any ignition system.

The ignition system includes:

1. The battery (source).

2. The ignition switch.
3. Any neutral safety and kill switches.
4. The stator
5. The coils.
6. The spark plug wires and spark plugs (load).
7. And a capacitive discharge (CD) unit.
8. Most of the newer engines are controlled by computers.

To troubleshoot the ignition system, use the following steps:

1. The newer engines must have a minimum of 9 volts of battery power for the computer to operate.

2. If the engine is miss firing on one or more cylinders check for adequate spark. First, pull off a spark plug lead from the spark plug. Hold the lead (with insulated pliers) about 3/16th of an inch from a good ground. When the starter is engaged, a good spark should be visible at regular intervals. To make sure the problem is not just one bad spark plug wire, do this with at least two leads. If the spark is good, check for burned or fouled spark plugs and replace if needed. If there is not a spark at the plug wire, have the engine checked by a trained marine technician. Only a trained technician should repair electronic parts of the ignition system.

3. Next, visually inspect the ignition system. Check all primary and secondary circuit wiring for bad connections, frayed insulation or grounds. Tighten or replace any defective parts, as needed

BE CAREFUL! There are very high voltages present in an electronic ignition system and make sure the boat's bilges are free of gasoline fumes before performing the spark test.

The Charging System

The charging system includes those parts that recharge the battery. Without it, the battery would eventually lose its charge. The charging system includes:

1. The battery.
2. The alternator
3. The regulator.

To troubleshoot the charging system, try the following steps:

1. Check the battery first. Check the battery's ampere-hour rating. It should at least have the amperage recommended in the owner's manual. Look for loose or corroded connections at the terminals. Clean corroded terminals with soda or soda ash and a wire brush. Test the battery's condition with a voltmeter. Put the meter's test leads on the battery posts and crank the engine for 15 seconds. If the voltage stays higher than 9.6 volts, the battery is, most likely, in good condition. Use a hydrometer to test the specific gravity of each cell in the battery.

2. Check the alternator (generator). The alternator's mounts may be loose or cracked. Tighten if possible. Check the alternator belt's tension it may be loose. Replace any broken or badly frayed belts. A voltmeter can test the alternator's output.

3. Check the wiring.

The electrical support system includes all the electrical units excluding those in the engine electrical system. These might include bilge pumps, blowers, navigation lights, cabin lights, horn, radios, radar, LORAN-C, GPS Fathometer, etc. Here are some basic rules of thumb for troubleshooting basic marine direct current systems.

Bilge Pumps and Blowers

1. With the switch closed (on), check for voltage at the output lead of the switch. If there is good voltage, go on to step two.
2. Go to the positive side of the unit (motor). Read from this lead to a good ground with the switch closed (on). If there is no voltage, check the wiring between the switch and the unit.
3. If there is good voltage in step two, disconnect the output or ground lead. Check voltage between it and a good ground. If there is no voltage, the unit is bad. Repair or replace.

Electronics

1. First, check for voltage input at the fuse.
2. If there is voltage at the fuse then check for voltage at the electronic device. If there is good voltage, go on to step three.
3. Go to the negative side of the unit and check for continuity to the ground. If there is a good ground then the device is bad. Repair or replace.

Horn

1. First, check for voltage input at the horn with the switch closed (on).
2. If there is no voltage in step 1, go to the switch. If you have good voltage at the switch, disconnect the output lead. Check for voltage between the output and a good ground. If there is good voltage, the horn is bad. If there is no voltage, there is a bad ground or the horn is bad.

Lights

1. With the switch turned on for a particular light, remove the bulb. Check for voltage between the two terminals in the socket.
2. If there is no voltage in step one, check the switch, fuse, and wiring to the light. If there is good voltage in step one. Check the bulb by trying it in a socket that works.

If the engine does not start or quits running, look for fuel problems. Check the fuel level. **Never trust the electric fuel gauge on a boat**. Often an engine will seem to pick up speed and power shortly before it runs out of fuel as it leans the fuel/air mixture. Pump the priming bulb to check if it gets firm, indicating fuel in the line. If the bulb does not “pump up” and stay pumped, after a few squeezes, suspect a bad check valve in the priming bulb.

Open the fill cap(s) on the fuel tank(s). If the tank draws air in when the cap is loosened, the air vent to the tank is clogged creating a vacuum in the fuel tank. Check fuel connections at the engine. On outboards with a plug-in type fuel line, use something (pen, knife, or paperclip) to depress the check ball in the tank side fitting while squeezing the primer bulb. Gas should shoot out when the bulb is squeezed.

Water in the gas will cause an engine to die similarly to fuel starvation. If a fuel/water separator filter is installed, in the fuel system, remove the filter and pour its contents into a clear glass container. If water is present, it will settle to the bottom of the glass. The act of emptying the filter and replacing it will correct the problem.

Steering problems occasionally arise. If the steering system completely fails and there is no steering oil on board, a boat hook or oar and a dock line can be used to fabricate a tiller arm to the engine.

Note: Use caution and maintain minimum speeds to prevent accidents when using this method.

Power head failures are common. While neglect or ignorance is one of the causes of failures, outboard engines simply do not last as long as most automobile engines. As discussed earlier though, many failures can be averted by preventive maintenance.

Know the alarm signals of the engine and make sure the mechanic has the alarms functioning. They are the early warning systems against overheating or inadequate oil flow. If an alarm goes off, come down on the throttle(s) immediately and troubleshoot the cause.

EPO #3 Identify and demonstrate the ability to perform pre and post operation checks of an assigned vessel

Pre operation inspection:

Effective preventive maintenance starts with the operator. A checklist should be completed prior to every underway day. Inspect the battery connections to make sure they are tight and not corroded. Gas and oil fluid levels should be checked. (Tip; Don't Trust Electrical Fuel Gauges on boats) Inspection of the VRO tank is very important, not just for oil but for cracks in the tank. Cracks can lead to water entering the VRO tank and settling on the bottom where it will be siphoned into the engine. Some outboards (notably Mercury) require the VRO tank to be air tight to feed oil. Cracks in the tank can lead to engine failure. Spark plug wires should be checked for cracking and positive connections. All fuel and oil lines should be inspected for cracks. A crack in an oil line where air can enter the system may result in a seized engine. Look in the bottom of the engine cowling for signs of oil, gas, or water. Turn the steering wheel and watch the engine(s) to make sure they move easily from full stop to stop. It's a good idea to regularly start the engine with the cowling removed. This will allow any undesirable noises to be heard more easily and to see leaks, loose components, or arcing sparks.

Trim the engine up and inspect the lower unit. A bent prop can quickly result in a trashed lower unit. Wiggle the prop back and forth on the prop shaft. There should be a little play but not a lot of slop. Look around where the prop meets the lower unit casing for fishing line. Line wrapped around the prop shaft can cut through seals and allow water to enter the lower unit. Many departments that patrol areas that have high recreational fishing require the operator to remove the prop to check for fishing line around the shaft. This is also a good idea because it ensures the prop will be easily removed if it has to be repaired or replaced. Do Not Force the engine into gear when it is not running unless the prop shaft is being turned while being shifted. Shifting without the prop turning can result in damage to the shifting mechanism.

Buy good gas, use good oil, and run the boat regularly. Running the boat regularly keeps seals and gaskets moist. It keeps fresh gas flushing through the motor. Regular operation also combats corrosion and water buildup in the fuel.

Perhaps even more detrimental to an outboard is the use of **old** fuel. Gasoline that has been stored for a long time loses many of its 'good' chemicals. Old gas burns irregularly and can build up deposits in the engine. Old gas can clog fuel passages in carburetors or injector systems. Bad gas can usually be detected by odor; it smells stale. Bad or old gas can cause a melted piston in an outboard in only a few minutes.

Just as important as using good quality gas, is using good quality oil. Whether using a two-stroke engine or a four-stroke engine always use the appropriate oil. Check the owner's manual to assure the oil meets or exceeds the manufacturer's specifications.

Keep the engine clean and lubricated on the outside with a moisture displacing lubricant like LDS or one of the corrosion guards sold by marine dealers. Replace wires, hoses, and water pump impellers regularly.

Fuel hoses should be inspected closely at least annually. It will be a benefit to visually inspect the fuel lines during every pre-inspection period before vessel operation. Check for cracks and for loose fittings. Ultra-violet rays from exposure to the sun deteriorate fuel lines. Alcohol in gasoline will deteriorate the inside of fuel lines. Make sure all fuel lines on the boat meet U.S. Coast Guard approval standards. USCG approved lines are safer, they will last longer, and it's the law.

Fuel filters should be serviced on a regular basis. Change filters at least annually. More often if fuel contamination is detected. If fuel filter fills with water the engine will not perform as it should. In an emergency the filter should be removed from its' bracket and the water poured out of the filter. Replace the filter if there is a spare on board the boat.

Follow other manufacturer's recommendations on lubrication and spray the engine(s) regularly with a rust inhibitor. This will help keep corrosion and moisture to a minimum and could help minimize repair cost.

Another area that needs inspection on the vessel is the steering cable, or the hydraulic steering system, if so equipped.

To check cable steering, turn the steering wheel from lock to lock to see if there is any tightness or binding. If there is tightness, lubricate the steering cable at both the engine and under the console. If lubrication does not free up the steering then have the cable replaced.

To check hydraulic steering turn the steering wheel from hard over to hard over watch the movement of the engine. If the engine does not respond appropriately check the fluid level in the hydraulic system and refill if necessary. After refilling the system check for oil leaks. If the engine still does respond like it should after adding oil then bleed the system according to the manufactures instructions to remove air.

At the completion of a patrol perform a post inspection of the vessel. Record the ending hour meter readings and document any problems with the boat. If repairs need to be made make sure that the information is given to the appropriate authority.

Simple economics dictate outboard preventive maintenance. Consider that a large outboard costs as much as a small new car. Even small outboards start in the four-figure range. Repairs to outboards are going to be, as, or more expensive than comparable repairs to an automobile. Combine these costs with the rule of thumb that an outboard engine's operating life is only a fraction of the life of a car only enhances the importance of getting the utmost endurance out of the engine.

SUMMARY

The ability to troubleshoot and make a quick repair can keep a boat operational when needed. In marine law enforcement, one can be called out at any time and a mechanic can rarely be called in the middle of the night. Knowing the common problems and the procedures to correct them are two of the skills a boat operator must possess. Electrical system and mechanical problems could cost the mission and often these problems are simple to correct with basic tools and knowledge of how they operate.

U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

Homeland Security

STUDENT TEXT

VESSEL HANDLING	
7521	NOV/2012

~~WARNING~~

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DESCRIPTION:

The knowledge requirements and performance skills for vessel operators are extensive. Vessel operators must apply good judgment, intelligence, and initiative. They must make decisions with the safety of their crew and vessel in mind. In addition to basic crew member skills, a vessel operator requires the additional knowledge and performance skills delineated in this course. Through lecture with discussion and laboratory exercises, they will gain a thorough knowledge of the handling characteristics of different types of vessels. The student will learn how varying weather and sea conditions will affect vessel operation. The student will become keenly aware of the limitations imposed by weather and sea conditions.

TERMINAL PERFORMANCE OBJECTIVE (TPO):

Given scenarios and exercises requiring students to handle marine law enforcement vessels, the student will identify factors and fundamentals affecting vessel handling under different environmental conditions and demonstrate docking procedures in accordance with marine industry standards and naval practices.

ENABLING PERFORMANCE OBJECTIVES (EPO):

INTRODUCTION

The knowledge requirements and performance skills for boat operators are extensive. Boat operators must apply good judgment, intelligence, and initiative. They must make decisions with the safety of their crew and boat in mind. In addition to basic crew member skills, a boat operator requires the additional knowledge and performance skills delineated in this course. Through lecture with discussion and laboratory exercises, they will gain a thorough knowledge of the handling characteristics of different types of vessels. They will learn how varying weather and sea conditions affect the operation of not just their vessel, but also they will become keenly aware of the limitations that the weather and sea impose on other vessels.

Marine law enforcement officers should be boating professionals. It is important for us to understand the "why's and how's" of our vessel's handling and performance characteristics. Knowledge of how our vessels respond to steering and power input will make us safer, more effective marine enforcement officers and aid us in marine related enforcement and investigations. Working familiarity with the capabilities and limitations of our vessels will increase our effectiveness on the water. Equally as important, this knowledge may improve our vessel handling skills and increase the public's perception of us as experienced vessel handlers.

The student will be able to identify the handling characteristics of different small craft hulls. The student will be able to identify the proper techniques for getting underway, bringing a planing hull vessel onto plane, setting the controls for prevalent sea conditions, and operating a small craft during close quarter maneuvers.

Throughout this lesson plan the word boat and vessel shall be used interchangeably.

EPO #1: IDENTIFY THE FACTORS THAT AFFECT VESSEL HANDLING

HULL DESIGN

Displacement Hulls-All hulls are displacement hulls when they are at rest or are moving slowly. A displacement hull pushes water aside as it cruises. It goes through the water and is limited in its speed by design.

Hulls operating in the displacement mode are more fuel efficient than planing hulls. A displacement hull takes longer to stop than a planing hull. The displacement hull's inertia through the water contributes to the vessel's fuel efficiency and its slow stopping characteristics. At rest and slow speeds, (while vessel is operated behind its bow wave) the planing hull acts as a displacement hull, displacing the water around itself.

HULL SPEED

Hull speed is defined as the maximum speed a hull can achieve without trying to lift onto plane. This speed coincides with a point where the hull makes a wave as long as its waterline length. When a hull tries to exceed this speed, it literally starts cruising "uphill" as the boat tries to rise over its bow wave.

The formula for determining hull speed is Hull Speed = 1.34 X the square root of the length at the water line.

For example, your patrol boat is 25' at the water line. The square root of 25 is 5. 5 X 1.34 = 6.7 knots hull speed.

While hull speed limits the maximum economical operation of patrol sized craft to relatively low speeds, the mathematics work out to allow a ship of 1000' feet run almost 50 mph relatively economically without overrunning the bow wave.

The planing hull reacts the same as a displacement hull when –off plane. Both require limited power to produce a small increase in speed. With considerable power added the external forces acting on the shape of the hull cause the bow to climb over the bow wave lifting the hull up onto the surface of the water. The planing hull lifts out of the surface of the water whereas the displacement hull always forces water around it. Once "on top," the power/speed ratio is considerably altered as less power increase results in greater speeds. Because the engines will face “maximum” load during this transition onto plane aggressive throttling will be required momentarily. Most planing hulls will accept slight increases of throttle, above idle, before the bow begins rising onto the bow wave. This is the point where maximum acceleration is applied. An example of properly planing a vee hull is:

- Idle = 4 kts @ 600 RPMs
- Increased throttle to "hull speed" of 8 kts @ 1200 RPMs
- Apply maximum throttle until the hull is fully planed.
- Reduce throttles to desired RPMs and adjust trim. (Drives and flaps)

Planing hulls use hull design and an abundance of power to 'lift' the boat up as power is applied. The hull exposes less wetted surface as speed is increased. In radical examples, such as racing boats the wetted surface is eventually reduced to a few square inches. Some deep vee designs employ a "pad keel" providing a small flattened area at the rear of the keel line for this purpose.

Planing hulls must have enough power to climb over the wave of water that is pushed in front of the boat; the bow wave.

- Displacement hull vessels ride behind their bow wave.
- As power is applied in a planing hull vessel, the bow starts to rise as the leading wetted area of the vessel climbs over the bow wave.
- Power must be continuously applied to keep the planing hull vessel "on top". For this reason, planing hulls are considered high fuel consumers.

When attempting to conserve fuel or during engine failure of one or more engines, conserve fuel by staying at or below "hull speed".

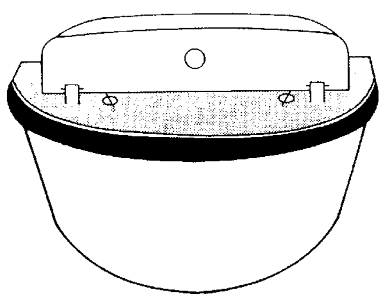
(The point where the vessel tries to rise over its bow wave)

Vessels intended for operation in rough seas and heavy weather have "full" bows. The bow increases the buoyancy of the forward part of a vessel and deflects water and spray. When a vessel is heading into a wave, the bow will initially start to cut into the wave. It may be immersed momentarily if the seas are rough. As the bow flare cuts into the wave it causes the water to fall away from a vessel's stern, shifting the center of buoyancy to move forward from the center of gravity. The bow lifts with the wave and the wave passes under the vessel, shifting the center of buoyancy aft. This action causes the bow to drop back down and the vessel achieves a level attitude.

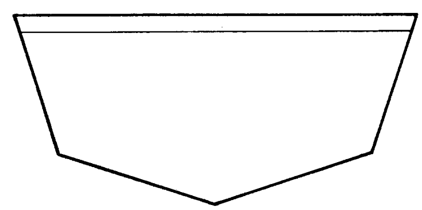
The shape of the stern affects the speed, resistance, and performance of the vessel. It also affects the way water is forced to the propellers.

THE DESIGN OF THE STERN IS CRITICAL IN FOLLOWING SEAS WHERE THE STERN IS THE FIRST PART OF A VESSEL TO MEET THE WAVES. IF THE FOLLOWING SEAS LIFT THE STERN TOO HIGH THE BOW MAY BE BURIED IN THE SEA. THE FORCE OF THE WAVE WILL PUSH THE STERN CAUSING IT TO PIVOT AROUND TOWARD THE BOW. IF THIS IS NOT CONTROLLED A "PITCH POLING" OR "BROACHING" COULD RESULT.

The rounded cruiser type stern presents less flat surface area for a following sea to push upon and tends to split the waves of a following sea allowing it to pass forward along each side of the vessel. Thus the wave has minimum impact on the attitude of the vessel and provides additional buoyancy for the stern.



THE ROUNDED CRUISER STERN PRESENTS LESS FLAT SURFACE AREA FOR THE SEA TO ACT UPON.



TRANSOM STERNS PROVIDE A LARGE SURFACE AREA FOR THE SEA TO ACT UPON, AND SHOULD NOT BE EXPOSED TO HEAVY FOLLOWING SEAS OR SURF CONDITIONS.

Always steer into any sideways movement of the stern. For example, when the stern slips to starboard, turn to starboard. It is particularly important that these corrections be made quickly and accurately in short duration following seas. Transom sterns provide a larger surface area for the seas to push upon and should not be exposed to heavy following seas or surf conditions

Other Hull Categories-because of the limited applications of these vessels, they will not be covered in this course material.

The shape of a vessel's bow, its profile, form, and construction determine hull resistance as the vessel advances through the water. Hull resistance develops from wetted surface friction and from the wave the hull makes as it moves in the water. Wave making resistance depends on the vessel's speed.

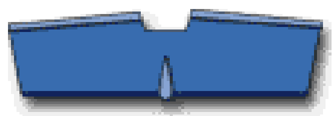
The bow of a vessel must be designed with enough buoyancy so it lifts with the waves and does not cut through them. The bow flare provides this buoyancy.

Vessels intended for operation in rough seas and heavy weather has "full" bows. The bow increases the buoyancy of the forward part of a boat and deflects water and spray.

When a boat is heading into a wave, the bow will initially start to cut into the wave. It may be immersed momentarily if the seas are rough. As the bow flare cuts into the wave it causes the water to fall away from a vessel's stern, shifting the center of buoyancy to move forward from the center of gravity. The bow lifts with the wave and the wave passes under the boat, shifting the center of buoyancy aft. This action causes the bow to drop back down and the vessel achieves a level attitude.

HULL SHAPES

Every hull design is a compromise. Factors to consider include anticipated sea conditions, predicted speeds, water depth, stability, load capacity, and a myriad of other decisions.



FLAT- Generally, lightweight for their size. Plane efficiently and can be propelled on plane with less horsepower of a similar length deep-vee hull.

Many flat bottom vessels are designed to carry heavy loads for their size.

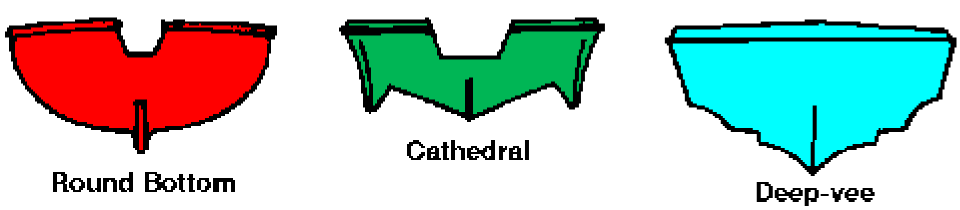
Flat bottom boats also have a high 'righting arm' factor. This is best identified as the resistance of a vessel to tipping. This makes the flat bottom a useful design for pulling heavy weights (nets, accident recovery) on board without capsizing.

When the righting arm factor of a flat bottom vessel is exceeded, the vessel may swamp or capsize very quickly and violently.

Flat bottoms are designed to primarily operate in shallow or calm water. They are not very 'sea-kindly'.

Flat bottom vessels also tend to slide when pushed hard into turns.

ROUND- These hulls usually are not designed to be pushed onto plane and tend to roll a lot in the ocean. A round bottom vessel may capsize more easily making their application in law enforcement limited



CATHEDRAL-The cathedral hull, sometimes called a tri-hull, offers a lot of positive features for a small boat hull.

Plane with relatively little power, though they require more power than the similar weight and length of a flat bottom vessel

Very stable and make good boarding platforms and dive boats.

Unlike flat bottom vessels, cathedral hulls track well in corners.

Cathedral hulls are best limited to use in relatively smooth waters.

While they track well, boat operators need to use caution when pushing cathedral hulls hard in turns. Some cathedral hulls will 'hook' violently when driven fast into a sharp turn throwing the unaware operator down or out of the boat.

NOTE: Some hull designers smooth out the transom so the cathedral hulls will not chine dig or "hook" as hard. Some of these hulls tend to 'porpoise' sideways. The best way to familiarize yourself with the handling characteristics of a cathedral hull is to take all safety measures (connect into the kill switch, properly wear your PFD, advise your crew to brace themselves) then put the boat into a series of hard turns

SEMI-VEE HULLS - defined as having less than 17 1/2 degrees of deadrise. Modified vee hulls offer a lot of compromises. They have a sharp bow entry for a smooth ride in rough water, but flatten out towards the transom.

Righting arm factor is less violent than that of the flat-hulled designs.

Tend to track well in turns and won't 'hook' like a cathedral might.

MODIFIED VEE- These hulls start with a deep vee at the bow. The angle of the vee tapers from front to back. The vee or deadrise may be almost flat at the stern.

These boats are well suited to rough, shallow water. In trying to anticipate the handling characteristics of a boat, a good rule of thumb is; "the less vee at the transom, the rougher the ride."

<u>DEEP VEE'S</u>- With the advent of higher powered drive units in smaller packages, manufacturers have produced vessels with higher degrees of deadrise in deep vee hull Design. These vessels,

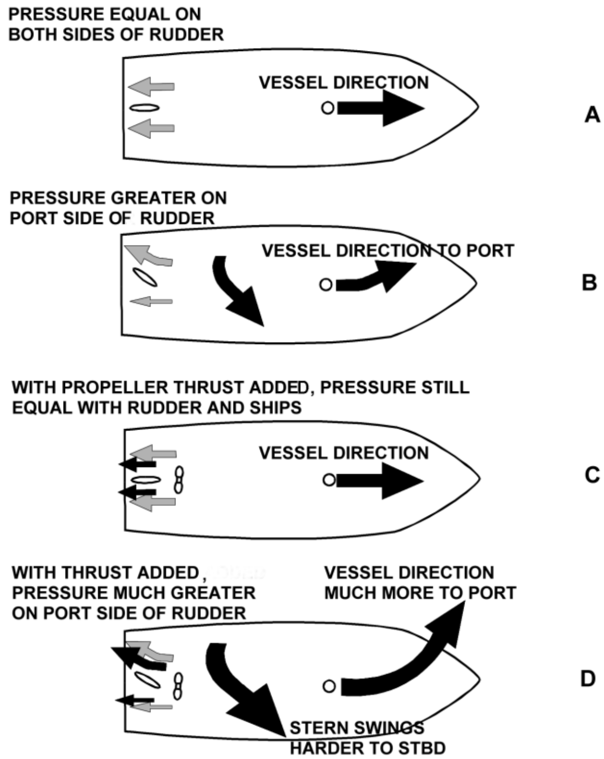
- With some bow flair, offer a drier ride.
- Ride smooth in rough water and tracks well in turns.
- Take an increased amount of power to keep on plane.
- Not well suited for operation in shallow water.
- Righting arm factor is gentle.
- Deep vee design is preferred for potentially rough open water where fuel consumption, stability, and shallow draft are secondary considerations.

STEERING

Vessels steer like forklifts as they both steer from the back. Vessels have other factors that influence steering;

- Wheel walk is the result of unequal blade thrust created when the propeller meets the arriving water at an angle. The greater angle from horizontal the propeller operates at the greater the wheel walk will be.
- Hull drag factors- caused by lower unit trim, trim tabs, and load distribution.

Inboard handling theory utilizes wheel walk principles only. Because of their limited application in the field, this course will focus on directed thrust application vessels. An illustration of inboard handling theory follows:



EPO #2: IDENTIFY THE FUNDAMENTALS OF DIRECTED THRUST AS IT APPLIES TO SLOW AND HIGH SPEED VESSEL HANDLING.

DIRECTED THRUST

Outboards and inboard/outboards (I/Os) are unique in that they direct the thrust of the propeller's discharge screw current. Outboards and I/O's accomplish the majority of their steering by turning their lower units through an arc away from parallel with the keel. The propeller thrust pushes the stern of the vessel to steer. This principle is called directed thrust.

- All steering is accomplished from the stern of the vessel. To steer the vessel to the left, the lower unit and propeller push the stern to the right.
- As the vessel is pushed forward and the stern of the vessel is pushed to the right, the keel of the vessel is forced left.
- Unequal thrust away from the keel line causes the vessel to list to port, increasing resistance on the left side of the vessel; the vessel turns left. "The vessel is turned left by pushing the stern to the right.", and vice versa.

When backing a directed thrust application the behavior is similar to backing a front wheel drive automobile. If you want to steer your vessel to the right in reverse, turn your wheel right- the outdrive pivots right- and the directed thrust of the propeller will pull you to the right.

POWER TRIM AND TILT

Most modern outboards and I/Os are equipped with power trim and tilt. We trim down for maximum stern lift when going onto plane. Once on plane, trimming the engine(s) up increases speed without increasing fuel consumption.

As the engine(s) are trimmed up, the direction of thrust forces the bow up. As speed increases, water's hardness increases. The harder water lifts the hull higher out of the water; decreasing the wetted surface area of the vessel, increasing the speed and leveling off the running attitude. We apply "bow up" adjustments to any trim to effect elevation out of the water verses altering the running angle.

Excessive trim is indicated by:

- Vessel "porpoises" noticeably
- Creates a large "rooster tail"
- May cause pulling to one side

TRIM TABS

Trim tabs are hydraulically or electrically actuated 'flaps' attached to the transom of a vessel. Trim tabs are raised and lowered to increase or decrease the lift in the stern.

Lowering the tabs together increases the amount of lift at the stern. Raising the tabs creates an opposite effect. Excessive use of flaps “down” will result in counterproductive drag on the vessel. Trim tabs can be used in concert with the engine trim to give a vessel maximum speed and fuel efficiency on plane.

Trim tabs can be used to adjust the running attitude of the vessel when on plane. If a boat is listing to port lowering the port tab will cause the port side to lift, leveling the vessel.

Trim tabs are often used to compensate for sea conditions. In choppy water, it is often best to push the bow down. In a heavy following sea, the operator raises the tabs, lessening the tendency of the vessel to submarine into the back of the wave forward.

When bringing your vessel up on plane it is usually best to leave the tabs either all the way up or depressed just a few degrees. When backing a vessel, raise flaps up to insure they do not scoop inbound water driving the stern under.

PROPELLERS

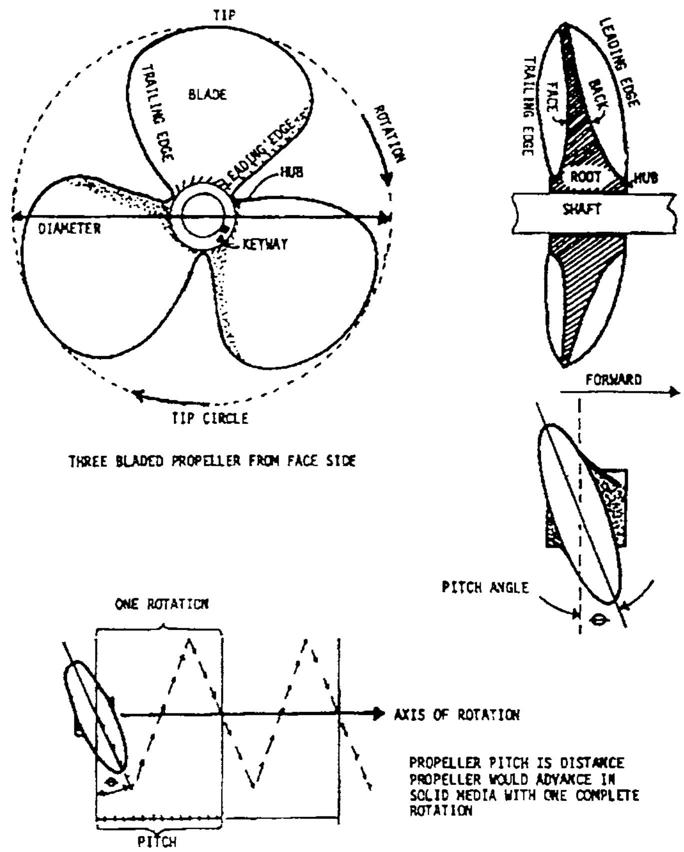
Most vessels are driven by one or more screw propellers which move in spirals somewhat like the threads on a screw. That is why the propeller is commonly referred to as a screw. The most common propellers are built with three and four blades. The propeller on a single-screw vessel typically turns in a clockwise direction (looking from aft forward) as the vessel moves forward. Such screws are referred to as "right-handed." On twin screw vessels, the screws turn in opposite directions, rotating outward from the centerline of the vessel. The port screw is "left-handed" and turns counter-clockwise. The starboard screw is "right-handed" and turns clockwise

A propeller consists of blades and a hub. The area of the blade down at the hub is called the **root** and its outer edge is called the **tip.**

The edge of the blade that strikes the water first is the **leading edge**; the opposite is the **following edge.** The diameter of the screw, the circle made by its tips and its circumference, is called the **tip circle.** Each blade has a degree of twist from root to tip called **pitch.**

The marine industry is continually improving and introducing new prop designs. Theoretically the most efficient propeller is a single bladed prop but the boater can now choose from multi-bladed props, counter rotating duo-props, two speed props, and surface piercing props.

Propellers are identified in terms of diameter and pitch. Pitch is the distance a propeller advances in one revolution with no slip. Generally, less pitch in the same diameter propeller makes it easier for the engine to reach its preferred maximum RPM; thus, like putting a car in first gear, more power (and sometimes more speed) is available. Similarly, (like third gear in a car) more pitch may give more speed, but lower revolutions per minute (RPMs) gives less power. Optimum performance is obtained when pitch is matched to the optimum design speed (RPM) of the engine



No propeller is 100% efficient; that is, no 19 pitch prop pulls itself forward 19 inches in one revolution. Props are also identified in terms of efficiency. Most recreational props are about least 80% efficient.

To calculate this, multiply 19 x .80= 15.2. Such a prop would pull itself 15.2 inches forward in a typical revolution.

Racing props are highly efficient. Some props, like those on small tugs, have a lot of 'slip' engineered in.

Marine engineers use props in much the same manner as an automobile designer uses tire size and gear ratio.

- A big diameter prop with lots of pitch requires high horsepower to function.
- Small props with small pitch are good for low powered boats.
- Large diameter or lots of pitch will give you a higher top speed. Smaller props and less pitch will give you more acceleration and pulling power.
- Vessels propped correctly will operate within 200 RPMs of the manufacturer's maximum recommended RPM limit.

Most outboard and I/O props are sleeved with a rubber or composite donut, called a hub, surrounding a splined shaft. The purpose of the hub is to save the drive train and prop in the event of a prop strike. If you experience a slipped hub do not try to plane the vessel. The composite is designed to “reset” and hold the shaft and prop together under reduced power.

VENTILATION AND CAVITATION

When the prop slips in the water, friction occurs between the prop and the water flowing over the blades. The heat causes water in contact with the prop to boil. Tiny air bubbles are formed in the intake stream in front of the prop blades; these bubbles allow the prop to slip. The rougher the surface of the prop, the more friction occurs along the wetted surface. This slippage is called **CAVITATION**.

- Props that are badly dinged or have heavy growth on them may cavitate so badly they fail to push a small boat onto plane.
- Eventually the boiling action and the stream of tiny bubbles exploding as they hit the blades of the prop will erode the prop away.
- Some props literally have holes eaten through them by cavitation bubbles.

VENTILATION of a propeller occurs when air is drawn down from the surface level of the water into the prop blades. When ventilation occurs the prop slip causes the engine(s) to over-rev.

- Ventilation commonly occurs in excessively sharp turns, when a boat jumps a wave or a wake, or when an operator trims too far out.
- Ventilation may cause a vessel to fall off plane or inflict damage to the engine(s).

EPO #3: MANEUVER A VESSEL, UTILIZING ENVIRONMENTAL EFFECTS, TO SAFELY LEAVE AND APPROACH A DOCK IN A CLOSE QUARTERS SITUATION.

The most challenging and probably most frequent maneuvering you will encounter is close quarters maneuvering. Approaching and departing other vessels, slips, dock areas, piers, boat basins and marinas require great skill levels.

Check the conditions before maneuvering. Always try to take advantage of wind and current when docking or mooring. To maintain best control, approach against the wind and current and moor on the leeward side of a mooring when possible.

- Maneuver your vessel into the current where possible. If the combined effects of wind and current do not permit a bow up approach, consider backing into the approach. NOTE: Trim engines up (beyond horizontal) to improve backing performance.
- Apply the principle of directed thrust by performing wheel work before engaging engines. By presetting the engines' directions, all thrust will be in the desired direction.

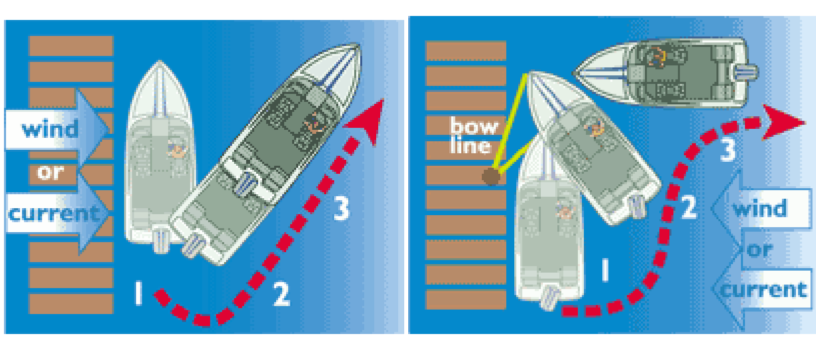
WIND SURFACE EFFECT of a vessel is dictated by the amount of boat sheer and superstructure above the waterline versus hull below the waterline. The effect of wind differs as the direction of the wind changes relative to the vessel. Outboard and I/O powered boats tend to be stern heavy causing the vessel's bow to lay down wind.

To determine the combined effects of wind and current before any close quarters maneuvers put your vessel in neutral allowing it to drift. Ignore the bow's swing downwind and observe the vessel's actual drift line.

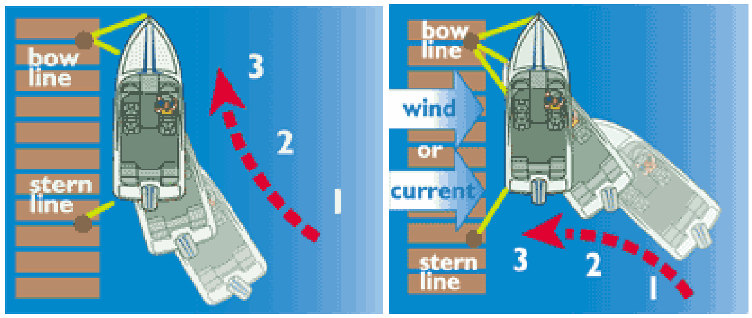
Rig all mooring lines and fenders before the approach. Emphasize control, not speed, when docking. "We approach all hard objects at a speed we don't mind having a collision at!"

Keep just enough headway or sternway to counteract the winds and currents and allow steerage while making progress to the dock.

Keep an eye on the amount of stern or bow swing. With a high foredeck, the wind can get the bow swinging much easier than it is to stop. In higher winds, a greater amount of maneuvering speed may be needed to lessen the time exposed to the winds and currents.



APPROACHING



Knowing which way the wind is blowing can greatly aid your docking. When coming alongside a pier with the wind in your face, head in at a 20-30 degree angle to avoid being blown out by the wind. If the wind is at your stern, come into the dock at a narrow angle and let the wind do the work of pushing your boat up against the dock.

Current can also affect your docking in a similar fashion to wind, and in some areas can preclude you from docking at all in low water. Consult your tide tables, especially when in unknown waters.

BACKING INTO THE CURRENT

The complex maneuvers of backing with the current (and or wind) require the operator to remain cognizant of the current's axis and the vessel's keel. When the vessel's bow is allowed to one side of that axis the additional effect of sideways movement is introduced to the vessel. To negate this sideways slide the operator simply turns the bow straight up into the current. To achieve slide (wedging the boat) in the other direction the operator redirects the bow to the "other side of the current".

LINE HANDLING is rigorous discipline when docking. Give specific line-handling instructions in a loud, clear voice. Ensure they are understood by anyone assisting.

Often, the presence of other craft or obstructions will complicate the clearing of a berth, or any simple maneuver. Wind and/or current can also become a factor. Before maneuvering, evaluate the options in order to take full advantage of the prevailing conditions.

Use of SPRING LINES to assist in approaches and departures is recommended.

- Use the after bow spring, or bow spring, #2, (leads aft to the dock from the bow) to "spring out" or move the stern away from the dock. The stern will move away with the wheel full toward the dock and the engines ahead.

- Use just the foreword quarter spring, or stern spring, #3, (leads forward to the dock from the quarter) to "spring out" or move the bow away from the dock. By backing down on a vessel's engines with just the forward quarter spring attached to the dock, the bow will move away from the dock.

EPO #4: IDENTIFY THE OPERATION OF PATROL CRAFT UNDER DIFFERENT ENVIRONMENTAL CONDITIONS AND SPEEDS

Professional vessel operators are thoroughly familiar with the handling characteristics of their vessel. They know how varying weather and sea conditions affect the operation of their vessel and are keenly aware of the limitations that the weather and sea impose on vessels.

Above all, the professional vessel operator understands how to mesh the capabilities of their vessel to weather and sea conditions in order to conduct the safest possible vessel operations. They:

- Know the vessel's limitations
- Know the maximum sea and wind conditions the vessel can operate in
- Navigate and pilot the vessel with confidence
- Know the local operations area (OPAREA)
- Demonstrate vessel handling skills to safely and prudently control the movement of a vessel while underway
- Understand the principles of risk management and incorporate them into the decision making process.
- These principles include detection, identification, evaluation, and mitigation or control risk as part of making decisions (e.g., slow to safe speed in restricted visibility, end a pursuit because of dangerous circumstances).
- Demonstrate correct application of regulations, policy, and guidance delineated by agency or higher authority to the circumstances at hand (e.g., safe navigation, safe speed, law enforcement, and rendering assistance).
- Demonstrate leadership that effectively coordinates, directs, and guides the performance of the boat crew during patrols.

The knowledge requirements and performance skills for vessel operators are extensive. Vessel operators must apply good judgment, intelligence, and initiative. They must make decisions with the safety of their crew and vessel in mind. In addition to basic crew member skills, a vessel operator requires these additional knowledge and performance skills.

HIGH SPEED MANUEVERS

With high-powered craft sharp turns at high speed will quickly stop a boat's progress in the original direction of movement. Though such a turning action is effective to avoid contact with an immediate hazard, the violent motion could eject unsuspecting crewmembers. Don't use this technique except as an emergency maneuver.

A keen knowledge of the vessel's characteristics and limitations, the outfit equipment, and the stowage will be invaluable in times of crisis.

Frequent practicing of the procedures for different emergency circumstances will teach crew members how to react correctly to each situation.

All crew members must continuously think about emergency situations and answer the hypothetical question, "What should I do if...?" so that it can be instantly put into action when the question becomes, "What do I do now?"

NORMAL OPERATIONS

- Check engine RPM's so both engines turn at the same speed.
- Use small amounts of helm to offset any effects of winds and seas. Always note compass course and correct frequently to stay on course.
- Develop a practiced eye and steer on a geographic point or range. Try to steer for a point between buoys.
- Apply small, early helm corrections to stay on course, rather than large corrections after becoming well off course.
- Do not over steer, leaving a snake-like path. At low speeds, helm correction will be more frequent than at higher speeds.
- Set drives and flaps for efficient fuel burn and comfort.

Observe the normal operating limit of 80 percent of maximum power reserving the remaining 20 percent for tactical or emergency maneuvering.

ROUGH SEAS

If necessary turn your boat into the sea. When pounding or launching the hull occurs the hull is fatigued and crew injury is likely. SLOW DOWN!

WHEN RUNNING **WITH** ROUGH SEAS, TRIM THE VESSEL UP TO PREVENT 'STUFFING'.

All vessel OPERATORS are responsible for any injury or damage THEY cause.

Becoming a Vessel Commander requires knowledge of hull shape, propulsion principles, and natural factors affecting the performance of your boat. A professional operator develops an instinctive feel for their boat; a "sixth sense" based on knowledge, experience, and familiarity with the boat they are operating. This "sixth sense" is exhibited by smooth maneuvers and the operator's concern for proper use and care of the equipment **their** lives may depend upon.

REFERENCES

BOATSAFE.COM Boating Safety Course www.boatsafe.com Nautical Know How, Inc. 2009

Maloney, Elbert S. Chapman, Piloting, Seamanship and Small Boat Handling. 66th Ed. New York, NY: Hearst Marine Books, 2009.

United States Coast Guard COMDTINST M16114.28 Non-Standard Boat Operators Manual July 2006

U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

Homeland Security

STUDENT TEXT

PURSUIT, STOP, AND APPROACH OF A VESSEL

7522 MAY/11

TERMINAL PERFORMANCE OBJECTIVE:

Given scenarios that involve stopping a vessel, the student will identify the accepted procedures for pursuit, stopping and approaching a vessel in accordance with the standards established by the United States Coast Guard.

ENABLING PERFORMANCE OBJECTIVES:

INTRODUCTION

Pursuit of a suspect vessel is the first step in [redacted] The safety of the officer and his crew is the primary concern during the pursuit, stop and approach of a suspect vessel. The officer on the street faces many hazards when making both felony and misdemeanor stops. The marine enforcement officer must not only face the same dangers, but also a number of other hazards unique to the marine environment: l) weather and sea conditions, 2) [redacted]. There is an old saying in law enforcement, "There is no such thing as a routine traffic stop." Yet an average of 12 percent of all officers killed in the line of duty lost their lives during vehicle stops. In marine law enforcement, likewise, there are no "routine" vessel stops or boardings.

Pursuit is [redacted] while following a suspect vessel. Pursuits begin after an attempt to stop suspect vessels in order to identify, investigate, arrest or seize. In any pursuit, the degree of danger is heightened. There is the distinct possibility that either of the vessels involved in the pursuit may exceed its design limitations.

As with proper vehicle pursuits, much of the danger involved in vessel pursuits can be kept under control. The marine enforcement officer must be thoroughly familiar with boat handling theory. The operator must know exactly what the boat can and cannot do when pushed toward its performance limits. Remember, the object is to maintain a visual or radar contact of the suspect during the pursuit. If the suspect vessel refuses to stop, even after the patrol boat is alongside, there is little that can be done to make the vessel stop. This handout will explain several recommended techniques for pursuing and approaching a vessel. The primary objective is always officer safety

EPO #1: Identify safe and effective operation of a vessel during a pursuit.

A. PURSUITS

THE DEFINITION OF "PURSUIT" ACCORDING TO WEBSTER'S DICTIONARY IS: "TO FOLLOW IN AN EFFORT TO CAPTURE OR OVERTAKE. VESSEL PURSUITS CAN BE CONSIDERED RISK OR HIGH RISK. ANY PURSUIT SHOULD BE CONSIDERED HIGH RISK UNTIL CIRCUMSTANCES DICTATE OTHERWISE.

1. NON[redacted]

a. [redacted]

b. (b)(7)(E) [redacted] A non-hostile pursuit will usually be of short duration. Normally the operator will comply when made aware of the signal to stop.

c. Non-hostile pursuits should not be viewed as routine; nothing in law enforcement can be considered routine. Always keep in mind that even during a non-hostile vessel boarding that the persons on board could have a criminal background, or may be currently involved in criminal activity. Do not become complacent.

2. HOSTILE PURSUIT

a. The marine law enforcement officer must be able to recognize the differences and the dangers between a hostile and non-hostile pursuit. A pursuit is considered hostile after (b)(7)(E) [redacted]

(b)(7)(E) [redacted]

b. These are just a few examples that may be observed that signal potential hostilities. Be aware and prepared to deal with hostile actions if they arise.

B. PREPARATIONS

The preparation for a pursuit begins before the enforcement vessel leaves the dock. The vessel should be checked off to ensure it is properly equipped and operational for day and night operations. All equipment must be (b)(7)(E) [redacted] A crew member that does not know, or will not perform assigned tasks, is a hindrance and danger to other crew members.

C. THE 80% RULE

There are a number of factors that affect crew and vessel safety which increase during a pursuit. This requires the operator to maintain composure while operating at accelerated speeds that require additional control measures.

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

D. PURSUIT INITIATION

A pursuit is generally initiated when the operator of the vessel refuses to stop after the recognition of law enforcement presence. At this point, the pursuit may advance from "non-aggressive" to "aggressive or hostile." Actions by the suspect vessel should cause the enforcement officer to prepare for defensive actions, if needed. For instance, the enforcement officer wishes to stop a vessel for investigative purposes and the suspect vessel does not come to an immediate stop after activating the blue light and siren. At this point, there could be several logical reasons for the vessel captain not stopping, i.e. he did not see the blue light, or could not hear the siren because of wind or engine noise.

a. If at any time during the pursuit hostile actions are observed be prepared both mentally and physically to respond. Some of the hostile actions that may be observed include:

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

E. VESSEL PURSUIT OPERATION

The effective operation of a vessel in a pursuit situation requires an understanding of several essential criteria:

a. The knowledge of the pursued vessel's handling characteristics is helpful to the pursuing officer's tactics. Understand that no one can be familiar with the handling ability of every vessel, the level of operator skill, and modifications to hull designs. (b)(7)(E) [redacted]

b. Another criterion for an effective pursuit is recognizing limitations. Weather and sea conditions can make the difference between successful vessel pursuits and dangerous results. Knowing the design capabilities of the vessels being operated will enhance the ability to safely complete a pursuit in rough seas, or will make the decision to terminate the pursuit easier. Knowing personal limitations will enhance the ability to safely complete a pursuit or justify the termination of a dangerous pursuit. Remember not all pursuits will result with successful apprehension.

c. A sensitive and very real limitation is that of the operator's ability. There is no room for the "ego" here. Confidence based on knowledge and "real-time" experiences will lay a safe foundation for this potentially dangerous task. Familiarization with the vessel, decision making ability and reaction time will affect the outcome of a pursuit situation. Preparation for the possibility of a stressful pursuit is built upon experience gained every time the boat is under way.

d. PURSUIT SKILLS

[redacted]

F. SUSPECT VESSEL OBSERVATION/[redacted]

[redacted]

NOTE: ALL FIGURES USED IN THIS HANDOUT ARE NOT TO SCALE. MOST FIGURES DEPICT THE VESSELS MUCH CLOSER TOGETHER THAN SHOULD BE IN AN ACTUAL PURSUIT.

1. ASTERN POSITION
   a. Information available from an Astern position:

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

(b)(7)(E)

[redacted]

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

G. EVASIVE MANEUVERS

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

H. DETERMINATION TO TERMINATE A PURSUIT

[redacted] (b)(7)(E)

[redacted] (b)(7)(E)

EPO #2: IDENTIFY THE PROCEDURES FOR APPROACHING A VESSEL SAFELY WITHOUT DAMAGE TO EITHER VESSEL.

<u>VESSEL STOP AND APPROACH</u>

1. VESSEL STOP AND APPROACH

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

[redacted]

g. Remember that the enforcement officer has assumed responsibility for the suspect vessel and crew and must ensure that the wind, seas and/or current will not take it into dangerous waters.

h. After stopping the vessel, communication between the suspect vessel and the enforcement vessel must be established. This can be accomplished by one of several means:

1) Intercom or loud hailer.

2) Direct voice from personnel on the enforcement vessel to persons on the suspect vessel.

[redacted]

j. During the interview with the captain, ask some of the following questions and record the responses. These responses could be [redacted] (b)(7)(E)

k. [redacted] (b)(7)(E)

l. [redacted] (b)(7)(E)

m. (b)(7)(E) [redacted]

n. [redacted]

2. **<u>TYPES OF APPROACHES</u>**

a. Determine the best approach under existing circumstances. In addition to the actions of the stopped boat and its crew, things to consider are sea and wind conditions, visibility, time (day/night), the type of vessel to be boarded, and the presence of nets or other obstructions in the water that can damage or disable a vessel.

b. (b)(7)(E) [redacted]

[redacted] (b)(7)(E)

[redacted] (b)(7)(E) [redacted] (b)(7)(E)

c. **Bow-on to amidships**

[redacted] (b)(7)(E)

(b)(7)(E)

[redacted]

(b)(7)(E)

[redacted]

(b)(7)(E) [redacted]

(b)(7)(E) [redacted]

(b)(7)(E)

[redacted]

(b)(7)(E)

EPO #3: IDENTIFY THE DUTIES AND RESPONSIBILITIES OF THE VESSEL OPERATOR AND CREW DURING THE PURSUIT, STOP AND APPROACH OF A VESSEL.

1. As officers begin their approach there are certain things that should be done before they close and board in addition to what has been discussed in the previous section.

   a. Law enforcement officer identification is essential.

(b)(7)(E)

[redacted]

[redacted] (b)(7)(E)

4. Finally, tell the boat's master of intentions to come aboard. [redacted] (b)(7)(E) (b)(7)(E) of intentions to come aboard. This can be done in a professional polite, but firm manner. From this point and until the boat is released, it is the lead officer's responsibility to ensure its safe navigation and the crew safety.

<u>SUMMARY</u>

The pursuit, stop and approach of a vessel require more demanding physical and psychological skills [redacted] (b)(7)(E) (b)(7)(E) (b)(7)(E) situation. The desire to "close the gap" in a turn and not realizing when the suspect gains the upper hand must be avoided at all costs. Patience and common sense must be exhibited by the marine law enforcement operator during a pursuit in order to be successful and safe. Even when the suspect vessel stops, due diligence to the entire surroundings of the marine enforcement officer must be maintained for officer safety and a successful boarding.

The Student Text incorporated in MLETP course 7523 “Navigation Rules” is the actual U.S. Coast Guard publication referred to as:

COOMDTINST 16661 Navigation Rules

And can be downloaded at:

http://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=9&cad=rja&ved=0CFgQFjAI&url=http%3A%2F%2Fwww.xmarks.com%2Fsite%2Fwww.navcen.uscg.gov%2Fmwv%2Fnavrules%2Fnavrules.htm&ei=evBCUv-fLu-44APet4CgAQ&usg=AFQjCNHMTDtDiD3em41sJC27pNN6-E96yg&sig2=XK2CPkg1Je2ykEtVEyA_EA&bvm=bv.53077864,d.dmg

U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

STUDENT TEXT

NAUTICAL TERMINOLOGY

7527 DEC/2011

TABLE OF CONTENTS

INTRODUCTION

This glossary of nautical terminology is intended to provide a basic working knowledge of terms commonly encountered in the maritime community. It is an abbreviated collection. For those terms not covered in this glossary, the following reference works are recommended as possible sources for information:

1. Ocean and Marine Dictionary, David F. Iver, Cornell Maritime Press, Inc., 1979.

2. Chapman, Piloting & Seamanship, Charles B. Husick, The Hearst Corporation, 66th Ed 2009

3. Dutton's Navigation and Piloting, Elbert S. Maloney, Naval Institute Press, 1972.

4. Seamanship, Naval Institute Press, 1972.

5. The Time-Life Library of Boating, Time, Inc., 1976.

6. Origins of Sea Terms, John G. Rogers, Nimrod Press, 1988.

7. Boat Crew Seamanship Manual COMDTINST M16114.5C, United States Coast Guard, 2009

Remember that "sailor's English" is a living, changing language and that usages of various terms may be different from place to place and within various segments of the marine community. Specialized terms affect sailing and commercial fishing, for example. By learning the appropriate language of your marine community, you will establish yourself as an professional from your first words with other local mariners.

TERMINAL PERFORMANCE OBJECTIVE (TPO):

Given a scenario involving nautical terms and descriptions used for direction, motion, structural components, and accessories, the student will identify common nautical terminology in accordance with marine law enforcement operations, industry standards, naval practices and nautical lore.

ENABLING PERFORMANCE OBJECTIVES (EPO):

EPO #1: Identify common nautical accessories found on and around vessels.

EPO #2: Identify the terminology of direction and motion aboard a vessel.

EPO #3: Identify basic hull types and major structural components of vessels.

GLOSSARY OF NAUTICAL TERMINOLOGY

ABAFT	Toward the stern.
ABANDON SHIP	Order given to all on board to leave a stricken vessel; there being no hope for its survival.
ABEAM	Off the side amidships; at right angles to the keel.
AB0ARD	On or within the vessel.
ABOUT	To take a different direction as when tracking.
ADRIFT	Floating at random; not fastened to moorings; at the mercy of winds and currents.
AFT	The rear part of a vessel; toward the stern; at or near the stern.
AHEAD	In front of the vessel.
ALOFT	Above the decks of a vessel.
ALONGSIDE	Along, or by the side.
AMIDSHIPS	In or toward the middle of the ship; over and in line with the keel.
ANCHOR	Device for securing a vessel to the ground underwater (bottom) by means of an attached cable.
ANCHORAGE	Area where ships anchor or may anchor safely either by suitability or by designation.
ASTERN	Behind the vessel.
ATHWART	Across; from side to side; perpendicular to the vessel's keel. (Athwartships.)
AWASH	Even with the surface of the water.
AWEIGH	Said of an anchor when the flukes have just cleared the bottom. (Anchors aweigh).
BAIL	To scoop water from a vessel by hand to counter flooding.
BALLAST	Weight carried by a vessel to insure proper stability. (In ballast without cargo and carrying only ballast.)
BEAM	Width of a vessel at its widest point. An athwartships support for a deck.

BEAM SEAS	Waves moving in a direction 90 degrees from vessel's heading, that is to or from the beam.
BELAY	To make fast; to cease performing a task.
BELOW	Any part of a vessel below upper decks.
BEND	To fasten by means of a bend or knot, as one line to another, or to an anchor.
BIGHT	The section of rope or line between the working end and the standing part.
BILGE	Bottom of a vessel below the flooring; the deepest part of a vessel's interior. (Bilge pump - pump that removes water from a vessel's bilge.)
BINNACLE	Stand or case for housing a compass so that it may be conveniently consulted.
BITTER END	The end of a line or the end of an anchor cable or chain.
BITTS	A perpendicular-post to which cables or lines are made fast. Generally, names according to their use (towing bitts, windlass bitts, etc.).
BOARDING	The act of going on board a vessel.
BOAT	Considered smaller than a ship. Typically under 65.7' (20 meters) civilian standards or under 100' military standards. (note; tugs and submarines are always called boats. Another term for "Small Craft"
BOOT-TOP	A painted band at the waterline of a vessel usually of contrasting color.
BOTTOM	Any ground covered by water.
BOW	The forward end of a vessel. The end opposite the stern.
BREADTH	Side-to-side measurement of a vessel at any given place.
BRIDGE	Navigating deck of a ship. (Flying bridge - open deck above bridge usually with a duplicate set of controls.)
BROACH	Veering of a boat sideways on the face of a wave, usually as a result of loss of control; placing the vessel in danger of capsizing.

BULKHEAD	Vertical partition in a vessel dividing the interior into compartments; a wall.
CABIN	Interior of deckhouse; usually space set aside for officers or passengers.
CAST OFF	To throw off a line; to let go.
CATENARY	Curve assumed by flexible cord in equilibrium when suspended from both ends.
CHAFING-GEAR	A wrapping of canvas or rope around spars, rigging, or lines to prevent wear.
CHINE	The angle or curve of the hull where sides and bottom of a vessel meet.
CHOCK	Oval shaped castings, fore and aft, through which anchor line or dock lines may pass. Wedge-shaped piece of wood inserted under sides of ship's small boat on deck to prevent movement. Wedge used to secure anchor or other bulk objects in place.
CLEAT	Fittings of metal or wood with outward curving arms or horns on which lines are belayed.
COCKPIT	An open after space or well dropped below the sheer line of a boat from which the boat may be steered.
COXSWAIN	Sailor who has responsibility for the boat.
CUDDY	Cabin on a small boat.
DEADHEAD	Partially submerged timber.
DEADRISE	The rise of a vessel's bottom from the keel to either the chine or the turn of the bilge.
DEBARK	Leave a vessel.
DECK	Horizontal planking resting on the deck beams of a vessel.
DECKHOUSE	Small house erected on the deck of a ship.
DERRICK	Device consisting of a kingpost and boom and necessary rigging for hoisting heavy cargo.
DINGHY	Small rowboat used as a tender.

DISPLACEMENT	Weight in tons of water displaced by a ship.
DOCK	A protected water area in which vessels are moored. The term is often used to denote a pier or wharf.
DRAFT	Depth of a vessel below the waterline to the lowest part of hull, propellers, or other reference point.
DRAFT MARKS	Number placed in a vertical scale at the bow and stern of a vessel to indicate draft.
DRIFT	Velocity of current in knots.
DROGUE	Conically shaped canvas bag with line streamed astern of a vessel for the purpose of keeping its stern to the seas when underway.
EMBARK	To go aboard.
ENSIGN	Flag or banner distinguishing a vessel.
EPIRB	Emergency Position Indicating Radio Beacon, a small continuously operating transmitter, using a standard distress frequency to alert authorities to the existence of a distress situation and to lead rescuers to the scene
EVEN KEEL	Vessel riding so that plane of flotation is either coincident to or parallel to its designed waterline.
FAIRLEAD	Fittings used in preserving the direction of liens, chain, or cable delivering it fairly or on a straight line.
FAKE DOWN A LINE	A method of coiling a line flat, with each loop overlapping, so that it will run freely without fouling.
FANTAIL	Overhanging stern of a vessel from stern-post aft. often used to describe, generally, the stern-most weather deck.
FATHOM	A unit of length used in measuring water depth; one fathom equals six feet.
FENDER	Various devices hung over the side of a vessel to cushion or prevent chafing and rubbing.
FEND OFF	To push or hold off.
FLARE	The outward curve of a vessel's sides near the bow.

FLOTSAM	Parts of a wrecked ship and goods found floating.
FLUKE	Broad triangular shaped blades of an anchor.
FOLLOWING SEA	One that comes up from astern.
FORE	Toward the bow of a vessel or forward of midships section; opposite of aft.
FOUL	Not clear; jammed (to foul one's screw with line).
FRAMES	The skeletal member of a ship's hull perpendicular to the keel to which planking is attached.
FREEBOARD	Distance from the vessel's sheer or gunwale to the water.
GALLEY	A ship's kitchen.
GANGPLANK	Structure running from vessel to dock allowing people to board or debark (also known as a gangway).
GEAR	A general name for line, blocks, and other equipment aboard a vessel. Also term-for-personal affects of those on board.
GELCOAT	The outside color and finish coat used in fiberglass construction.
GIMBALS	Two moveable rings, one within the other, moving on horizontal pivots to provide level mounting of lamps, compass, chronometer, or other instruments.
GPS	Global Position System, A worldwide radio navigation system of high accuracy using orbiting satellites.
GRAPNEL	Anchor for small boat with 4 - 6 hooks at one end instead of flukes. Also used in dragging for objects on the bottom.
GUNWALE	Upper portion of a vessel's side; top edge of a small boat's sheer; top of any rail of a vessel (pronounced, gunnel).
HANDRAIL	Grab rail provided for the safety of personnel.
HATCH	Covered opening from deck to interior of a vessel.
HAWSER	Thick line used for towing or mooring large vessels.
HEAD	A vessel's toilet.

HEAD SEA	One that comes toward the bow.
HEADWAY	Forward motion of a vessel; normally used to indicate enough way forward to answer the helm.
HEAVE	To throw, as in to heave a line. Motion imparted to a vessel by waves.
HEAVE TO	To virtually stop a vessel's forward motion usually with its bow into the wind and seas or nearly so.
HEAVING LINE	Light line with weight attached at one end used to pass a larger line.
HEEL	To tilt, cant, or incline from the vertical position.
HELM	Term applied to tiller wheel, steering gear and rudder.
HELMSMAN	One who steers the boat.
HOLD	Interior part of a vessel in which cargo is stored.
INBOARD	Within the vessel or toward its fore and aft centerline.
INBOARD-OUTBOARD (1/0)	A marine propulsion system consisting of an inboard engine and an outboard drive unit connected through the transom.
JACOB'S LADDER	Also called jack's ladder. Ladder with wooded rungs strung together with rope.
JETSAM	Goods or cargo thrown overboard or jettisoned to lighten a vessel in distress.
KEDGE	A type of anchor. Kedging is to move a boat in water by hauling on a line attached to an anchor.
KEEL	The longitudinal member from which all frames and stems rise. The backbone of a vessel.
KNOT	A nautical mile-per-hour measure of a vessel's motion. A pattern of twists, curves, or turns that fastens a line into itself.
LANDFALL	First sighting of land when coming in from sea.

LANDLUBBER	A person who, from what of experience, is awkward or lubberly on board a vessel.
LANYARD	Small rope or cord used for certain purposes on board ship.
LARBOARD	Old term for "port", left side of vessel when facing the bow.
LASH	To fasten or tie down with cordage.
LAY	To move or go, as in "lay below."
LAZARETTE	Also lazaret. Below deck storage in the stern of a vessel, usually used to stow line, tackle, and other deck gear.
LEAD LINE	Sounding device consisting of a lead weight attached to a linemarked at intervals for measuring depth of water.
LEE	The side-opposite from which the wind blows.
LEEWARD	Toward the lee (pronounced, loo-erd).
LEEWAY	Sideways motion through the water to leeward caused by the pressure of wind and waves.
LENGTH	Measured from the fore part of the stem to the after part of
OVERALL	the stern along the centerline, excluding any projections that are not part of the hull (L.O.A.)
LIFELINES	Lines along the rail of a vessel supported by stanchions.
LINE	General term for cordage which has been made up for specific tasks. Ship operating business or firm (Cunard Line).
LIST	Lean of a vessel to one side or the other due to weight on board rather than pressure of wind and wave.
LOCKER	Storage closet or cabinet on board vessels.
LOG	Device used to measure the speed of a vessel.
LOGBOOK	Official record of activity on board a vessel. A journal of important happenings during the entire voyage.

LONGITUDINAL	Parallel to the keel; one of the structural members running fore and aft.
LOOKOUT	Watching. A place where watch is kept.
LORAN	LOng RAnge Navigation. Radio navigation system enabling the mariner to determine his position at sea by means of pulsed signals broadcast by two or more stations. LORAN-C.
LUBBER LINE	Mark in a compass indicating the fore and aft line of the vessel.
MADE FAST	Secured permanently to some object.
MAIN DECK	Highest deck which runs the full length of a vessel.
MANHOLE	Access to a tank, boiler, or compartment allow in a person to conduct inspections or maintenance.
MARLINESPIKE	Pointed metal device used to separate strands of cord or cable while splicing.
MARRY	Join the ends of two lines together.
MAST	Spar of wood or metal, usually circular in cross section, which is erected vertically on the centerline of a vessel.
MAYDAY	Phonetic spelling of the French “m’aider " which means help me. International Code of Signals words for distress.
MESSROOM	Compartment where ship's crew dines. Also called mess deck or galley.
MONKEY FIST	Large round knot at the end of a heaving line.
MOORING	Act of securing a vessel to a dock, buoy or other structure. A buoy, chain and anchor to tie a vessel to.
NAMEBOARD	Board or surface on which a vessel displays its name.
NOSE	Stem of a vessel, extreme forward end of bow.
OUTBOARD	Toward the sides of a vessel or outside it.
OUTBOARD MOTOR	An engine with a propeller attached, designed to be attached to the transom or stern of a vessel.
PAD EYE	Fitting having an eye intergral with a plate or base in order to distribute strain over a greater area.

PAY OUT	To slack away or allow to run out a line, chain or cable.
PENNANT	An emblematic flag usually having a greater length (fly) than breadth (hoist). Also a length of line for securing to an anchor buoy.
PIER	A structure of steel, concrete, or wood extending out from shore into a water area (dock) to provide mooring facilities.
PILOT	One who conducts vessels in and out of harbors.
PITCH	Motion of the ship with alternate fall and rise of bow and stern when passing over waves.
PITCHPOLE	A boat is said to pitchpole when it capsizes end over end.
PORT	Harbor; small opening in side of vessel; left side of vessel when facing bow.
PROPELLER	Multi-bladed, rotation wheel which furnishes propulation.(Also SCREW.)
QUARTER	Side of ship aft, between main midship frame and stern.
RADAR	Electronic system using superhigh radio waves; when reflected they show on a screen the position, sitance and size of an object. Radio detection and Range
RAIL	Upper edge of bulwarks.
RHUMB LINE	Curve which crosses all meridians at a constant angle.
RIGGING	A general term for various lines and Stays used in supporting or operating mots and booms. Standing rigging is more or less permanent; running rigging is moveable.
ROLL	Sidewise motion of a vessel caused by wind and wave.
ROPE	Cordage which has not been made into LINES, except for MANROPES, FOOTROPES, and BUCKET-ROPES.
RUB RAIL	Strip of molding protruding from the side of a vessel's hull.
RUDDER	The underwater part of a vessel's steering mechanism, usually a flat blade of wood or metal which can be turned right or left.

SAMSON POST	Short heavy mast used as boom supports and often used as Ventilators (kingpost). On small boats, a bitt located on the forward deck used for anchoring, mooring or towing.
SCOPE	Length of anchoring chain out.
SCUPPER	Any opening allowing for the drainage of water from a deck.
SCUTTLE	Small opening, usually circular, fitted with a cover which allows access to a manhole. As a verb, to sink a ship deliberately by opening seacocks or holing the hull.
SEA ANCHOR	A drogue, usually canvas sewn into a cone, thrown overboard to keep a vessel from drifting and help keep it pointed into the wind.
SEACOCK	A valve for opening or closing a pipe connection through the hull.
SEAWARD	Direction toward the sea.
SEA WALL	Man-made structure of rock or concrete built along a portion of coast to prevent shore erosion.
SECURE	Close a vessel's openings and make moveable objects fast.
SEIZE	To wrap, bind, or secure with small stuff (twine or wire).
SET	Direction toward which the current flows.
SEXTANT	A navigational instrument used on vessels to measure altitudes of sun, moon, and stars.
SHACKLE	Link with bolt fastened through its eyes, used for fastening chains and eye loops together.
SHAFT	The cylindrical rod which transmits power from the engine to the propeller.
SHEER	The fore and aft curvature of the deck and hull.
SHIP	In general, over 65.7' (civilian standards) or 100' Military standards.
SINK	To displace the volume of an underlying substance (water) and become submerged or partially submerged.
SKEG	Aftermost part of the keel on which the sternpost rests.
SKIN	Plating of a ship's hull.

SLACK	To ease off, as to slack a line at the dock.
SLIP	To let run overboard. The area of water between two wharves.
SONAR	Sound Navigation and Ranging an electronic device based on the principle that sound waves bounce back when they hit a target.
SOUNDING	To measure depth of water. SPAR General term for masts, gaffs, booms, and other poles.
STANCHION	A fixed upright post or beam used to support deck, rails, awnings, or lifelines.
STARBOARD	The right side of a vessel when facing forward.
STAY	Wire or rope used to support a mast fore and aft.
STEM	The foremost frame of a vessel reaching from the keel to the meeting of the port and starboard rails.
STERN	The after part of vessel, the part opposite the bow or stem.
STERNWAY	When a vessel responds to rudder, going astern.
STOW	Pack or put away. Load cargo.
STRAND	Run a vessel aground. Yards twisted together, when strands are twisted together, they form rope.
STRINGER	Large beam used as a fore and aft strengthening member.
STRUT	A bracket which supports the propeller shaft.
STUFFING BOX	A device designed to prevent water from leaking into a vessel from around the propeller shaft or rudder post.
SUPERSTRUCTURE	Any part of a vessel which extends above the uppermost complete deck (main deck).
SWAMP	To sink by taking on water over the rail.
SWELL	Ocean wave which has travelled out of its generating area.
TACKLE	Combination of lines and blocks for purpose of increasing pull.
TENDER	A vessel that heels over easily. Also a marine launch.

THIMBLES	Shaped metal placed inside an eye-splice in rope or wire to prevent chafing.
THWARTS	Transverse seat in a boat.
THWARTSHIPS	At right angles to the fore and aft line of a vessel.
TILLER	A bar of wood or metal fitted into the top of the rudder or an outboard motor by means of which the boat is steered.
TOPSIDE	That part of a hull above the designed waterline.
TRANSOM	The athwartships portion of the hull at the stern.
TRIM	The longitudinal balance of a vessel. If either the bow or stern is riding lower in the water the vessel is said to be trimmed by the bow or trimmed by the stern.
UNDERWAY	When a vessel moves through the water it is said to be underway. According to rules of the road, a vessel is underway at anytime it is not aground, at anchor, or made fast to shore.
VEER	To change or alter course by turning a vessel's stern to windward.
VESSEL	Under admiralty jurisdiction, "every description of water craft or other contrivance used or capable of being used as a means of transportation on water."
WAKE	Region of turbulence immediately to the rear of a body in motion through a fluid. Behind, water left astern of a vessel underway.
WASH	Waves created by the passage of a vessel.
WAY	Controlled movement of a vessel through water.- "Have way on" when the vessel is moving. "To have headway" when the vessel answers to the helm.
WEIGH	To lift or raise; as to weigh anchor.
WHARF	A waterside structure of wood, masonry, etc., at which vessels may be berthed for landing or taking on cargo or passengers.
WHEEL	Steering wheel connected to rudder also called the helm.
WHIPPING	Light twine wrapped around the end of a line.

WINCH	Device for hauling on a line or cable by turning a handle that revolves a drum.
WINDWARD	Direction from with the wind blows. Opposite of leeward.
YACHT	A pleasure vessel, sail or power, generally over 40', usually associated with luxury. Can be described for government vessels utilized by dignitaries or officials.
YAW	Motion of a vessel when thrown off course to either side by heavy seas on the quarter by a following sea.

EPO #1: IDENTIFY COMMON NAUTICAL ACCESSORIES FOUND ON AND AROUND VESSELS

As with any profession or skill, there are special terms that mariners use. Many of these terms have a long fascinating history. Fellow mariners will expect that you are familiar with these terms and use them in your routine conversation. It is a language all its own and just like any language which is foreign to our native tongue it requires practice and repetitious use to master.

First, what is a **vessel**? It is a broad generic term for every description of watercraft or other contrivance used as a means of transportation on the water. It could be described as a **Boat, Ship,** or **Yacht.**

Boat - Boat has no precise definition. It is a waterborne vehicle smaller that a ship. A traditional definition held that a boat can be carried on a ship but a ship cannot be carried on a boat.
Many consider a boat as being not over 65.7 feet (20 meters) in length, as used in the Rules of the Road.

The military considers a boat to be less than 100 feet (excluding tugs and submarines which are always called boats despite their length). "SMALL CRAFT" is often used interchangeably with boat.

Ship - A ship, in general, is a vessel over 65.7 feet (civilian standards) or over 100 feet (military standards). There are exceptions, however; Great Lakes freighters are often referred to as boats even though they might be several hundred feet long, as are submarines.

Yacht - A yacht is a pleasure vessel, either power or sail. The term usually denotes luxurious accommodations and not used for vessels under 40 feet (12.2 meters) in length. Also, it is used to describe government vessels used by dignitaries and officials (Presidential Yacht, Royal Yacht).

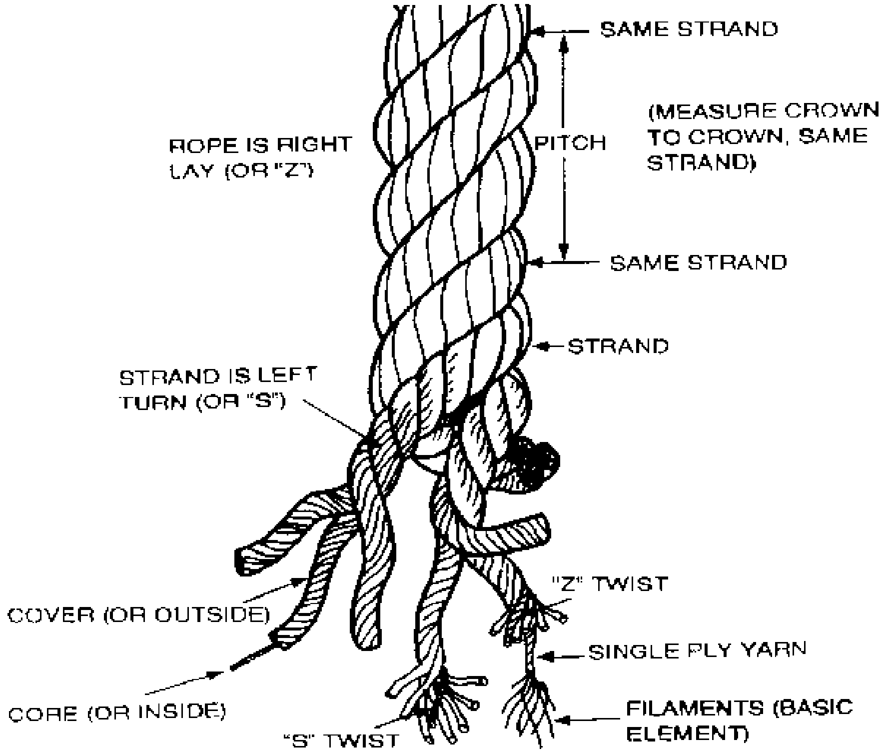
Crew members must be familiar with the use of the equipment carried on board and where it is located. Common nautical accessories found on vessels include the following:

CORDAGE

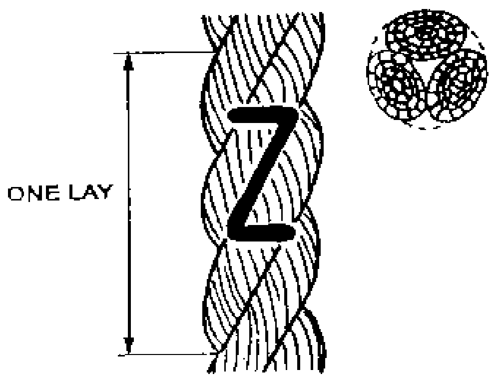
Marlinespike Seamanship is the art of handling and working with all kinds of line or rope. It includes knotting, splicing, and fancy decorative work. There is no better measure of a sailor's worth than skill in marlinespike seamanship. Much practice is required to become proficient in this skill. Knowledge of line handling terminology, phrases and standard communication among the crew is necessary. To be less than proficient may be costly when the safety of LIFE and PROPERTY depends on the crew's knowledge of marlinespike seamanship.

Rope – Cordage, lines made of fiber or steel; rope may be braided or formed with twisted strands; when in use aboard a vessel it is generally referred to as **line.**

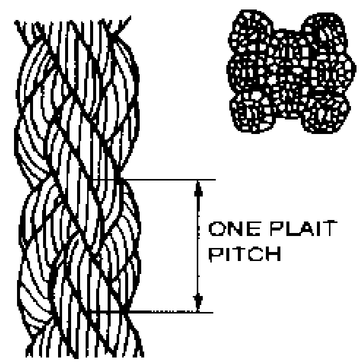
Line – A rope used aboard a vessel; laid line is formed by twisting three or more strands; braided line may be single or braid over a core.



THREE-STRAND ROPE COMPONENTS



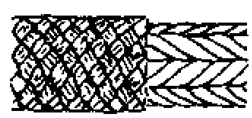
3-STRAND ROPE, "Z" LAY



8-STRAND ROPE

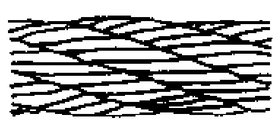
3-STRAND ROPE

12-STRAND ROPE

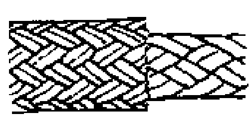


PARALLEL STRAND

8-STRAND ROPE



WIRELAY DESIGN



DOUBLE BRAID

GROUND TACKLE

All boats should carry basic equipment for the routine procedures, such as tying up, or anchoring.

There is also equipment that is needed to conduct specific operations, such as Law enforcement, search and rescue, towing, and pollution response.

Anchors for anchoring in calm, moderate, and heavy weather.

Anchor Lines - Provides scope to prevent the anchor from dragging. Enables retrieval of the anchor. Serves as an additional towline if necessary.

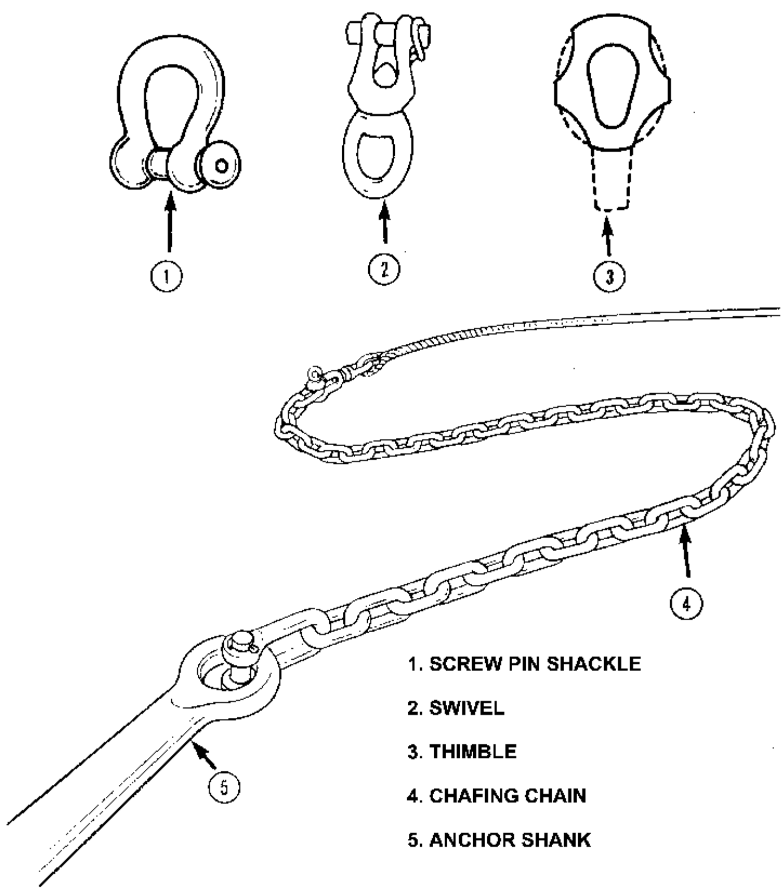
Chafing Chain - Assists in preventing chafing of the anchor line on the bottom.

Screw Pin Shackle - Attachs chafing chain to shank of anchor.

Swivel- Allows anchor line to spin freely.

Thimble- Prevents chafing of anchor line at connection point with associated hardware

There are various methods for securing the **rode** to the **anchor ring**. With fiber line, the preferred practice is to work and eye splice around a **thimble** and use a **shackle** to joint the thimble and ring.



DECK FITTINGS

Deck fittings are attachments or securing points for lines. They permit easy handling and reduce wear and friction on lines. (See Figure 1-1)

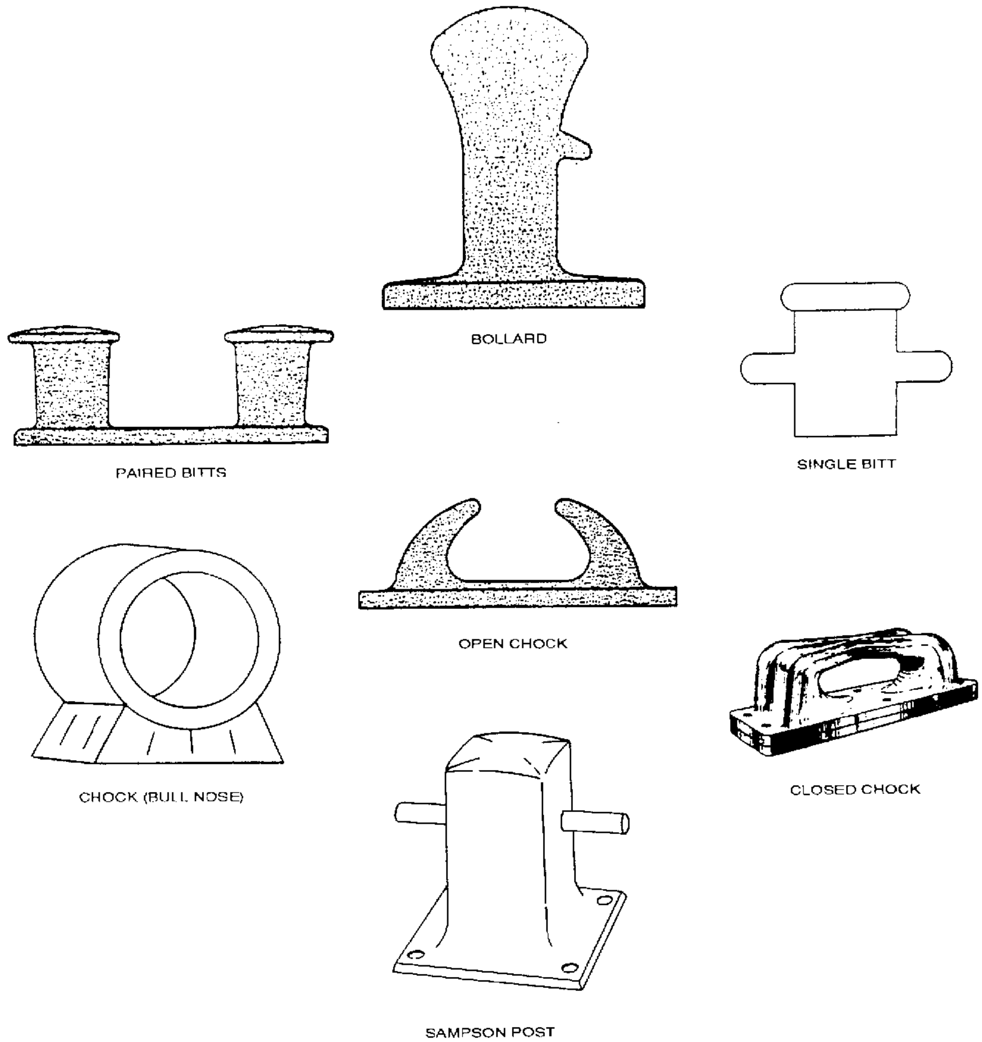


Figure 1-1

There are three basic types of deck fittings: Bitts, cleats, and chocks.

Closed chock with double bitts

All deck hardware that is used for towing should have back up plates to distribute the load over a wide area (See figure 1-3). The back up plate can be made of pressure treated hardwood or exterior grade plywood, at least twice as thick as the largest bolt diameter. Use bolts, not screws. A flat washer and a lock washer must be used with the bolt. The flat washer is three times the bolt diameter. If metal is used, the thickness should be at least the same as the bolt diameter. The use of soft aluminum is not recommended. Bedding compound should be used in all installations

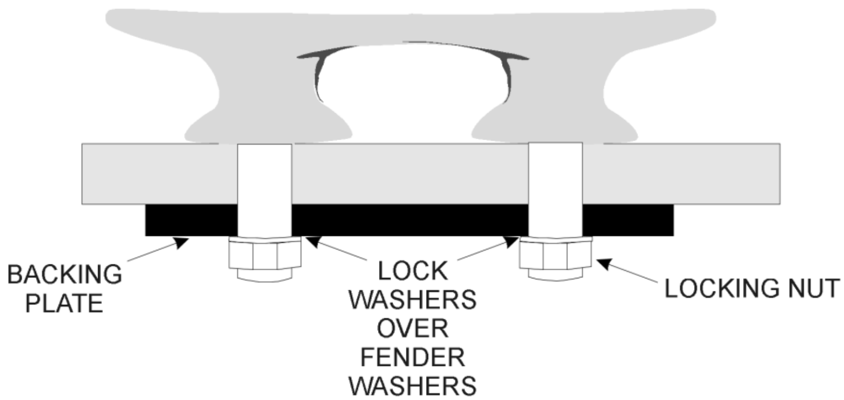


FIGURE 1-3

The size of the deck hardware depends on the size of line to be used for mooring docking and towing. Cleats are sized by length, and the rule of thumb is the line should be 1/16" in diameter for each inch of cleat ($^{3}/_{8}$" line = 6" cleat, 1/2"line = 8" cleat.

Deck fittings used during towing.

It is not always possible, appropriate, or safe to attach a towline from the stern of a towing vessel to a single point on the bow of a distressed vessel. The distressed vessel's deck layout may not have a single direct run through a bull nose; there might not be a Samson post (see figure 1-4) or centered bitt; the towline might be too large for deck fittings; or deck fittings may be improperly mounted, rotted or corroded where they attach to the deck. In these cases, rig a pendant or bridle.

Figure 1-4

Towline - Used for towing astern

Alongside Lines - Used for alongside towing, joining to kicker hooks, passing a pump, etc.

Heaving Lines (75' to 100') - Used for passing a towline when a close approach is not possible

Boat Hook - For reaching dockside lines, fending boat from boat, and recovering objects from water.

Compass- A navigational instrument, either magnetic or electrical gyro**.** Magnetic compasses are ususally found in a **Binnacle** (see figure 1-5**)** which is a stand or housing in which the magnetic compass is housed.

Figure 1-5

Kicker Hook - Attaches to trailer eyebolt on small boats for towing, weighing anchor, or disabled boats, etc.

Shackles - For weighing a disabled boat's anchor, attaching towing bridles to towlines, attaching towlines to trailer eyebolt, etc.

First Aid Kit - For emergency treatment of injuries suffered by crew members or survivors.

WARNING	**In lightweight or highly buoyant outboard powered boats, use of full power in tight turns can cause loss of control or ejection of crew or coxswain. If installed, the helmsman should always attach engine kill switch lanyard to themselves.**

Personnel Survival Kits - Used by crew members in the event of a capsizing or person overboard.

Personal Floatation Devices (PFDs) - Each with a distress signal light, a whistle, and retroreflective tape provides personal flotation support. Worn by all crew members and given to persons who are brought on board. Also worn by persons who remain on their own boat when it is in tow.

Ring Buoy - 30" diameter Used during person overboard emergencies

Harbor - A water area that provides anchorage protected from wind and seas.

Port - A harbor including all its facilities

Yacht Basin - A protected facility for recreational craft, also called a MARINA.

Dock - A water area in which a boat lies when made fast to shore.

Wharf - A structure parallel to shore at which boats may moor.

Pier - A structure that projects out from shore at which boats may moor.

Travel Lift - Mobile cranes which haul out boats by lifting them on SLINGS.

Cradle - Framework that supports a boat on ground after it has been hauled out.

Slip - The space between neighboring piers.

EPO #2: IDENTIFY THE TERMINOLOGY OF DIRECTION AND MOTION ABOARD A VESSEL

Terminology of direction and motion aboard a vessel:

The following are common terms used for location, position and direction aboard a boat

The front end of a boat is the **bow**. When <u>you</u> move toward the bow, you are going **forward;** when the <u>boat</u> moves forward, it is going **ahead**. When facing the bow, the front right side is the **starboard bow**, and the front left side is the **port bow**.

The central or middle area of a boat is **amidships**. The right center side is the **starboard beam,** and the left center side is the **port beam.**

The rear of a boat is the **stern**. When you move toward the stern, you are going **aft.** When the boat moves backwards, it is going **astern.** If you are standing at the stern looking forward, you call the right rear section the **starboard quarter** and the left rear section the **port quarter.**

The entire right side of a boat, from bow to stern is called **starboard**. The entire left side of a boat, from bow to stern is called **port.**

A line, or anything else, running parallel to the centerline of a boat is said to run **Fore** and **aft**.

A line or anything else running from side to side is said to be **Athwartships.**

From the centerline of the boat toward either port or starboard side is considered to be **outboard.** From either side toward the centerline; however, there is a variation in the use of outboard and inboard when a boat is tied up alongside something (e.g., pier or another vessel). The side tied up is inboard; the side away is outboard.

Moving from a lower deck to a weather deck or upper deck is considered **going topside**. Moving from an upper deck to a lower deck is considered **going below**.

Windward is the direction from which the wind is blowing; toward the wind. **Leeward** is the Opposite point from which the wind is blowing; away from the wind. Pronounced "loo-urd."

Figures 2-1 and 2-2 provide diagrams of boats with the more common terms noted

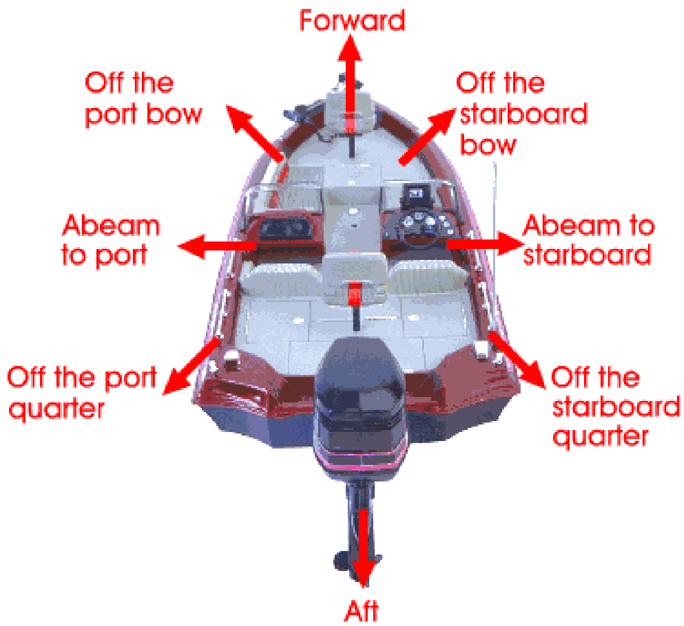


Figure 2-1

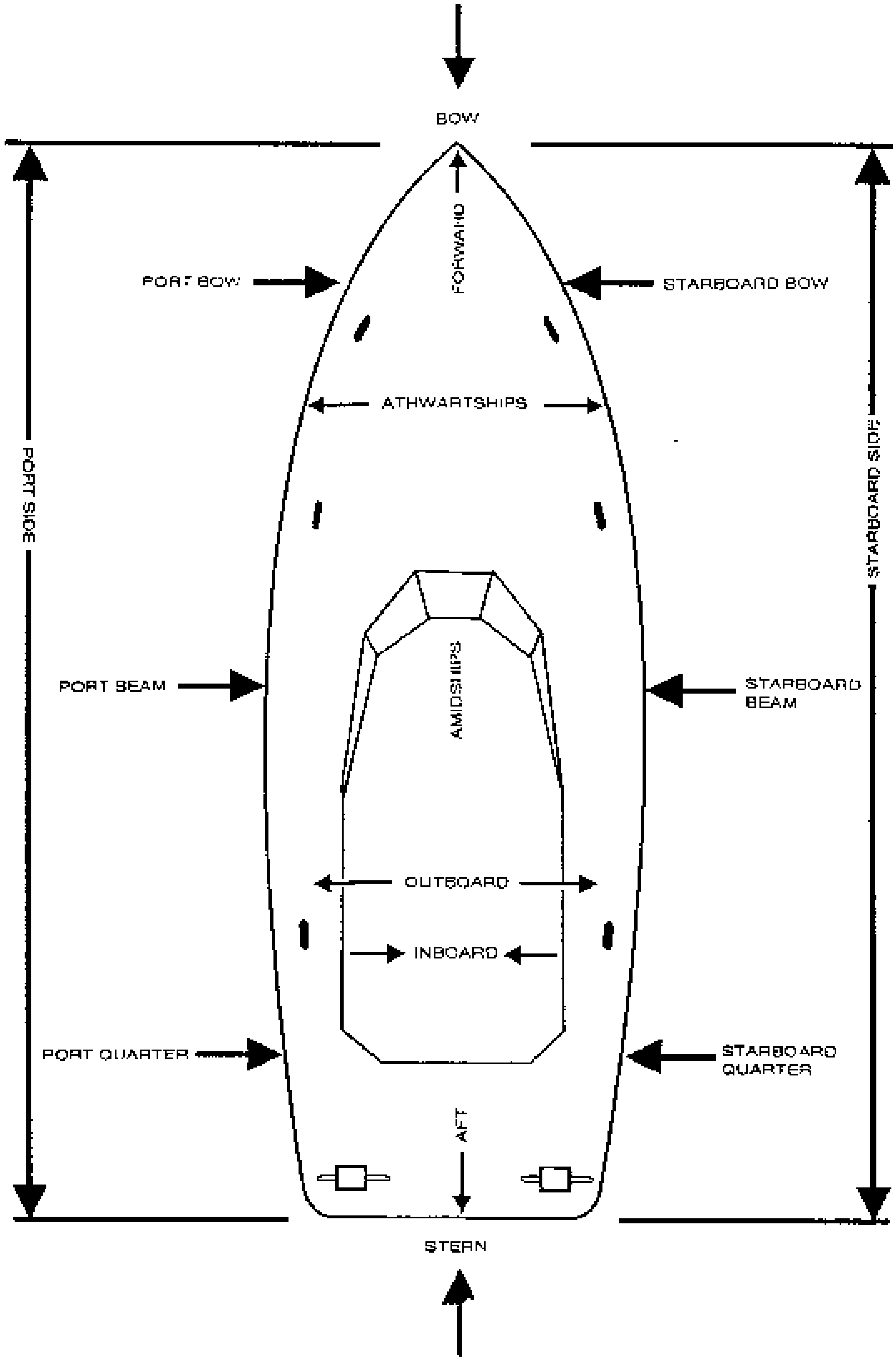

BOW
FORWARD
PORT BOW
STARBOARD BOW
ATHWARTSHIPS
PORT SIDE
STARBOARD SIDE
AMIDSHIPS
PORT BEAM
STARBOARD BEAM
OUTBOARD
INBOARD
PORT QUARTER
STARBOARD QUARTER
AFT
STERN

FIGURE 2-2

The hull (see figure 3-1) is the main body of a boat. It consists of a structural framework and a skin or shell plating. The hull may be constructed of many different materials, the most common being metal or fiberglass. A metal skin is usually welded to the structural framework, although riveting is sometimes used.

FIGURE 3-1

EPO #3: IDENTIFY BASIC HULL TYPES AND MAJOR STRUCTURAL COMPONENTS OF VESSELS

A vessel could be mono-hull or multi-hull, such as catamarans and trimarans. The three basic types of hull forms based on vessel speed are:

- Displacement hull
- Planing hull
- Semi-displacement hull

Many factors influence hull shapes and affect the boat's **buoyancy** (its ability to float) and **stability** (its ability to remain upright).

Factors that influence hull shapes are discussed as follows:

Flare is the outward turn of the hull as the sides of the hull come up from the water line. As the boat is launched into the water, the flare increases the boat's displacement and creates a positive buoyant force to float the boat.

Tumble home is the reverse of flare and is the shape of the hull as it moves out going from the gunwale to the water line. This feature is most noticeable when viewing the transom of an older classic cruiser.

A deck usually curves athwartships, making it higher at the centerline than at the gunwales so the water flows off the deck. This curvature is called **camber.**

Sheer is the curvature of the main deck from the stem to the stern. When the sheer is pronounced and the bow of the boat is higher than the main deck at amidship, additional buoyancy is provided in the bow. Reserve buoyancy is the additional flotation provided by flare and sheer.

The turn of the boat's hull below the water line is called the **chine**. It is "soft" if it is rounded and "hard" if it is squared off. Chine affects the boat's speed on turning characteristics.

The **transom** at the stern of the boat is wide, flat, or curved. The shape of the stern affects the speed, hull resistance, and performance of the boat.

The boat's **length on water line** (LWL) is the distance from the bow to the stern, measured at the water line when the boat is stationary. Note that this length changes as the boat rides high or low in the water. Another way of measuring the length of the boat is the length of the craft from its stem to its stern in a straight line. This is termed **length over all** (LOA) and does not change according to the way the boat sits in the water.

Beam and **breadth** are measures of a boat's width. Beam is the measurement of the widest part of the hull. Breadth is the measurement of a frame from its port inside edge to its starboard inside edge.

a. **Molded beam** is the distance between outside surfaces of the shell plating of the hull at its widest point.

b. **Extreme breadth** is the distance between outside edges of the frames at the widest point of the hull.

Draft is the depth of the boat from the actual waterline to the bottom of its keel.

Draft appendage is the depth of the boat from the actual water line to the bottom of its keel or other permanent projection (e.g., propeller, rudder, skeg, etc.), if such a projection is deeper than the keel. The draft is also the depth of water necessary to float the boat. The draft varies according to how the boat lies in the water

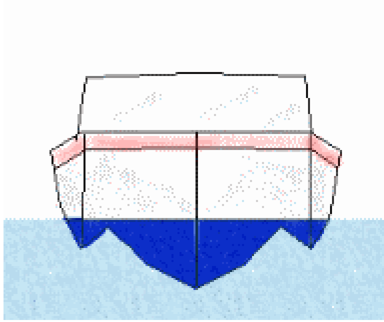
Trim is a relative term that refers to the way the boat sets in the water and describes generally its stability and buoyancy. A **change in trim** may be defined as the change in the difference between drafts forward and aft. A boat is **trimmed** by the bow when the draft forward increases and the draft is greater than the stern draft. A boat is trimmed by the stern if it is down by the stern.

A **displacement hull** boat pushes away (displaces) water allowing the hull to settle down into the water. Underway, the hull pushes out this water, creating waves. Displacement vessels are designed to move through the water with a minimum of propulsion. They will have a large underwater profile and will ride comfortably although slowly. Trawlers and large sailing vessels are displacement vessels. Tremendous forces work against a displacement hull as the power pushing it and the boat's speed both increase. At maximum displacement speed, there is a distinct **bow** and **stern** wave. The length of these waves depends upon the boat's length and speed. (The longer the boat the longer the wave length.) The bow and the stern ride lower in the water as you increase speed and the water level alongside, amidships becomes lower than that of the surrounding water.

WARNING □ **When towing a vessel, be careful not to tow beyond the vessel's design speed.**	This is caused by the increase in the velocity of the water flowing under the boat and its interaction with the bow and stern wave. As the boat travels along, it rides in a depression created by its own passage. The displacement hull vessel's maximum speed is determined by the vessel's waterline length**.** Heavy displacement hulls cannot exceed a speed of 1.34 times the square root of their waterline length without requiring excessive power. This speed is known as **critical** speed. When towing a vessel, you must be careful not to tow beyond that vessel's critical speed. For details on towing displacement hulls.

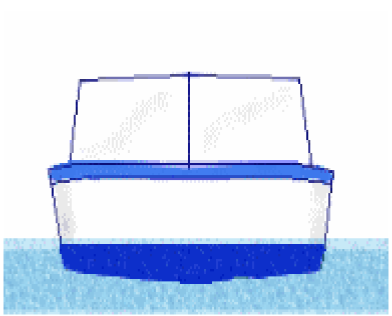
Planing hull - At rest the planing hull and the displacement hull both displace the water around them. The planing hull reacts nearly the same as a displacement hull when it initially gets underway - it takes considerable power to produce a small increase in speed. But at a certain point, external forces acting on the shape cause an interesting effect - the hull is lifted up onto the surface of the water. (See Figure 8-3) The planing hull skims along the surface of the water whereas the displacement hull always forces water around it. This is called planing. Once "on top," the power/speed ratio is considerably altered--very little power increase results in a large increase in speed. You must apply power gradually when going from the displacement mode to the planing mode or from the planing mode to the displacement mode.

When you decrease the power gradually, the hull makes an even, steady transition, like slowly moving your hand from above the water's surface, through it, and into the liquid below. However, if power is rapidly decreased the transition will be a rough one, for the hull will slap the surface of the water like the slap resulting by hitting a liquid surface with your hand. Additionally, the rapid "re-entry" into the displacement mode from above the surface, through the surface, and back into the water causes rapid deceleration as the forces in the water exert pressure against the hull. The effect is like

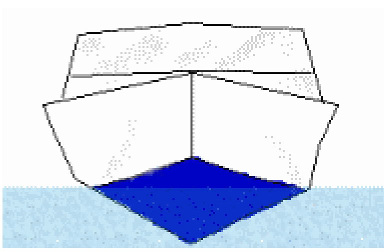


rapidly braking an automobile

Semi-displacement hull - The semi-displacement hull is a combination of characteristics of the displacement hull and the planing hull. Many Coast Guard boats are this type (e.g., 44 ft MLB). This means that up to a certain power level and speed (power/speed ratio), the hull remains in the displacement mode. Beyond this point, the hull is raised to a partial plane. Essentially, the semi-displacement hull, like the displacement hull, always remains in the water; it never gets "on top." When in the displacement mode, the power/speed ratio is similar to the power/speed ratio described above for the displacement hull. When in the semi-planing mode, it is affected by a combination of forces for the displacement mode and some for the planing mode. Thus, while a small power increase will increase speed, the amount of resulting speed will not be as great as the same power increase would produce for a planing hull.

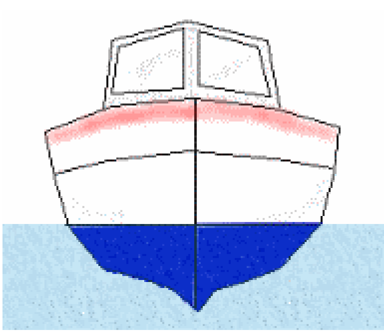


Flat bottom boat - These boats are generally less expensive to build and have a shallow draft. They can get up on plane easily but unless the water surface is perfectly calm they tend to give a rough ride because of the flat bottom pounding on each wave. They also tend to be less stable and require careful balancing of cargo and crew. Examples of flat bottom boats might be Jon boats, small utility boats, and some high speed. runabouts



Vee bottom boat - The vee bottom tends to have a sharper entry into the water which provides for a smoother ride in rough water. They do, however, require more power to achieve the same speed.

Many runabouts use the vee-bottom design.



Round bottom boat - These move easily through the water, especially at slow speeds. They do, however, tend to roll unless they are outfitted with a deep keel or stabilizers. Many trawlers, canoes and sailboats have round bottoms.

Multi-hull boat - Catamarans, trimarans, pontoon boats and some house boats carry the multi-hull design. The wide stance provides greater stability. Each of the hulls may carry any of the above bottom designs.

Frames are attached to the keel, which extend athwartships (from side to side). The skin of the boat is attached to the frames. The keel and the frames strengthen the hull to resist external forces and distribute the boat's weight.

The **stem** is an extension of the forward end of the keel. Although there are a number of common stem shapes, all are normally slanted forward (raked) at an upward angle to reduce water friction.

The **sternpost** is a vertical extension of the aft end of the keel.

Keel - There are many types of keels. However, in metal boats, there are two types of particular interest: the bar keel and the flat plate keel.

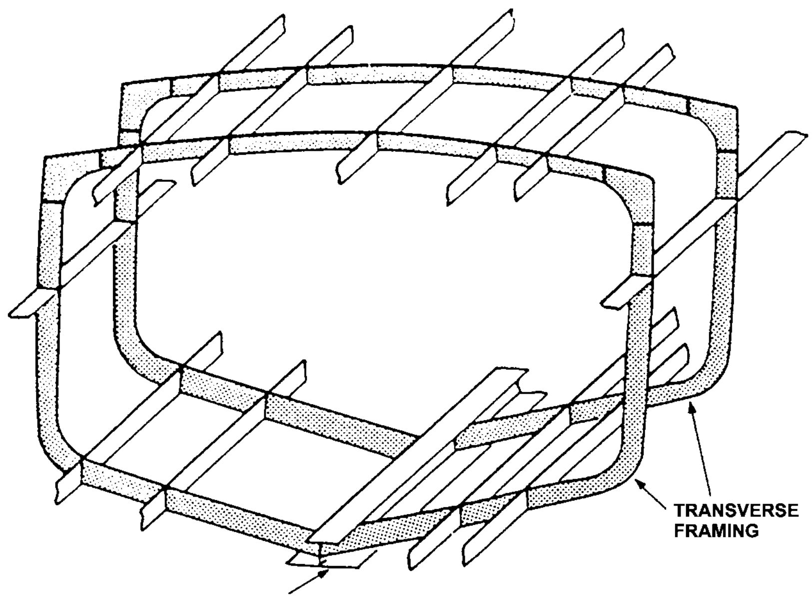
The bar keel is popular because of its **stiffeners** (vertical or upright members which increases strength) protect the boat's hull plating if the boat grounds on a hard bottom. It also reduces rolling in much the same way as the more modern bilge keel does.

The bilge keel is a fin or stabilizer fastened horizontally to the turn of the bilge. A disadvantage of the bar keel is that, because it extends below the bottom of the boat, it increases the boat's draft.

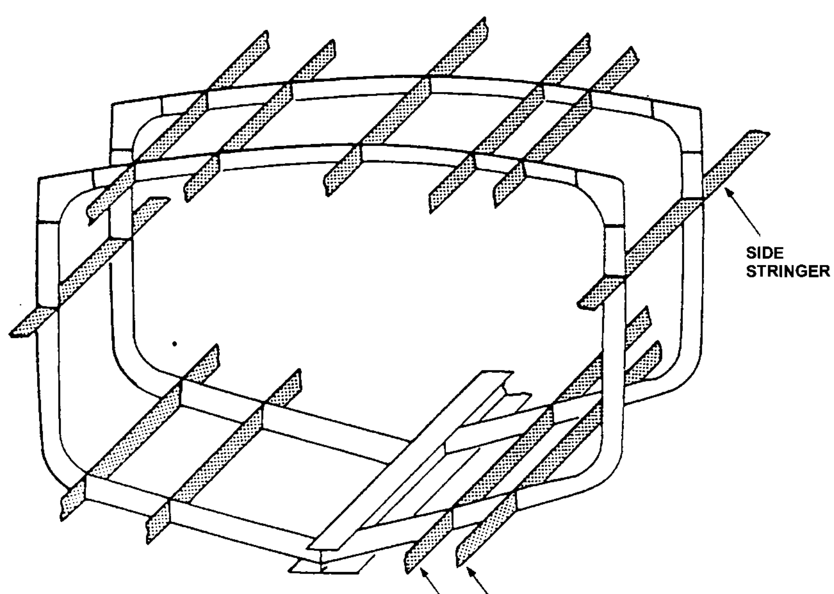
It consists of an "I" beam fastened to the flat plate or it may be built-up from a "rider plate" - a metal plate reinforcing the upper or inner surface of the keel, a vertical keel, and a flat keel. The flat keel, with its vertical keel and rider plate, is built within the boat's hull.

As previously stated, it is the framing that gives the hull its strength. Frames are of three types; watertight, bulkheads, or **web frames** are located at certain points in the hull to further increase the strength of the hull.

Just as the keel is the backbone of the hull, **transverse frames** are often referred to as ribs. Transverse frames extend athwartships and are perpendicular (vertical or upright) to the keel and are spaced at specified distances. (See Figure 8-8). They vary in size from the bow to the stern giving the boat hull its distinct shape when the skin is attached. They are numbered from the bow to the stern to help you quickly identify a particular location in the interior and, in the event of damage to the hull, to isolate the area of damage.

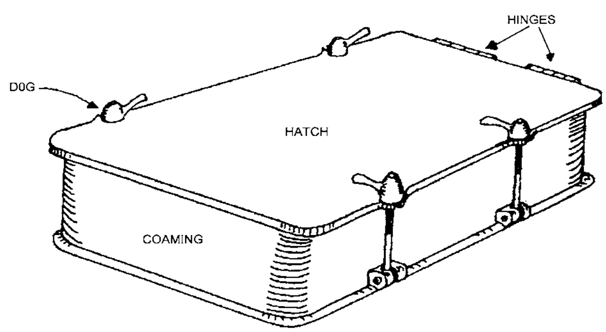


Longitudinal frames provide hull strength along the length of the hull (fore and aft). (See Figure). As you will note, they run parallel to the keel and at right angles to the transverse frames. In addition to strengthening the hull, the top longitudinal frames provide a skeletal structure over which deck plating is laid.

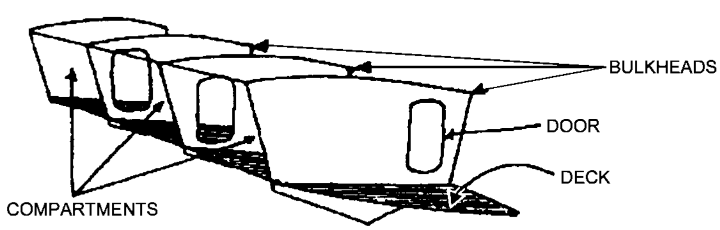


A deck is a seagoing floor and provides strength to the hull by reinforcing the transverse frames and deck beams. The top deck of a boat is called the weather deck because it is exposed to the elements and is watertight. In general, decks have a slight downward slope from the bow. The slope makes any water taken aboard run aft. A deck also has a rounded, athwartship curve called **camber.** The two low points of this curve are on the port and starboard sides of the boat where the weather deck meets the hull. Water that runs aft down the sheer line is forced to the port or starboard side of the boat by the camber. When the water reaches one of the sides, it flows overboard through holes, or **scuppers**, in the side railings.

If decks are seagoing floors, then **hatches** are seagoing doors. In order for a **bulkhead** (a seagoing wall) with a hatch in it to be watertight, the hatch must be watertight. A weather deck hatch is made watertight by sealing it into a raised framework called a **coaming.** Hatches operate with quick-acting devices such as wheels or handles or they may be secured with individual dogs.

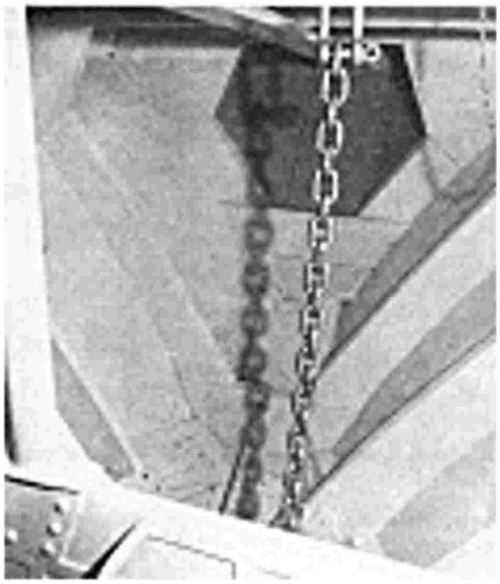


The interior of a boat is compartmentalized into bulkheads, decks, and hatches. The hatches are actually "doors" through the decks (see Figure). These watertight compartments are extremely important. Without them the boat has no **watertight integrity** and a hole anywhere in the hull will cause it to sink.

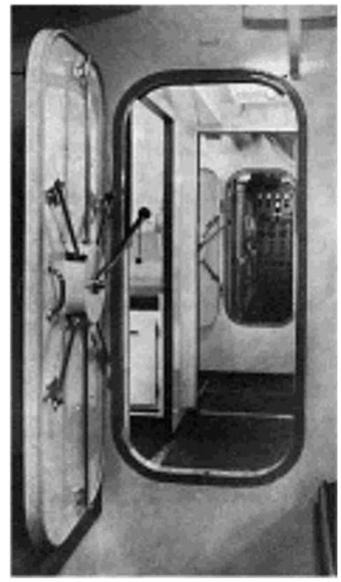


By dividing the hull into several watertight compartments, the watertight integrity of the boat is significantly increased. One or more of these compartments may flood without causing the boat to sink. A boat could be made unsinkable if its hull could be divided into enough watertight compartments. Unfortunately, excessive compartmentation would interfere with the engineering spaces and restrict your movement in the interior spaces.

A forecastle (see figure) is the cabin furthest forward. The Lazarette is the storage compartment in the stern of the boat. These compartments are usually watertight. You must enter passageways (figure) with hatches to access them.



Figure



Figure

Bow - The shape of a boat's bow, its profile, form, and construction determine hull resistance as the boat advances through the water. Hull resistance develops from friction and from the wave the hull makes as it moves in the water. Wave making resistance depends on the boat's speed.

The bow of a boat must be designed with enough buoyancy so it lifts with the waves and does not cut through them. The bow flare provides this buoyancy.

Boats intended for operation in rough seas and heavy weather have "full" bows. The bow increases the buoyancy of the forward part of a boat and deflects water and spray. When a boat is heading into a wave, the bow will initially start to cut into the wave. It may be immersed momentarily if the seas are rough. As the bow flare cuts into the wave it causes the water to fall away from a boat's stern, shifting the center of buoyancy to move forward from the center of gravity. The bow lifts with the wave and the wave passes under the boat, shifting the center of buoyancy aft. This action causes the bow to drop back down and the vessel achieves a level attitude.

The shape of the stern affects the speed, resistance, and performance of the boat. It also affects the way water is forced to the propellers.

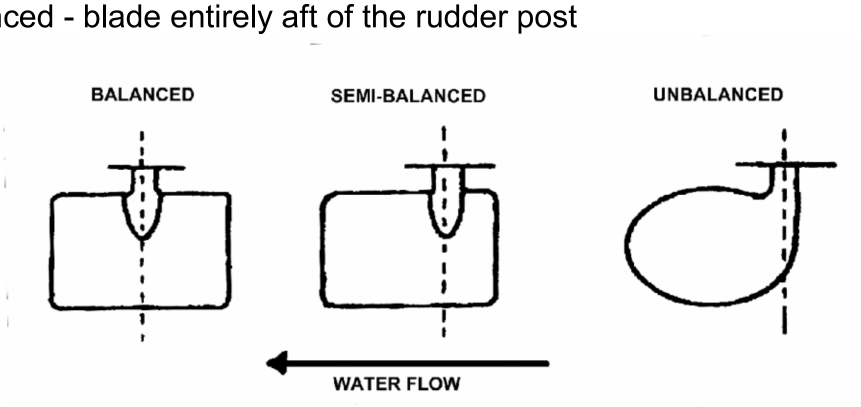
The design of the stern is critical in following seas where the stern is the first part of a boat to meet the waves. If the following waves lift the stern too high, the bow may be buried in the sea. The force of the wave will push the stern causing it to pivot around toward the bow. If this is not controlled, the result can be that a boat pitch poles or broaches.

The rudder controls the direction of the boat and may vary widely in size, design, and method of construction. The shape of the stern, the number of propellers, and the characteristics of the boat determine the type of rudder a boat has.

Rudder types are shown in

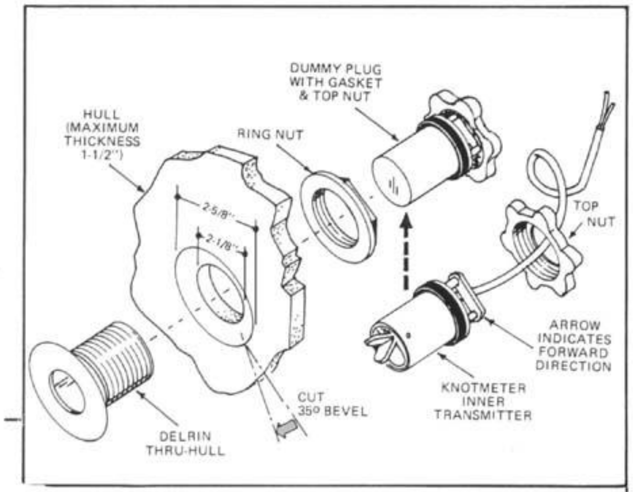
- Balanced - blade about half forward and half aft of the rudder post
- Semi-balanced - more than half of the blade aft of the rudder post

- Unbalanced - blade entirely aft of the rudder post



Zincs - Sacrificial metal that is attached to the hull or a underwater metal surface to help prevent the destruction of metal by electrolysis.

Through-Hull Fitting - Fitting that allows the intake or discharge of water, and also a water-tight fitting that allows electronic devices to pass the hull. See figure below.



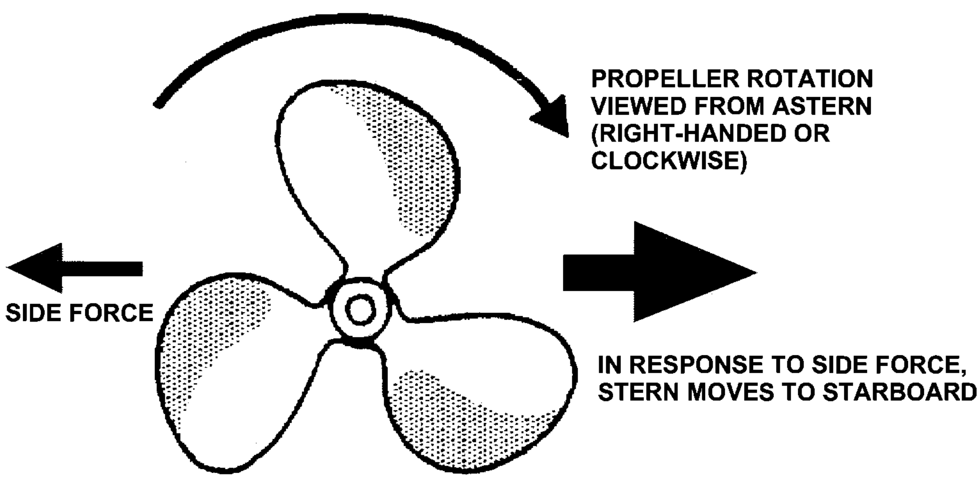
Props - Most boats are driven by one or more screw propellers which move in spirals somewhat like the threads on a screw. That is why the propeller is commonly referred to as a screw.

The most common propellers are built with three and four blades. The propeller on a single-screw boat typically turns in a clockwise direction (looking from aft forward) as the boat moves forward. Such screws are referred to as "right-handed." On twin screw boats, the screws turn in opposite directions, rotating outward from the centerline of the boat. The port screw is "left-handed" and turns counter-clockwise. The starboard screw is "right-handed" and turns clockwise.

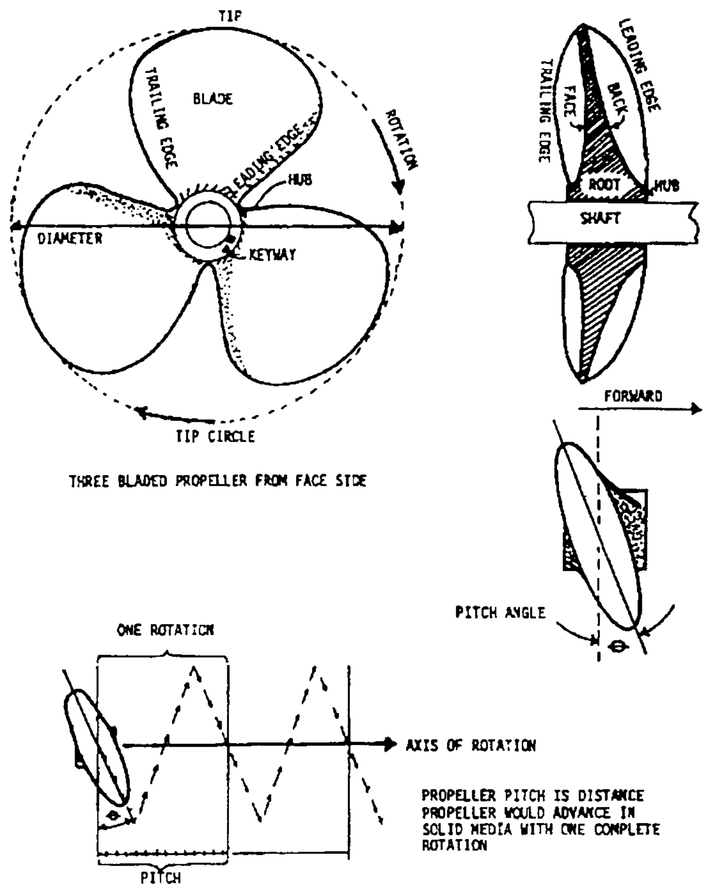
A propeller consists of blades and a hub. The area of the blade down at the hub is called the **root** and its outer edge is called the **tip.**

The edge of the blade that strikes the water first is the **leading edge**; the opposite is the **following edge.**

Facts to remember **About Props and forces that affect your vessel**	*The important facts to know: for a right-handed screw turning ahead, the stern will tend to move to starboard(see figure , and for a right-handed screw when backing, the stern will tend to move to port. For a left-handed screw (normally the port shaft on a twin-screw boat), the action is the opposite.* *An easy way to remember how side force will push the stern is to think of the propeller as a wheel on the ground. As the wheel rolls clockwise, it moves to the right. As a propeller turns clockwise when viewed from astern, the stern moves to starboard.*



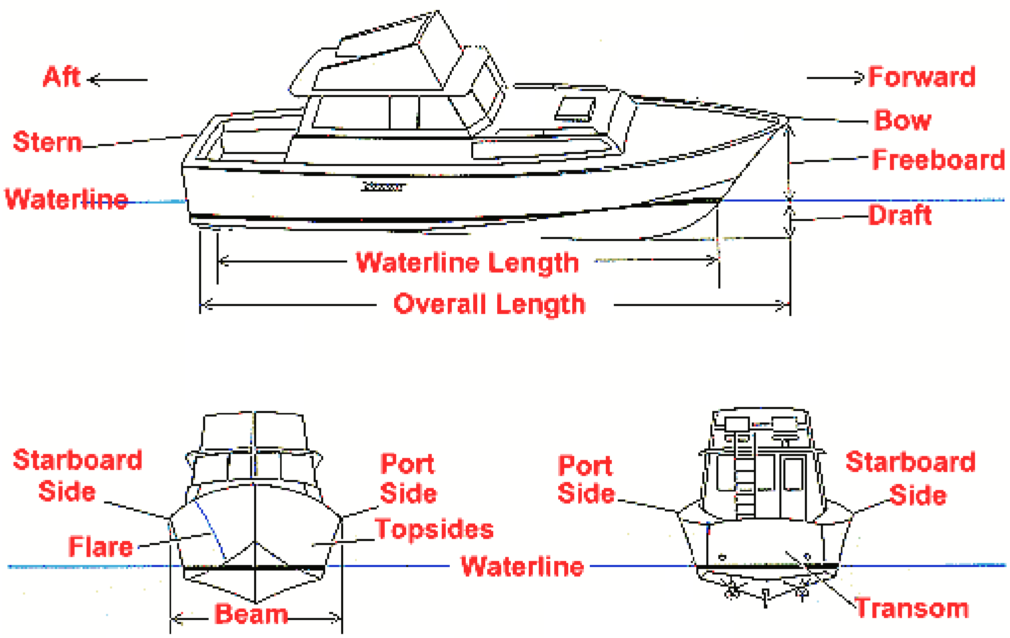
The diameter of the screw, the circle made by its tips and its circumference, is called the **tip circle.** Each blade has a degree of twist from root to tip called **pitch.** Pitch is the distance a propeller advances in one revolution with no slip (see Figure). Generally, less pitch in the same diameter propeller makes it easier for the engine to reach its preferred maximum RPM; thus, like putting a car in first gear, more power (and sometimes more speed) is available. Similarly, (like third gear in a car) more pitch may give more speed, but lower RPMs gives less power. Optimum performance is obtained when pitch is matched to the optimum design speed (RPM) of the engine.



BOAT MEASUREMENTS

There are specific terms for the length and width of a boat and also specific methods for determining these measurements.

The overall length of a boat is technically called the length overall (LOA) and is the distance from the foremost to the aftermost points on the boat's hull.



The waterline length of a boat is technically called the length on water line (LWL). It is the distance between fore and aft where the surface of the water touches the hull when a boat is normally loaded.

Beam and breadth are measures of a boat's width. **Beam** refers to the distance from the outside hull plating on one side of the boat to the outside hull plating on the other side. **Breadth** refers to the distance between the outside edge of a frame on one side.

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

Gross tons - The entire cubic capacity of a boat expressed in tons of 100 cubic feet.

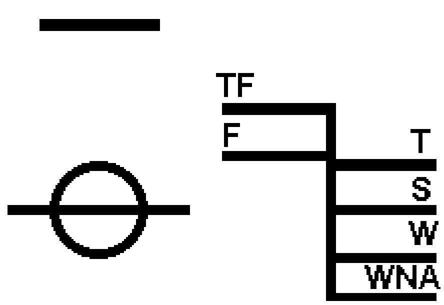
Net tons - The carrying capacity of a boat expressed in tons of 100 cubic feet. It is calculated by measuring the cubic content of the cargo and passenger spaces.

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

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

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

Cargo ships have markers called the "International Loading Line", "Plimsoll Line" or "**load line**" indicating the maximum depth a vessel can be loaded to in different waters. It is illegal for a ship's master to allow their vessel to be loaded any deeper than the marks indicate. From your knowledge of Hydraulics you should understand why. Imagine, for example if the ship was loaded to the very top mark in the Northern Atlantic (i.e., to the TF mark) and then sailed to a fresh water port. It would sink lower down in the fresh water. If there was a storm the ship could be in danger of sinking**.**

Plimsoll Line - The International Load Line for Shipping	
	**(a) the *Summer load line*, shall correspond horizontally with the line passing through the centre of the ring of the load line mark, and shall be marked S;** **(b) the *Winter load line*, which shall extend forward of the vertical line, and be marked W;** **(c) the *Winter North Atlantic load line*, which shall extend forward of the vertical line, and be marked WNA;** **(d) the *Tropical load line*, which shall extend forward of the vertical line, and be marked T;** **(e) the *Fresh Water load line*, which shall extend abaft the vertical line, and be marked F; and** **(f) the *Tropical Fresh Water load line*, which shall extend abaft the vertical line and be marked TF.**

U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

STUDENT TEXT

ELECTRONIC NAVIGATION	
7568	JAN/10

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DESCRIPTION:

Through classroom lecture and learning activity, the student is familiarized with the basic procedures for energizing, optimizing the display, and using a marine radar unit to assist in safe navigation in a marine environment. Additionally, this course requires the student to demonstrate navigation using a GPS and to determine the accuracy of a GPS.

TERMINAL PERFORMANCE OBJECTIVE (TPO):

Given a marine radar unit with integrated GPS chartplotter, the student will identify the principles of radar, energizing and tuning procedures, basic operating procedures, and methods for using them during marine craft operation and determining the accuracy of a GPS receiver in accordance with standard maritime practices and procedures.

ENABLING PERFORMANCE OBJECTIVES (EPOS):

EPO #1: Identify the basic operating principles of radar.

EPO #2: Identify the basic controls for marine radar and chartplotter units.

EPO#3: Identify the positioning abilities of a marine radar unit.

EPO #4: Identify the basic operational functions of a marine radar unit.

EPO #5: Identify the basic operational functions of an integrated GPS chartplotter.

EPO #6: Identify the minimum steps needed to correctly plot a position on a chart from information provided by a GPS receiver.

EPO #7: Identify the types of information a GPS receiver may provide a user.

EPO #8: Describe the reasons for performing an electronic navigation accuracy verification (ENAV).

EPO #9: Identify the procedures for performing an ENAV.

Table of Contents

INTRODUCTION

RAPPORT AND OPENING STATEMENT

1. Radar, Chartplotters, and GPS are valuable aids to safe navigation.
   a. None of these navigational tools should ever be relied on as the sole means of obtaining navigational data.
   b. Proper radar operation can assist the navigator in periods of reduced visibility, determining the position of other vessels for law enforcement purposes, or when out of sight of land.
   c. Radar also has benefits as a collision avoidance device.
   d. Chartplotters provide the operator with a great deal of useful information, but they do not fulfill the need of having a nautical chart of the area of operation onboard.
   e. GPS is a valuable tool for determining your location and for navigating from one point to another, but it does not take into account what hazards to navigation may exist between points.
   f. Law enforcement officers should understand the importance of determining a GPS receiver's accuracy, as well as the procedures for doing so.
2. Neither radar nor GPS is a substitute for chart interpretation, local area knowledge, or maintaining a proper lookout.
   a. Always practice using radar and GPS during good visibility.
   b. Practice these systems while using a nautical chart and compare information from the systems to the chart.
1. Installed chartplotters routinely have accuracy errors of between 3 and 12 yards. This does not sound like much, but can be a major problem when in narrow waterways.

PRESENTATION

A. EPO #1: IDENTIFY THE BASIC OPERATING PRINCIPLES OF RADAR.

1. Definition of RADAR is: **<u>Ra</u>**dio **<u>D</u>**etection **<u>a</u>**nd **<u>R</u>**anging. Pulse-modulated high frequency radio waves are utilized to measure direction and range to an object.

2. The major components of a radar unit are:

   a. The Modulator. The function of the modulator is to insure that all circuits involved operate in a definite time relationship with each other, and the time interval between pulses is the proper length. The modulator sends a synchronizing signal to trigger the transmitter and display unit which provides the time reference for the travel of the transmitted pulse to an object, and its return as an echo on the display unit.

   b. The Transmitter. Also known as a Magnetron, the transmitter generates the radio frequency (RF) energy in the form of pulses which are turned on and off by the modulator. The transmitted RF energy travels at the speed of light (162,000 nm per second).

   c. The Antenna. The antenna takes the RF energy generated by the transmitter and directs this pulsed energy in a specific direction (a beam). The antenna then receives the returned energy, called echoes (or reflections) from any object large and solid enough to cause the RF energy to bounce off. The returning RF pulsed energy is received by this same antenna while in receive mode, and then passes these signals to the receiver.

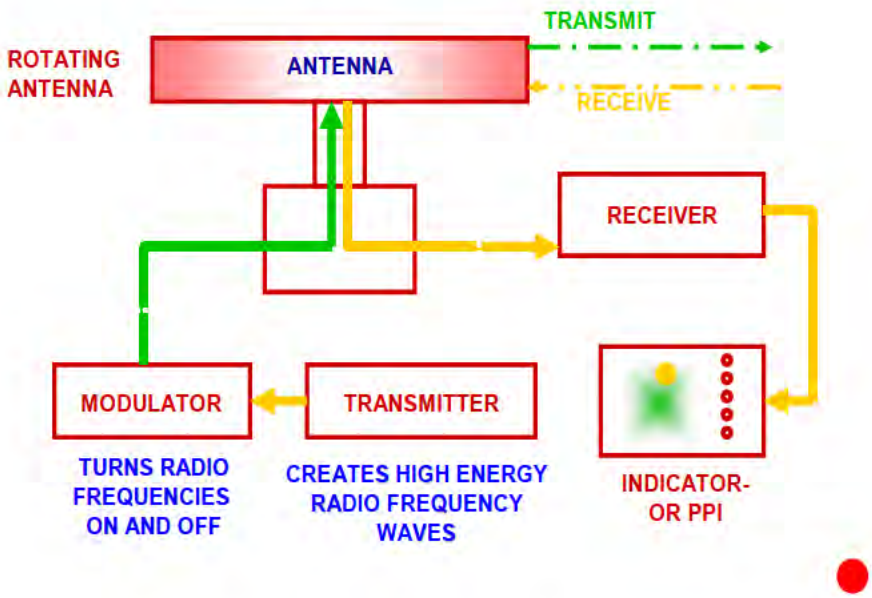
1) Antennas are directional with both vertical and horizontal beam and lobes. Marine radar antennas rotate between 10 and 20 RPM. This rotating speed allows for all targets to be displayed, what ever the range, as long as the transmitted energy strikes it. The antenna speed has to be such that the energy has time to be transmitted, travel to the object, bounce off, and return to the antenna before the antenna rotates any further around.

2) Open antennas are usually found on larger vessels and have better ability to distinguish objects close together since the larger surface area allows for a more concentrated (narrower) beam width. Closed antennas are the type usually found on smaller vessels due to space limitations, and sailboats to prevent becoming tangled in the rigging.

d. The Receiver. The receivers function is to amplify, or increase, the strength of the returning radio frequency energy; and reproduce them as video signals to be passed on to the display unit.

e. The Indicator, or display unit. The indicator has a primary function of providing a visual display of the range and bearing of any radar targets reflected energy (echoes). The transmitting vessel is always in the display sweep center with any target echo images being displayed at either a relative or true bearing (selectable), and at their appropriate range from the transmitting vessel. The unit has a secondary function of providing the means (a physical place) for the various operating controls

Components of a radar system



1. Advantages of using radar include:

   a. It is an aid during night or periods of restricted visibility.

   b. It can be used to fix your position using ranges and/or bearings to charted landmarks.

      1) These fixes can be obtained quickly.

      2) These fixes can be when out of sight of land.

   c. It can be used in collision avoidance. If a vessel is radar equipped, U. S. Coast Guard Navigation rules mandate its use, and thusly places a higher level of responsibility on these vessels. Additionally, the best operator on board should be operating the unit.

   d. It can be used for surveillance and determining the location of other vessels.

2. The disadvantages of radar include:

   a. It is subject to mechanical and electrical failure.

   b. There are both minimum and maximum range limitations.

   c. Interpretation of radar images is not always easy. We (the human operator) are the weak link.

   d. Charts do not always show information necessary for identifying radar echoes, and not all targets provide a good radar return.

3. Detection range of radar varies with environment, reflecting material, and radar specifics.

   a. Normal detection range is 1.22 times the square root of the height of the radar antenna. Using this formula a small vessel whose antenna is 11 feet above the water will have a nominal radar range of 4.04 nm. This detection range is with the normal bending of radar waves called standard refraction which occurs in what would be considered a standard atmosphere. (NOTE: Often money is wasted on radars of large range capabilities when the antenna height is the limiting factor.)

   b. Detection range is increased or decreased when the environment changes from the standard as follows:

      1) Super refraction occurs when there is an upper layer of warm, dry air over a surface layer of cold, moist air. The result is an increased downward bend of radar waves which increases the ranges at which targets can be detected.

      2) Sub-refraction occurs when a layer of cold, moist air overrides a shallow layer of warm, dry air. The result is the radar waves are bent upwards resulting in shorter detection range.

   c. Radar specifics that affect detection include:

1) Frequency. The frequency of most marine radars is between 3000 (S band radar) to 10000 (X band radar) megahertz (MHZ). The lower the frequency the longer the theoretical detection range, the higher the frequency the shorter the theoretical detection range. This is due the higher attenuation, thus shorter wavelength found at the higher frequencies. The radars found on most Law Enforcement vessels are in the higher (around 9700 MHZ), X band, radar frequencies.

2) Attenuation. Attenuation is the scattering and absorption of the transmitted radio frequencies found in the radar beam as it passes through the atmosphere.

3) Pulse length. The longer the pulse length, the greater is the theoretical range capability of the radar because of the greater amount of energy that can be transmitted.

4) Pulse Repetition Rate (PRR). Ample time must be given between pulses for an echo to return from any target located with the maximum workable range of the system, otherwise echoes returning from the more distant targets are blocked by the succeeding transmission. Thus the PRR determines the maximum measurable range of the radar.

5) Target characteristics: Images seen on a radar screen often differ greatly from what the actual objected detected because some contacts reflect radio waves better than others.

    a) Breakers and waves may return echoes if they are high enough. They will normally appear as clutter blips.

    b) Sandy spits, mud flats, beaches or gently sloping shoreline return poor echoes. This may reflect a false shoreline from bluffs, trees, or buildings returning strong echoes from behind the actual shore.

    c) Isolated rocks, islands, and points return strong echoes and provide excellent position information.

d) Radar reflective buoys, piers, bridges, and jetties give strong returns at short range.

e) Vessels, particularly those made of a hard material like steel, generally give strong returns. However, some vessels are harder to detect;

(1) Boats made of wood or fiberglass.

(2) Boats with low silhouettes.

(3) Vessels that are in rain, hail, and snow can also be detected on radar, if the radar is properly tuned.

B. EPO #2: IDENTIFY THE BASIC CONTROLS FOR MARINE RADAR AND CHARTPLOTTER UNITS.

1. In both radar and chartplotter modes, the unit is operated using the same controls.

a. Power button. This labeled button turns units on and off, and on some units allows for placing radar in and out of standby mode when radar is selected for display. When first turning on, the radar will go into standby after warming up. This must happen before the operator can then take it out of standby into radiate.

b. Cursor control: the trackpad.

   1) Moves the cursor (pointer) around the screen to:

      a) Show a latitude and longitude (if integrated with a GPS),

      b) Select a navigation aide, or waypoint/mark,

      c) View a new area of a chart by moving cursor to the screen edge.

   2) Select an item from a pop-up menu.

   3) Adjusts a selected variable soft key control.

   4) Controls movement of the Variable Range Marks (VRM) and Electronic Bearing Line (EBL).

c. Display, or function control keys. Allows for the selection of what you want to be displayed on the screen. Normal selections include radar, chart, sounder, and the ability to display more than one choice simultaneously. Different methods are used for this depending on brand name.

d. Range Control. This button, or buttons, allows the operator to change the size of the area displayed.

e. MOB (man overboard) button. This button is combined with another function key, however will be clearly labeled. Allows for the rapid placing of a symbol in the system where a person has fallen overboard. Gives a visual and (on some units an auditory) cue until cleared.

f. Soft keys. These are control keys whose function will change depending on which primary function key has been pressed. Also could be considered sub-menu keys that change depending on what equipment is being displayed.

g. Brilliance control. This control allows for more brilliance during the day so the display can be seen, and dimming to protect night visibility at night. Position of key is brand dependent, but when activated all will give a sliding bar indicator to assist in selecting appropriate brightness.

C. EPO #3: IDENTIFY THE POSITIONING ABILITIES OF A MARINE RADAR UNIT.

1. Radar Operation

a. Radar can assist in fixing the vessel's position on the navigation chart. This position can be established by using two or more ranges, bearings, or combinations of range and bearing.

b. An offsetting current can be detected by comparing this fix to the vessel's dead reckoned position. This is especially useful in periods of reduced visibility.

c. Remember to use prominent, charted targets such as points of land, fixed aids to navigation, bridges, piers, etc.

d. Most accurate ranges can be measured by using the installed variable range marker (VRM).

e. Most accurate bearings can be obtained using the installed electronic bearing line (EBL).

f. Generally, it is best to use the smallest range scale that covers the area of interest because this provides the greatest resolution of detail.

2. The Planned Position Indicator (PPI) displays relative images (unless stabilized by GPS, or Gyroscope).

a. In other words, their position on the screen is relative to the direction your bow is pointing (heads up).

b. Your boat is represented at the center of the screen and sweep origin.

c. Originating from own vessel, the ships heading marker (SHM) indicates the direction your boat is traveling.

d. Use the adjustable overlay or cursor (Electronic Bearing Line or EBL) to obtain the bearing to targets.

3. Remember, lines of position (LOPs), no matter how they are obtained, are plotted and labeled on the chart.

a. To obtain True bearings to a contact, add the relative bearing obtained from the radar to the true bearing of your own vessel.

b. Electronic fixes are identified with a triangle instead of a circle.

c. The accuracy of a radar fix depends on the combination of ranges and bearings used.

d. Radar ranges combined with visual LOPs on two or more prominent isolated objects would generally result in the best overall fix.

e. Radar ranges on three conspicuous objects is second best overall, **<u>but the best radar only fix</u>**.

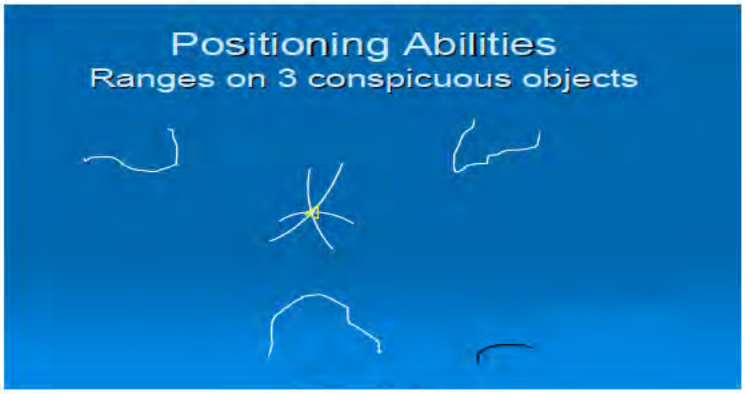
f. A radar range and bearing on a single object is the second best radar only fix.

g. Radar bearings alone on two or more charted objects are less accurate than the above due to the inaccuracies caused by beam width distortion.

h. Least accurate are tangent bearings.

   1) Adding a range to the tangent bearing increases its reliability.

   2) Tangent lines touch, but do not cross.



B. EPO#4: IDENTIFY THE BASIC OPERATIONAL FUNCTIONS OF A MARINE RADAR UNIT.

1. Range Control.

   a. Minimum for greater detail. (1/8 NM is minimum equipment selection option).

   b. Maximum for greater overview. (72 NM is maximum equipment selection option. Your actual radar range is determined by antenna height and power output).

   c. The range scale selected and the default associated range rings change together. The range selected is the distance from the sweep center (your vessel) to the top, and to the bottom of the display unit.

2. Radar Tuning Adjustments.

   d. Choice of manual or automatic (factory default) options.

1) Gain: The gain control adjusts the strength of target returns. Too much gain results in distorted, blurry radar display. This is just as bad as too little gain, as both will result in the operator being unable to visually discern targets.

2) Sea Return: The sea return control is a circuit designed to suppress sea clutter out to a limited distance from your vessel. The distance involved will depend on the range selected and the height and steepness of the sea waves around your vessel.

3) Rain: The rain control gives the operator the ability to reduce close rain or snow interference with the presenting valid radar contacts being displayed. (On or Off are only options.)

4) Fast Time Constant (FTC): This control allows for the adjustment of the radar to filter out, or reduce distant rain or snow interference with the presenting of valid radar contacts. (On or Off are only options.)

e. Automatic may be the best setting for inexperienced operators. Its use is “Ok” for normal environmental conditions, but it is just factory default (or baseline) settings

f. Manual is the best for radar utilization, but can be operator intensive as each control must be manipulated for each different range setting for a given environmental condition.

g. Care must be taken when making any adjustments as each of the controls will have an affect over the others. An example would be that turning the sea return control up to filter out sea return would also affect the gain. To offset this affect, the operator would need to adjust the gain to ensure any valid radar contacts would be seen through the sea filter.

3. VRM/EBL Display(s). These are used to obtain the most accurate bearings and ranges to radar returns.

a. One or two - Can be turned on and off independently of each other.

b. Data boxes for each active VRM/EBL displayed on the screen.

c. Origin of each can be moved, or floated to obtain a bearing and range from any point on the radar display to any other.

4. Guard Zones. Guard Zones are areas of the display where special attention is to be directed.

   g. One or Two zones may be selected at a time.

   h. Each zone is adjustable in width up to 360 degrees, and in depth.

   i. Each zone is referenced to your vessels heading and moves as the vessel moves.

5. MARPA (Mini Automatic Radar Piloting Aid).

   j. This function is used for target tracking and risk analysis. This function will show bearing, range, course, speed, and calculate the closest point of approach (CPA), and time of CPA for targets you select, up to 10 targets at a time.

   k. Not all radar brand names have MARPA capability.

6. Automatic Identification System (AIS)

   a. This is a shipboard broadcast system that acts like a transponder and allows overlay on a display of important information, like the name, registration number, course and speed of another vessel.

7. Heading modes:

   a. Heads up:

      1) This choice is relative to vessel's bow, so all movement is in relative motion.

   b. North up:

      1) North is always at top of screen.

   c. Course up:

      1) Autopilot input required for proper operation.

      2) Similar to Heads Up, but picture is stabilized.

D. EPO #5: IDENTIFY THE BASIC OPERATIONAL FUNCTIONS OF AN INTEGRATED GPS CHARTPLOTTER.

1. Chartplotter:

   a. A chartplotter is basically a computer that provides an electronic chart of an area.

b. It provides highly accurate positional and directional data to an operator.

c. Chartplotters obtain this data using the Global Positioning System (GPS).

2. Chartcard:

   a. Displays up to 4000 miles from top to bottom, or can be zoomed down to 1/64 mile if the chart card has the detailed information to support this scale.

   b. When range is decreased, chart plotter zooms in on an area, offering greater detail.

   c. Additional information available such as marinas, fuel, yards, greater detail reference ATON's, etc.

3. Waypoints:

   a. Edit - enables alteration of symbol, name, and position.

   b. Move - can be accomplished either through edit function, or by using waypoint softkeys and cursor (except target waypoint).

   c. Erase - Waypoints used in active routes cannot be erased.

   d. Place:

      1) At own vessels position,

      2) At cursor position,

      3) At a latitude/longitude using the MARKS/waypoint list keys.

4. Man Overboard (MOB).

   a. This feature should be activated immediately, even if the person is in sight.

   b. Press and hold MOB button (some units also require you to press ENTER)

   c. Navigate back to missing person.

   d. Navigate back to an object.

   e. Cancel by pressing MOB button (some units also require you to agree to DELETE MOB).

5. Alarms:

a. Arrival at the active waypoint (arrival circle or CPA).

b. Off track (by a specified distance).

c. Anchor alarm (drifted from anchor position more than specified distance).

d. Countdown timer (as specified).

6. Routes:

a. Allow operator to navigate to a series of waypoints without reprogramming at each one.

b. Create a route using multiple waypoints

c. Name after creating to keep from confusing with other routes

d. Save

E. EPO #6: IDENTIFY THE MINIMUM STEPS NEEDED TO CORRECTLY PLOT A POSITION ON A CHART FROM INFORMATION PROVIDED BY A GPS RECEIVER.

1. The correct time is needed, which is contained in the satellites' transmission.

2. A clear line of sight between the receiver's antenna and the satellites is necessary. Recent improvement in antennas, combined with stronger satellite transmissions have made this easier to achieve. Some new antennas can actually be mounted inside a boat's console.

3. At least three satellites overhead with acceptable angles in order to provide a two dimensional fix (Latitude and Longitude). A fourth satellite will also provide calculation of elevation.

4. When plotting a displayed position from your GPS onto a chart, it is critical that the receiver's displayed position is calculated in the same horizontal datum as the chart is drawn to. To illustrate the importance of this, see the below study done by the University of Texas. A GPS antenna was placed on the Capitol Dome of the State House. Without moving the antenna, the GPS receiver datum selection was changed and the corresponding displayed positions are shown on the diagram.

F. EPO #7: IDENTIFY THE TYPES OF INFORMATION A GPS RECEIVER MAY PROVIDE A USER.

1. Accurate displayed time in 12 or 24 hour format and in local time or Zulu time.
2. Position in various coordinate systems and formats when using three satellites.
3. Heading in either true or magnetic (with averaging options).
   a. **A STANDARD GPS RECEIVER IS NOT A COMPASS.** If the user is standing still, the computer in the receiver does not know which way the unit is pointing. A GPS receiver must be moving storing a series of points to establish direction. There are now models available with a built-in fluxgate compass, which will display correct direction while motionless. Some models are built with two antennae and the receiver calculates the relative positions of each to determine direction.
4. Course Deviation Indicator, aka Cross Track Error – How far off the course line at any given time.
5. Course Line – A straight line from starting point to destination.
6. Course Made Good – Actual course achieved.
7. Course Over Ground – True direction of travel which may differ from course line or compass.
8. Distance Made Good – Distance from last position to present

position.

9. Distance to a Waypoint – Distance from present position to a waypoint, as well as the position of that waypoint and the date and time it was created.
10. Estimated Time of arrival to a waypoint based on your speed.
11. Elevation/Altitude – determined when calculating with 4 or more satellites.
12. Actual speed can be calculated (with averaging options).
13. Speed Over The Ground – Your actual speed including effects of wind or water. Same as Speed made good.
14. Satellite signal strength and position of each satellite is displayed.
15. Dilution Of Precision (DOP) – Margin of error based on the satellites' positions. Horizontal DOP (HDOP) is margin of error of a 2D fix. Geometric DOP (GDOP) and Position DOP (HDOP) are margins of 3d error. The smaller the DOP, the more accurate is the information.
16. Estimated Position Accuracy. This value is displayed in feet and can be graphically shown on the map page by a circle around the current position.

G. EPO #8: DESCRIBE THE REASONS FOR PERFORMING AN ELECTRONIC NAVIGATION ACCURACY VERIFICATION (ENAV).

1. There have been many forms of Electronic Navigation Accuracy Verification (ENAV) used by many mariners. Some were very rudimentary and others more accurate.
2. The primary reason for performing an ENAV is officer safety.
   a. An ENAV should be performed on any piece of electronic equipment that you use for navigation (GPS, DGPS, Radar, Loran, etc.). You could at any unexpected time have to rely on your electronics to safely navigate back to port.
   b. That is not the time to discover that your electronics are displaying inaccurate information.
3. A secondary but still important reason is to give better credibility to your cases when electronics are utilized in making the case.
   a. By checking the accuracy of your electronics before and after documenting a violation you have taken away from the defendant's attorney the ability to question how accurate

your information is with regards to their client's position.

b. The ENAV procedure assures that the officer's navigation receiver is operating within the design parameters of the system; i.e. +/- 100 meters 95% of the time for GPS. The ENAV procedure will allow you to determine a much more precise position than the design accuracy stated by manufacturers.

c. Many GPS receiver manufacturers now have a real time accuracy data box.

1) The receiver is performing an ENAV constantly.

2) It is strongly suggested that when a position is being documented for case data, include the accuracy data to add credibility to the position.

4. It is imperative that you keep a written record of these checks and are able to produce them whenever you go to court. By establishing this pattern, your credibility will be improved and defendants will shy away from discussing their electronic information at the time of the violation during the trial.

5. If during the documentation of a violation you are able to record any information from the suspect's electronics, do so.

a. Remember that any information you see displayed on those electronics is admissible. By all means, try and have the defendant sign and date whatever information you have recorded.

b. Obtaining the signature of a violator establishes two important facts on your behalf. By comparing the defendant's readings of his or her equipment to yours, you add validity to your position determination. It also lets the judge and/or jury understand that the defendant had the appropriate electronic equipment to determine their own position.

6. If you deem it appropriate to seize charts from the suspect vessel, always provide that suspect with the appropriate charts that will enable them to return safely to port.

H. EPO #9: IDENTIFY THE PROCEDURES FOR PERFORMING AN ENAV.

1. An ENAV is simply occupying a known position and comparing that position to the displayed position of the GPS or LORAN-C receiver.

a. The difference in latitude and longitude could be expressed in decimals of a minute's difference, but that is difficult to understand for someone without marine knowledge.

b. Instead of fractions of minutes of latitude and longitude, the ENAV allows the user to convert to yards, which will be more easily understood by people without marine knowledge.

2. An ENAV also verifies the accuracy of the Variable Range Marker on the RADAR.

3. Obtain the most accurate position of a location that is convenient for you.

a. While dead in the water (DIW), keep your antenna as close as possible to the known position. This could be right at your berth, if you keep your patrol vessel at a fixed location.

b. It could be a daybeacon that is convenient to a boat landing that you use.

c. You can even collect several locations if you trailer your vessel.

4. It is strongly suggested that you obtain this position data from an outside source such as the USCG Aids to Navigation team, a State geodetic survey team, etc. This provides a credible and verified position to judge the accuracy of your equipment by.

5. It is universally accepted that 1 minute of latitude is equal to 2000 yards. A minute of longitude is equal to 2000 yards only at the equator. As we move north or south of the equator, the meridians of longitude converge and therefore become shorter. This is when we must rely on "the expert" to determine what that distance is at any given degree of latitude on the earth.

a. There are four methods to determine the number of yards in one minute of longitude at any given latitude.

1) The first method is by using Table 6 from the American Practical Navigator by Nathaniel Bowditch, which is included in the student handout.

a) Begin on the left column of this table at the nearest degree of Latitude of your area of responsibility. Move to the right side of this table until you come to column under "Degree of Longitude" in "feet".

b) Divide the number of feet in one degree by 60 to calculate the number of feet in one minute of longitude.

c) Now, divide that number by 3 which will determine the number of yards in one minute of longitude at the given latitude. Use this number to convert the angular difference of the displayed position of longitude compared to the known position of longitude supplied to you by the table into yards.

d) To convert the difference of latitude in yards, simply multiply the difference times 2000 yards.

2) The second method is a much easier and more accurate way to obtain this value.

a) The Internet has these same tables in computer format.

b) All you have to do is type in the degrees and decimals of degrees of latitude at your location and press compute to display that particular line from Table 6

c) http://pollux.nss.nima.mil/calc/degree.html is the web site address.

d) At this site, type in the degree of latitude at your location and the software will automatically calculate the result

e) You must enter the Latitude in degrees and decimals of degrees (i.e., 30^0 30', would be typed in the box as 30.5^0).

3) The third method is the quickest and easiest.

a) Directly read on the tables provided in the attachments the correct latitude and the corresponding number of yards in one minute of longitude at that location.

4) The fourth method is the least accurate, but is quick and will work at any location in the field without any tables.

a) With your GPS receiver on and fixed, store a waypoint whose latitude is the same as your position and a longitude that is exactly one minute more or less than your current position.

b) Command a go-to function and the distance displayed is the distance for one minute of longitude. The normal displayed distance is to the hundredth of a nautical mile.

c) Therefore your accuracy will be +/- 20 yards.

6. When you acquire an accurate position from a reputable source, also obtain a second one which will be within range for your radar to detect when you are positioned by the first position.

   a. By entering those two positions as waypoints into your GPS and then creating a route, you can obtain the distance between them.

   b. Alternatively, you can simply use the ENAV procedure and calculate the number of yards between the two positions.

      1) Compare this distance with what the Variable Range Marker indicates on your radar.

      2) Record this value in nautical miles on the ENAV sheet.

   c. It is recommended that the accuracy of the radar's VRM be checked periodically by a licensed FCC technician. A receipt of this check should be kept and available for inspection.

7. ENAV procedure: Place your vessel next to the known position keeping in mind wind and current as well as the location of your GPS antenna on your vessel.

   a. Record the position displayed on your GPS.

   b. Also, adjust the VRM of the RADAR to the next known object and record the distance on the ENAV sheet.

   c. Calculate the difference in latitude between the known position and the displayed position.

      1) If the displayed position is greater than the known, you are north of the known (In the northern hemisphere).

2) If the displayed position is less than the known, you are south of the known (in the northern hemisphere).

3) Multiply the difference by 2000 yards to convert the decimals of minutes of difference to yards.

d. Do the same for Longitude.

1) However, multiply those decimals of minutes by the distance that was calculated in Step 3 as described above.

2) If the displayed position is greater than the known position, you are westerly of the known and vice-versa if the value is less or easterly.

8. With the two offset distances calculated, you can now obtain the resultant or combined accuracy of your receiver.

a. Use the Pythagorean Theorem to obtain the offset distance in yards.

b. This formula is $A^2 + B^2 = C^2$ where A = yards of latitude and B = yards of longitude.

9. The accuracy can also be shown graphically by using the grid and compass rose shown on the bottom of the ENAV sheet.

a. Using this method, you can also obtain the direction in true that the displayed position is from the known position.

b. Select the larger of the two offsets and select an even number of yards slightly larger than that offset.

c. Divide that number by 5 and that is the value of each of the grids on the diagram.

1) This will be true for any direction you move on the diagram.

2) The crossbar in the middle of the grid is the known position.

a) If your latitude offset is north of the known, count up the appropriate number of yards in a northerly direction and place a mark.

b) From that point, apply the offset of longitude in either an easterly or westerly direction.

c) From that second point measure the distance back to the crosshair to determine the resultant offset distance.

d) Directly read on the compass rose your bearing from the known point to your offset position in True.

10. It is imperative that these records be kept and performed EVERY time that you get underway. These records should always be available for examination at court.

SUMMARY

A. REVIEW OF PERFORMANCE OBJECTIVES.

1. EPO #1: Identify the basic operating principles of radar.
2. EPO #2: Identify the basic controls for marine radar and chartplotter units.
3. EPO #3: Identify the positioning abilities of a marine radar unit.
4. EPO #4: Identify the basic operational functions of a marine radar unit.
5. EPO #5: Identify the basic operational functions of an integrated GPS chartplotter.
6. EPO #6: Identify the minimum steps needed to correctly plot a position on a chart from information provided by a gps receiver.
7. EPO #7: Identify the types of information a gps receiver may provide a user.
8. EPO #8: Describe the reasons for performing an electronic navigation accuracy verification (ENAV).
9. EPO #9: Identify the procedures for performing an ENAV.

B. REVIEW OF MAIN TEACHING POINTS.

1. All means of electronic navigation are merely aids to safe navigation, and none should be used as a replacement for chart interpretation, local area knowledge, or maintaining a proper lookout.
2. Proper use of marine electronics requires a knowledgeable user. The appropriate time and place to acquire this knowledge is during daylight hours when visibility is good.

3. Remember that the Rules of the Road place a greater burden on boats equipped with radar.
4. For both radar and GPS/Chartplotters, the vessel in reality is further ahead than it is shown on the display when at speed.
5. The primary information that a GPS provides is position, heading, speed, time, and navigation information to a waypoint.
6. The two reasons for performing an ENAV are officer safety and to add credibility to navigational evidence when documenting violations.
7. An ENAV is taking the difference in latitude and longitude displayed on the electronics versus the known latitude and longitude and converting that angular difference into yards of accuracy.

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REFERENCES

[redacted]

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[redacted]

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National Imagery and Mapping Agency – Marine Navigation Calculator.13 May 2010
http://www.nga.mil/

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Latitude N or S	Yards in 1 min. of Longitude	Latitude N or S	Yards in 1 min. of Longitude	Latitude N or S	Yards in 1 min. of Longitude	Latitude N or S	Yards in 1 min. of Longitude
0° 00'	2029.01	12° 15'	1983.11	24° 30'	1847.38	36° 45'	1627.70
0° 15'	2028.99	12° 30'	1981.22	24° 45'	1843.71	37° 00'	1622.41
0° 30'	2028.93	12°45'	1979.30	25° 00'	1840.01	37° 15'	1617.08
0° 45'	2028.83	13° 00'	1977.34	25° 15'	1836.27	37° 30'	1611.72
1° 00'	2028.70	13° 15'	1975.34	25° 30'	1832.49	37° 45'	1606.33
1° 15'	2028.53	13° 30'	1973.31	25° 45'	1828.68	38° 00'	1600.91
1° 30'	2028.32	13° 45'	1971.23	26° 00'	1824.83	38° 15'	1595.46
1° 45'	2028.07	14° 00'	1969.12	26° 15'	1820.96	38° 30'	1589.98
2° 00'	2027.78	14° 15'	1966.98	26° 30'	1817.04	38° 45'	1584.47
2° 15'	2027.46	14° 30'	1964.79	26° 45'	1813.09	39° 00'	1578.93
2° 30'	2027.09	14° 45'	1962.57	27° 00'	1809.11	39° 15'	1573.36
2° 45'	2026.69	15° 00'	1960.31	27° 15'	1805.09	39° 30'	1567.76
3° 00'	2026.24	15° 15'	1958.02	27° 30'	1801.04	39° 45'	1562.13
3° 15'	2025.77	15° 30'	1955.68	27° 45'	1796.95	40° 00'	1556.46
3° 30'	2025.25	15°45'	1953.31	28° 00'	1792.83	40° 15'	1550.77
3° 45'	2024.69	16° 00'	1950.91	28° 15'	1788.68	40° 30'	1545.05
4° 00'	2024.10	16° 15'	1948.46	28° 30'	1784.49	40° 45'	1539.30
4° 15'	2023.47	16° 30'	1945.98	28° 45'	1780.27	41° 00'	1533.52
4° 30'	2022.79	16° 45'	1943.46	29° 00'	1776.01	41° 15'	1527.71
4° 45'	2022.08	17° 00'	1940.91	29° 15'	1771.72	41° 30'	1521.87
5° 00'	2021.34	17° 15'	1938.31	29° 30'	1767.39	41° 45'	1516.01
5° 15'	2020.55	17° 30'	1935.68	29° 45'	1763.03	42° 00'	1510.11
5° 30'	2019.73	17° 45'	1933.02	30° 00'	1758.64	42° 15'	1504.18
5° 45'	2018.87	18° 00'	1930.32	30° 15'	1754.22	42° 30'	1498.23
6° 00'	2017.97	18° 15'	1927.58	30° 30'	1749.76	42° 45	1492.25
6° 15'	2017.03	18° 30'	1924.81	30° 45'	1745.27	43° 00'	1486.24
6° 30'	2016.05	18° 45'	1921.99	31° 00'	1740.74	43° 15'	1480.20
6° 45'	2015.04	19° 00'	1919.14	31° 15'	1736.19	43° 30'	1474.13
7° 00'	2013.98	19° 15'	1916.26	31° 30'	1731.59	43° 45'	1468.03
7° 15'	2012.89	19° 30'	1913.34	31° 45'	1727.14	44° 00'	1461.91

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7° 30'	2011.76	19° 45'	1910.38	32° 00'	1722.32	44° 15'	1455.76
7° 45'	2010.59	20° 00'	1907.39	32° 15'	1717.63	44° 30'	1449.58
8° 00'	2009.39	20° 15'	1904.36	32° 30'	1712.91	44° 45'	1443.37
8° 15'	2008.15	20° 30'	1901.29	32° 45'	1708.15	45° 00'	1437.13
8° 30'	2006.87	20° 45'	1898.19	33° 00'	1703.36	45° 15'	1430.87
8° 45'	2005.55	21° 00'	1895.06	33° 15'	1698.54	45° 30'	1424.58
9° 00'	2004.19	21° 15'	1891.88	33° 30'	1693.69	45° 45'	1418.26
9° 15'	2002.79	21° 30'	1888.67	33° 45'	1688.81	46° 00'	1411.92
9° 30'	2001.36	21° 45'	1885.43	34° 00'	1683.89	46° 15'	1405.54
9° 45'	1999.89	22° 00'	1882.14	34° 15'	1678.94	46° 30'	1399.14
10° 00'	1998.38	22° 15'	1878.83	34° 30'	1673.96	46° 45'	1392.72
10° 15'	1996.84	22° 30'	1875.48	34° 45'	1668.94	47° 00'	1386.26
10° 30'	1995.26	22° 45'	1872.09	35° 00'	1663.90	47° 15'	1379.78
10° 45'	1993.63	23° 00'	1868.67	35° 15'	1658.82	47° 30'	1373.28
11° 00'	1991.97	23° 15'	1865.21	35° 30'	1653.72	47° 45	1366.74
11° 15'	1990.27	23° 30'	1861.71	35° 45'	1648.57	48° 00'	1360.19
11° 30'	1988.54	23° 45'	1858.18	36° 00'	1643.41	48° 15'	1353.61
11° 45'	1986.77	24° 00'	1854.62	36° 15'	1638.20	48° 30'	1346.99
12° 00'	1984.96	24° 15'	1851.02	36° 30'	1632.97	48° 45'	1340.36
Latitude N or S	Yards in 1 min. of Longitude	Latitude N or S	Yards in 1 min. of Longitude	Latitude N or S	Yards in 1 min. of Longitude	Latitude N or S	Yards in 1 min. of Longitude
49° 00'	1333.69	61° 15'	978.45	73° 30'	578.05	85° 45'	150.87
49° 15'	1327.01	61° 30'	970.67	73° 45'	569.53	86° 00'	142.01
49° 30'	1320.29	61° 45'	962.87	74° 00'	561.01	86° 15'	133.15
49° 45'	1313.56	62° 00'	955.06	74° 15'	552.47	86° 30'	124.28
50° 00'	1306.79	62° 15'	947.22	74° 30'	543.92	86° 45'	115.42
50° 15'	1300.00	62° 30'	939.37	74° 45'	535.36	87° 00'	106.54
50° 30'	1293.19	62° 45'	931.49	75° 00'	526.79	87° 15'	97.67
50° 45'	1286.35	63° 00'	923.61	75° 15'	518.21	87° 30'	88.80
51° 00'	1279.48	63° 15'	915.70	75° 30'	509.62	87° 45'	79.93
51° 15'	1272.59	63° 30'	907.78	75° 45'	501.02	88° 00'	71.05
51° 30'	1265.68	63° 45'	899.83	76° 00'	492.42	88° 15'	62.17
51° 45'	1258.74	64° 00'	891.87	76° 15'	483.79	88° 30'	53.29
52° 00'	1251.78	64° 15'	883.89	76° 30'	475.17	88° 45'	44.41
52° 15'	1244.80	64° 30'	875.90	76° 45'	466.53	89° 00'	35.53
52° 30'	1237.79	64° 45'	867.89	77° 00'	457.88	89° 15'	26.65
52° 45'	1230.76	65° 00'	859.86	77° 15'	449.23	89° 30'	17.77
53° 00'	1223.70	65° 15'	851.82	77° 30'	440.57	89° 45'	8.88
53° 15'	1216.62	65° 30'	843.76	77° 45'	431.89	90° 00'	0.00
53° 30'	1209.52	65° 45'	835.68	78° 00'	423.21		
53° 45'	1202.39	66° 00'	827.59	78° 15'	414.52		
54° 00'	1195.24	66° 15'	819.48	78° 30'	405.83		
54° 15'	1188.07	66° 30'	811.35	78° 45'	397.12		
54° 30'	1180.87	66° 45'	803.21	79° 00'	388.41		
54° 45'	1173.66	67° 00'	795.06	79° 15'	379.69		

55° 00'	1166.41	67° 15'	786.88	79° 30'	370.96
55° 15'	1159.15	67° 30'	778.69	79° 45'	362.22
55° 30'	1151.86	67° 45	770.49	80° 00'	353.48
55° 45'	1144.56	68° 00'	762.28	80° 15'	344.73
56° 00'	1137.23	68° 15'	754.04	80° 30'	335.98
56° 15'	1129.87	68° 30'	745.80	80° 45'	327.22
56° 30'	1122.50	68° 45'	737.54	81° 00'	318.45
56° 45'	1115.11	69° 00'	729.26	81° 15'	309.67
57° 00'	1107.69	69° 15'	720.97	81° 30'	300.89
57° 15'	1100.25	69° 30'	712.67	81° 45'	292.11
57° 30'	1092.79	69° 45'	704.35	82° 00'	283.32
57° 45'	1085.31	70° 00'	696.02	82° 15'	274.52
58° 00'	1077.81	70° 15'	687.68	82° 30'	265.72
58° 15'	1070.28	70° 30'	679.32	82° 45'	256.91
58° 30'	1062.74	70° 45'	670.95	83° 00'	248.09
58° 45'	1055.18	71° 00'	662.57	83° 15'	239.28
59° 00'	1047.59	71° 15'	654.17	83° 30'	230.46
59° 15'	1039.99	71° 30'	645.76	83° 45'	221.63
59° 30'	1032.37	71° 45'	637.34	84° 00'	212.79
59° 45'	1024.72	72° 00'	628.91	84° 15'	203.96
60° 00'	1017.06	72° 15'	620.46	84° 30'	195.12
60° 15'	1009.38	72° 30'	612.00	84° 45'	186.28
60° 30'	1001.67	72° 45'	603.53	85° 00'	177.43
60° 45'	993.95	73° 00'	595.05	85° 15'	168.58
61° 00'	986.21	73° 15'	586.56	85° 30'	159.73

U.S. DEPARTMENT OF HOMELAND SECURITY

FEDERAL LAW ENFORCEMENT TRAINING CENTER

OFFICE OF TRAINING OPERATIONS

DRIVER AND MARINE DIVISION

Homeland Security

STUDENT TEXT

EMERGENCY PROCEDURES

7600 **AUG / 11**

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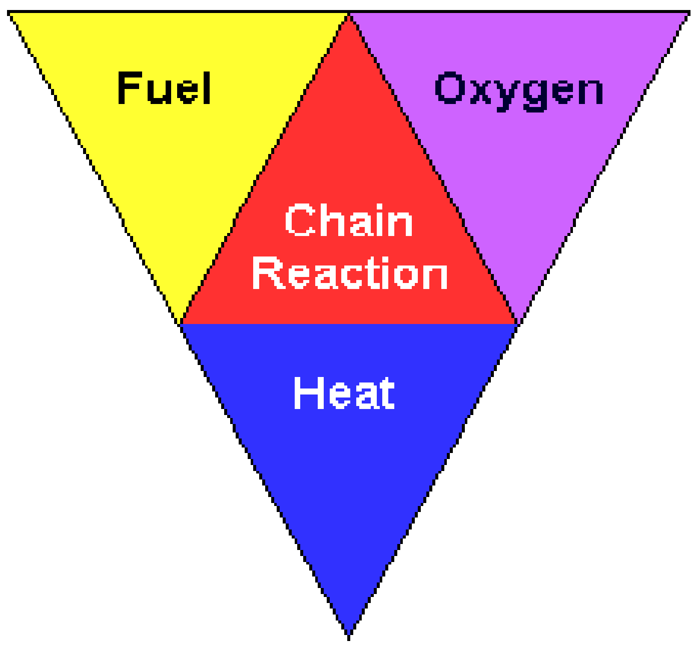
INDEX

OPENING STATEMENT

It has been said, by experienced seamen, that their most terrifying fear on the water is fire. Fires and explosions aboard small vessels are the single highest dollar value of insurance claims paid to vessel owners annually. Most boating accidents are collisions, either with other boats or with fixed objects. Either incident can quickly result in the loss of your vessel.

Even good swimmers can become disoriented in the water after falling overboard. Immediate action is important when a man overboard situation takes place. Every second counts, particularly in heavy or cold weather. Every crew member must learn the proper procedures thoroughly. The reason is obvious; you may be the one overboard!

The students will correctly identify the four different classes of fire and the recommended procedures for combating them, and the procedures for stemming flooding and the methods of de-watering aboard small vessels. Identify the proper procedures for personnel recovery. The proper procedures are those presented during instruction, and in this assigned reading.



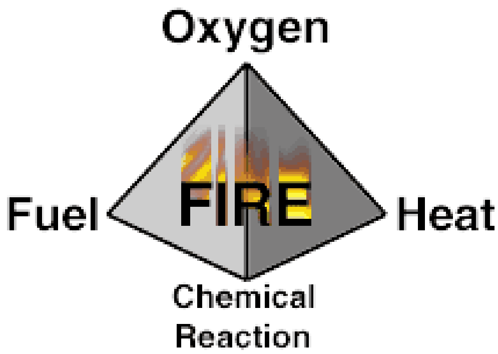
FIRE TETRAHEDRON

FIRE AND DAMAGE CONTROL

A. EPO #1: IDENTIFY THE FOUR PARTS OF THE FIRE TETRAHEDRON

What a Fire Needs to Burn:

A fire requires four elements to continue burning: oxygen, heat, fuel, and an uninhibited chemical chain reaction. When any of these elements is removed, combustion ceases to take place.



The combustion reaction in a fire releases the energy from chemical bonds in the form of heat and radiant (light) energy. The reaction is usually initiated by the addition of heat, but quickly begins to generate enough heat to feed itself on its own energy. This is why fires rapidly grow to uncontrollable proportions. A fire will double every minute that it is left freely burning.

Example: You can break a stick and you haven't chemically changed it. Burn the same stick and you change the molecular structure, **eliminating oxygen and adding carbon to molecular chains.**

The following is a brief description of each element and their interaction:

<u>Fuel</u> - May be any combustible material. Can be a solid, liquid, or gas. Typically solids and liquids must be heated to the point where they are converted into a vapor or gas before they will burn.

<u>Oxygen</u> - Air contains about 21% oxygen, and most fires require at least 16% oxygen content to burn. Oxygen supports the chemical processes that occur during a fire. When fuel burns, it reacts with oxygen from the surrounding air releasing heat and generating combustion products (i.e. gases, smoke, and particles). This process is known as oxidation.

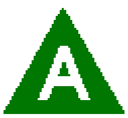
<u>Heat</u> - Heat is the energy needed to increase the fuel's temperature to the point where sufficient vapors are produced for ignition to occur.

Chemical Chain Reaction - The chemical chain reaction known as fire occurs when fuel, oxygen, and heat are present in the right conditions and amounts.

B. EPO #2: IDENTIFY THE CHARACTERISTICS OF CLASS A, B, C, AND D FIRES, AND THE APPROPRIATE EXTINGUISHING AGENTS.

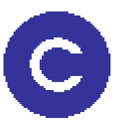
Classes of Fire

There are four classes of fires, categorized according to the kind of material that is burning. For the first three classes of fires, there are two sets of color-coded icons in common use. One or both kinds of icons appear on most fire extinguishers to indicate the kinds of fire against which the unit is intended to be used. There is only one icon used to indicate the fourth (class D) kind of fire. Class D fires involve uncommon materials and occur in fairly specialized situations. Note that any given fire can fall into more than one class; a fire that involves both burning paper and kitchen grease would be a Class AB fire.



Class A fires are those fueled by materials that, when they burn, leave a residue in the form of ash, such as paper, wood, cloth, rubber, and certain plastics. Smoke is gray to dark gray.

Class B fires involve flammable liquids and gasses, such as gasoline, paint thinner, kitchen grease, propane, and acetylene. Smoke is black and heavy. May produce heavy black soot.



Fires that involve energized electrical wiring or equipment (motors, computers, panel boxes) are Class C fires. Note that if the electricity to the equipment is turned off, a Class C fire becomes one of the other three types of fires. Smoke is blue to dark grey.

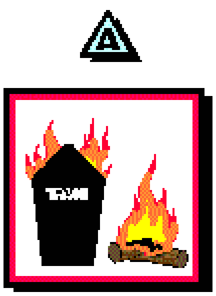
Class D fires involve exotic metals, such as magnesium, sodium, titanium, and certain organometallic compounds such as alkyllithium and Grignard reagents.

Fire Extinguishers

Although not all vessels are required to carry a fire extinguisher, it is highly recommended that you do. There are numerous types and sizes of extinguishers and each one has to be U. S. Coast Guard approved.

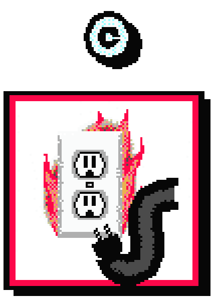
Fire Extinguishers are classified by letters and numbers according to the class and size fire they can put out. The letter, (A, B, C, or D) indicates the class of fire. The number is a measure of the capacity of the extinguisher - the larger the number the greater the capacity to put out a fire.

Although some boat fires involve burning wood and paper (Class A), these fires can be put out with water. Do not use water on gasoline, oil, or electrical fires. Water causes gasoline and oil fires to spread and electrical current is conducted through the water.



"A" is for combustible solids like wood.

"B" is for flammable liquids such as gasoline.



"C" is for electrical fires.

"D" is for combustible metals like magnesium

Make sure to inspect your fire extinguishers on your daily boat checks to make sure they are properly stored, charged and undamaged. Portable extinguishers should be mounted where they are accessible. Check the gauge to make sure the extinguisher is still charged. Check the seals to make sure they have not been tampered with. Replace cracked or broken hoses and keep nozzles free from obstruction.

Once you use a fire extinguisher, you should either have it recharged, if it is rechargeable, or replaced if it is a disposable type. In any event, always make sure that your extinguisher label indicates that it is a U.S. Coast

Guard approved marine type device.

Which extinguisher is best for which type of fire?

Type of Extinguisher	Class of Fire	Notes:
Carbon Dioxide (C02)	B, C	Carbon Dioxide is a class B, C, agent only. Because of the CO2 high pressure, it is not recommended for use on Class A, amber and ash based fires. Why? Because of the hazard of spreading the fire when blasting it with the high pressure gas.
Halon (until year 2000)	A, B, C	Halon 1211 carries the A, B, C rating only in a capacity of 9 pounds. Units smaller than 9 pounds only carry the B, C rating. Halon gas, in small quantities, vaporizes too quickly to maintain a Class A fire.
Dry Chemical	B, C	Dry chemical extinguishers come in three varieties. Sodium Bicarbonate B, C (Alkaline); Potassium Bicarbonate, Purple "K", B, C (Alkaline); and Mono Ammonium Phosphate A, B, C (Acidic). The A, B, C dry chemical is not recommended for marine use for two reasons: • It is corrosive • The way in which this agent obtains it class A rating is its ability to melt, seep and encase. This necessitates dismantling of equipment to repair or rebuild.
Foam	A, B	Foam extinguishers are water based and quench Class A fires. They also blanket, smother and separate the vapor layer in Class B fires.

All power boats, except outboards, under 26 feet and of open construction must carry **one B-I**, U. S. Coast Guard approved fire extinguisher.

All power boats 26 feet to less than 40 feet must carry **two B-I** or **one B-II**

U. S. Coast Guard approved fire extinguishers.

40 feet to less than 65 feet must carry **three B-I** or **one B-II and 1 B-I** U. S. Coast Guard approved fire extinguishers.

Vessels over 65 feet must comply with Federal standards.

An onboard fire is a serious event. If the fire cannot be controlled where do you go except in the water? The fire tetrahedron consists of fuel, oxygen, heat. All three must be present to start a fire (chain reaction) and the removal of any single one can extinguish a fire.

Fuels, such as gasoline and propane, can be very dangerous if precautions are not taken. The fumes of these fuels are heavier than air and tend to collect in the cabin, bilge and other lower areas of the boat. Because they naturally are surrounded by oxygen all that is necessary to start a fire is heat. This could come from something as simple as a spark from an ignition component. All you did was turn the key to start the engine and boom.

You should read and understand the instructions on your fire extinguisher(s). If a fire starts you should be prepared and not hesitate. Grab the fire extinguisher, activate it, and direct it at the base of the flames using short bursts and sweeping it from side to side.

If underway and a fire starts, stop the boat and position it in such a manner that the fire is downwind. Order everyone to put on lifejackets. If possible try to turn off the fuel source to the fire. Grab the extinguishers and control the fire.

C. EPO #3: IDENTIFY THE PROPER USE OF PORTABLE FIRE EXTINGUISHERS.

Before deciding to fight a fire first call in your position with the vessels condition and number of persons on board incase you have to abandon ship and cannot come back to the radio.

Used properly, a portable fire extinguisher can save lives and property by extinguishing a small fire or containing it until the fire department arrives. Portable fire extinguishers, however, are not designed to fight large or spreading fires.

Reactions to a fire can determine whether or not the incident is controlled. Following established procedures is critical to saving lives and property. It is important that employees learn appropriate emergency procedures.

Before deciding to fight a fire, follow RACE:

- **R**escue anyone in immediate danger and remove the person to a safe area.
- **A**ctivate the fire alarm to all crewmembers, then call the U.S. Coast Guard on channel 16 VHF-FM and report your position, number of persons on board, status of your emergency and description of your vessel.
- **C**onfine the fire by closing all hatches and securing compartments.
- **E**vacuate if the fire is spreading beyond the point of origin or the fire could block your exit or you are not sure how to use an extinguisher.

OR

- **E**xtinguish the fire if you have activated the fire alarm and closed hatches, the fire is small and contained, you have a clear exit from the fire and you have been trained on the proper use of an extinguisher within the last year.

Remember fire spreads quickly. If you cannot extinguish it in 30 seconds, get yourself out.

Choose The Proper Extinguisher:

- For ordinary fires involving solids such as wood, paper, and cloth; choose a water or dry chemical extinguisher with a label that says Class A. Do not use water on flammable liquid or electrical fires.
- For fires involving flammable liquids, choose a dry chemical or carbon dioxide extinguisher with a label that says Class B. Never use a water extinguisher.
- For fires involving active electrical equipment, choose a dry chemical or carbon dioxide extinguisher with a label that says Class C. Never use a water extinguisher.
- For fires involving metals, chose a graphite extinguisher with a label that says Class D or use sand if available. Never use an A, B, or C extinguisher on this type of fire.
- For fires involving cooking equipment such as a deep fat fryer choose a wet chemical extinguisher with a label that says Class K. Never use a water extinguisher.

To Use an Extinguisher:

- Remember the acronym **PASS**, keep a clear exit behind you and stand 6-8 feet away from the fire.
- **P**ull the pin to activate the handle.
- **A**im the nozzle at the base of the fire.
- **S**queeze the handle to expel the extinguishing agent. (When the agent first hits the fire, the fire may briefly flare up. This should be expected.)
- **S**weep the extinguishing agent from side to side pushing the fire away from you. Once the fire is out, the user should carefully back away from the fire with the extinguisher ready until the user is safe. Never turn your back on fire as it could flare back up. Set a reflash watch until the area is cooled to normal outside temperatures.
- Mount powder extinguishers horizontally, if possible.
    - Vibration can cake or compact the powder over time.

- Inspect pressure gauge and fire extinguisher with every boat check off.

- Occasionally remove the extinguisher, invert it, and tap to knock the powdered retardant loose.

- Galleys and engine rooms are the most likely location for fires to start.

- If possible, secure the ignition and fuel supply.

- Block any fresh air vents feeding oxygen into the room.

If you must go below deck to fight the fire, establish at least one safe escape route.

Be careful opening any engine room hatch. This may feed oxygen to the fire. Keep your body clear of openings. After the fire is out, watch for reflash.

D. EPO#4: IDENTIFY THE PROPER METHODS FOR CONTROLLING FLOODING ON SMALL VESSELS

In addition to the efforts for controlling flooding, contingency plans must be made in case the vessel sinks.

- Radio position and condition of vessel.

- Get all personnel in PFDs and all floating objects on deck.

  - More debris in the water makes it easier to spot for rescue.

  - Coolers, cushions, etc. can provide additional personal floatation.

- If feasible, head towards shore. Beaching is better than swimming.

- DO NOT PANIC!

  "Holing the Hull" collisions are the most common boating accident.

- Immediately check below deck for flooding after striking an object.

- Holes at the waterline in small vessels may be countered by shifting personnel and gear to the opposite side of the vessel, or trimming the damaged side out of the water.
- Stem flooding by sticking any object in the hole.
  - Seat cushion.
  - Rain coat.
  - Any improvised plug.
  - Tape or epoxies, impervious to water, may be applied outside to stop flooding.
- Start bilge pumps. It may also be necessary to hand pump or bail.
- Radio your situation and head for shore.
- Leaks from through hull fittings are another likely source of flooding.
- Sea cocks should be exercised regularly to make sure they're not frozen.
- Rudder posts.
- Shaft stuffing boxes.
- Engine exhaust: shut that engine off!
- Raw water intakes: On many inboard/outboard boats, no sea cocks.
- Out drive flange: Almost impossible to stop in the water, arrange for pull out immediately.
- Overboard discharges: Damage control plugs can be driven in to these or leaking hoses.
- De-watering is important even after flooding is stopped, because water in the bilge can affect the vessels stability.
- Use bilge pumps, buckets, hand pumps.

- On planing hulls, if you can pull the drain plug, planing the vessel will suck the water out.

- Inboard powered vessels can use their raw water intake to de-water.

  - Shut down engine.
  - Shut off seacock.
  - Disconnect raw water intake hose (may be very difficult to disconnect).
  - Tape or epoxies, impervious to water, may be applied outside to stop flooding.
  - Start engine. Water pump on engine will pull bilge dry and blow water out the exhaust.
  - Watch process carefully. DO NOT allow engine to run after bilge is dry. Keep hose clear of entering debris.

- Damage control kits should be carried anytime you are going any distance from shore. Some recommended items include:

  - Silicone rubber (RTV) should set up underwater.
  - Duct tape.
  - Hose clamps, in conjunction with RTC, can be used to secure and patch leaking hoses.
  - Two part waterproof epoxy, available at any hardware store
  - Water proof 3M self-vulcanizing electrical tape, (used on nuclear subs - Great Stuff!). Waterproof, but not petroleum proof.
  - Replacement hoses.
  - Damage control plugs and wedges.
  - Rags.
  - Knife, saw, and hammer.

E. EPO #5: IDENTIFY THE DUTIES OF THE BOAT OPERATOR AND CREW DURING A PERSONNEL RECOVERY SITUATION

All crew members must be prepared when someone falls overboard. Rehearsing how to react is vital to a successful and safe recovery of the individual. Assume the person who is in the water is suffering from shock, may be unconscious, and possibly injured.

The information here is only a general guideline, as each boat and situation presents problems beyond the scope of this publication. A professional understands and rehearses each possibility remembering that the key to a successful rescue is preparation, practice, and alertness.

The rescue of persons from the water has always been a difficult operation. Each Person in the Water (PIW) rescue will have different characteristics. Prior to making an approach to a person in the water, BRIEF YOUR CREW. Know in advance which side the pickup will be on and what type of pick up it will be: reach and grab, or a personnel retrieval line. Remember, your first approach may be your last. If the person in the water is not wearing a life jacket, he or she may not get a second chance.

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

You don't have time to analyze the situation, you must react automatically.

The operator should push the Man Overboard (MOB) button on the GPS receiver (if so equipped) to mark the exact position of the distress.

Use all possible means to identify the position (dead reckoning, visual landmarks, radar, etc.). Note the location on the chart so that the boat can return to the vicinity of the person in the water.

Where the correct equipment is available, a more precise position locked into the navigation receiver will be invaluable in recovery of the crewmember.

Throw a ring buoy with strobe light (or anything that floats) over the side towards the person in the water. It does not matter if the person is visible at this time or not. The person in the water may see the flotation device and be able to get to it. Additionally, the ring buoy or any floating object thrown over the side (if a ring buoy is not available) serves as a reference point (datum) marking the general location of the incident and for maneuvering the boat during the search.

Do not throw the floatable object(s) at the person overboard. It could cause further injury if it hits the individual. Throw the object so that it or its line can drift down to the person while avoiding fouling the line in the propeller.

Once a device is thrown, the operator will assign duties to each crew member.

- If weather conditions permit, a POINTER will be positioned on or near the bow of the boat.
- A RECOVERY/PICK-UP crew member will be assigned to prepare a heaving line to be used in retrieving the person from the water.
- A SURFACE SWIMMER will be made ready as needed, as well as another crew member on the tending line to the surface swimmer's safety harness whenever the swimmer is in the water.

The Pointer will visually search for the person overboard, and when located, will point to the person overboard at all times. The operator will guide on the Pointer's hand signals in maneuvering the boat for the recovery approach.

In smaller boats, anyone simultaneously can yell to the helm, keep their eyes on the person overboard, and throw something in the water. The larger the boat, the harder it becomes to do this and keep sight of the person overboard. Even given the maneuverability and short distances involved in smaller boats, sight of a head in the water can be quickly lost. The operator should ensure that the crew member keeping an eye on the person overboard is relieved of any other duties that could be distracting.

When the operator is ready to commence the recovery approach, he must brief the crew on how the recovery will be made and whether it will be accomplished on the port or starboard side. The approach will be influenced by:

- Wind
- Sea surf conditions
- Maneuverability of the boat
- Maneuvering space restriction

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

If the person overboard has not been located and immediately recovered and assistance of other boats is needed, transmit the emergency call signal “Pan-Pan” (pronounced PAHN) three times on channel 16 VHF-FM radio. Follow this with the boat's identification, position, and a brief description of the situation. Do not use "Mayday-Mayday." A boat uses a Mayday call only when threatened by grave and imminent danger. After returning to datum and completing a quick scan of the area, if the PIW is not found, drop a datum marker and commence an initial search pattern. Continue the search until otherwise directed by the USCG.

When circumstances and time permits, the operator must notify the operational commander of the man overboard situation. This should be done as soon as possible after the occurrence.

Requests for additional assistance may be made to the operational commander by radio. Also, any craft near the scene may be requested by the operator to assist as needed.

The general person in the water recovery procedure described above applies whether the individual fell overboard from your boat or from another boat. These steps are in a sequence as it occurs in time:

PROCEDURE

1. *Someone falls over the side.*

2. *The first crew member to observe the incident or the person overboard calls out "MAN OVERBOARD" and follows this exclamation with the side from which the event occurred or the person was sighted; then maintains sight of and continuously points to the individual in the water.*

   - *A crew member throws a ring buoy with strobe light over the same side that the person fell (or was sighted on) and in the general direction of the person in the water.*

3. *Events happening at approximately the same time:*

   - *The operator reduces speed, turns the boat in the direction indicated in the alarm, depresses the GPS Man Overboard button (if this equipment is on the boat), sounds 5 or more short blasts on whistle or horn, and notifies the USCG at the earliest possible moment.*

4. *The operator assigns crew member duties:*

- *The Pointer (or first person to see the member go overboard) moves forward near a pilothouse window, weather permitting, locates the person overboard and points to the location of the person at all times.*
- The Recovery / pick-up crew member makes preparation for the pickup.
- When the Recovery / pick-up crew is ready, they must sound out "READY ON DECK."

5. *The operator makes the recovery approach, briefs the crew as to how the recovery will be made and which side of the boat it will be made on. Based on existing conditions, the operator will select either a leeward or a windward approach.*

THE APPROACH

The operator must select an approach that is suitable for the existing conditions. There are two basic approaches:

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

Perform the leeward approach with the bow facing into the greatest force of oncoming resistance at the time of pickup. (See Figure 3-14.) This may be the wind, current, seas, or any combination of the three. There are times when the wind and current are from different directions. Select the heading which will best ease the approach. The operator must also balance the effect of any swell that might be present.

The approach must be made rapidly but as the boat nears the person you must slow the boat and reduce your wake enough to where a short burst backing down stops your headway.

The person in the water should be next to the recovery area on the boat and the boat should be dead in the water. Place the engines in neutral and, when the person overboard is alongside, have a crewmember make the recovery.

Make all pick ups in to the prevailing weather and sea conditions. Take care not to overrun the person overboard or to have so much headway on that the boat drifts beyond the person overboard.

WARNING: If the person in the water does drift aft of the boat, do not back down to effect the recovery. The propeller could injure the person.

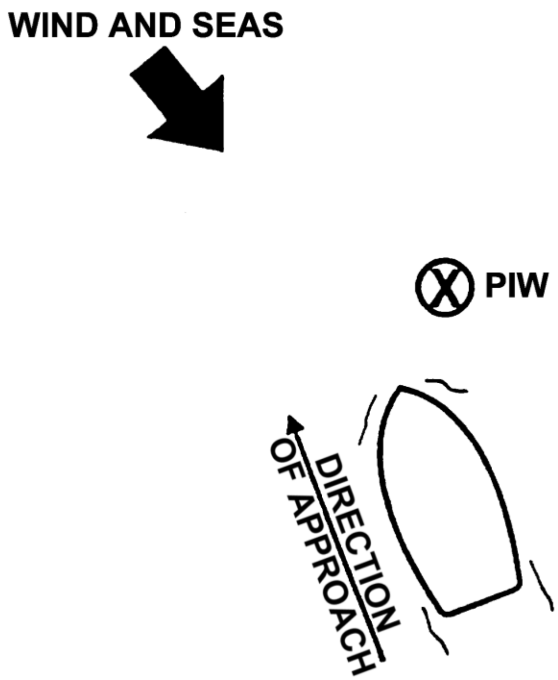


FIGURE 3-14

Perform the windward approach with the wind coming from behind the boat. Use the windward approach when the person overboard is in a confined space or a leeward approach is impossible. However, avoid a situation where the boat can not turn into the wind due to superstructure or bow sail area ("in irons"). The operator must maneuver into a position upwind and up current from the person overboard, place the engine in neutral, and drift down to the person. Ensure that the boat drifts so it places the person overboard along the "recovery' side but do not allow the boat to drift over the person.

Depending upon skill and experience, a combination of the windward and leeward approaches may be necessary. One instance may be in the case of recovering multiple persons in the water. (See Figure 15-4.)

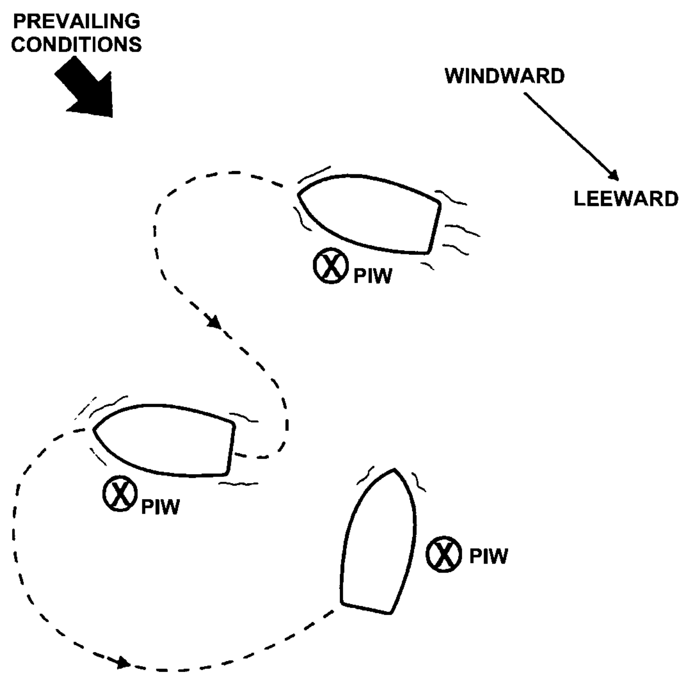


FIGURE 15-4

There may be instances when stopping the boat and allowing the person overboard to swim back to the boat, or at least to reach the tethered floating object is the most appropriate action. Especially if the boat can be stopped quickly after the person falls overboard.

The boat can be turned in the quickest time with full rudder and moderate speed. The turn can be achieved with a short turning diameter on twin prop boats by backing the inboard propeller. Whether single or twin propeller, the operator will slow the boat on the final approach such that the boat will nearly be DIW (dead in the water) when the person in the water comes abeam. You cannot do this maneuver on some twin outboards due to the close proximity and limitations of the props and side force.

The approach should be made in such a way as to keep your boat ten to fifteen feet away from the person in the water.

This prevents inadvertently striking the person in the water with the boat's hull or with the propellers.

The pick-up crew will throw a rescue line to the person in the water and pull the person in the water to the boat. As with any close-in maneuver, take your time.

Approach slowly using clutch speeds only. A slow approach is the best approach. If you make a mistake on the approach, simply go around and make another approach.

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

Severe conditions may dictate that the approach be made from leeward with the bow dead into the seas and/or wind in order to maintain control of the boat. In severe conditions, particularly aboard single propeller boats, this will test the experience and skill of the operator.

Never have the propeller turning when the person overboard is next to the boat. If you have to add power and maneuver with the person in the water in close proximity to the boat, turn the bow toward the person, swinging the stern and propeller(s) away and at a safe distance. This prevents injuring the victim with your propeller.

During low visibility and night operations when a crew member sees another crew member go over the side the same general procedures apply. The crewmember seeing the person go overboard tosses a flotation device with a strobe (or any other light) attached, if available. They also continue to observe and point to the person overboard as long as possible. The operator presses the Man Overboard button on the Loran-C or GPS receiver, if so equipped, sounds signals, and goes to the datum.

With a large crew, personnel who are not the lookout or boat operator, ready the boat for recovering the person in the water.

If the lookout is the only available crew member, he does this after the boat operator relieves him of the lookout.

On two person crews, the boat operator must act as the pick-up crew after the boat approaches the person in the water.

Equipment used in the rescue includes:

- Rescue line commercially made rescue lines are on the market. You can also make one by tying a line on a life ring or other floating object.
- Boarding ladder can be made by tying a loop in a line. The bitter end of the line is tied to cleat with the line positioned near the water surface.
- First aid kit.
- Blanket and dry clothes.
- As they are making ready, the pick-up crew must take care. The boat will be making radical maneuvers.
- The hand should be left free to grab handrails, the other can carry the gear.
- When the Recovery / pick-up crew is ready, they must sound out "READY ON DECK!"
- As the boat approaches the person in the water, the Recovery/pick-up crew throws the lifeline.
- As the line is thrown, yell out to the person in the water "GRAB THE LINE!" The throw must be over and behind the person in the water.
- The boat may still have way on. Throwing over and behind allows the rescue line to be dragged by the boat to the person in the water.
- An improper throw means the line is pulled away because of the wind and or current away from the person in the water.
- Pull the person in the water to the boat.
- Entering the water to retrieve a person in the water is dangerous. It should only be done if the person in the water is a child, elderly, injured, disabled or unconscious. If you must enter the water, take the following precautions.
- You must don a PFD.
- Tie a safety line from your waist to the boat.
- Take a ring buoy or other floating object with you.

- Shove the ring buoy at the person in the water. When the person in the water grasps the buoy, drag him or her to safety.

> NOTE: This is the most dangerous rescue technique. It should be done only by someone with proper training, and in good physical condition.

With most boats, it is safer and easier to lift the person in the water out of the water near the stern. Freeboard is usually lower at the stern. Use a boarding ladder or line stirrup if the person in the water is conscious.

A retrieval strap can aid rescuers in getting a good handhold on the person in the water. Commercially manufactured straps are available. A strap can also be fashioned from line on board the boat.

Position the strap under the person in the water's armpits. When lifting without a strap, grab the person in the water under the armpits. If this is not possible, grab the person in the water's wrists, shirt or PFD.

Use the bounce technique to assist in retrieving the person in the water. The person in the water bobs twice with the rescuers pulling the person in the water into the boat on the second bob.

Conduct an assessment of the person if the person is conscious he or she can tell you if they are hurt.

If the person is unconscious check A, B, C, start CPR if necessary.

1. Treat for hypothermia.
2. Prevent further heat loss.
3. Re-warm with blankets or dry clothes.
4. Treat for head, neck and back injuries.
5. Secure person in the water to prevent further damage.
6. Contact U.S. Coast Guard and, or local EMS immediately.
7. Treat for cuts and lacerations.
8. Use items in first aid kit if applicable.

9. Apply direct pressure.

ANDERSON TURN (NONE TESTABLE)

An advantage of the Anderson Turn is that it is the fastest recovery method. A disadvantage is that it is not meant for use by a single propeller boat. Even thought the Anderson Turn will not be discussed and the procedure is not taught during this course it warrants mention in this handout. The Anderson Turn involves the following:

PROCEDURE

1. Put the rudder over full in the direction corresponding to the side from which the person fell. Go ahead full on the outboard engine only.

2. When about 2/3 of the way around, back the inboard engine 2/3 or full.

3. Stop engines when the person overboard is within about 15° of the bow.

4. Ease the rudder and back the engines as required to attain the proper final position. (See Figure 17-5.)

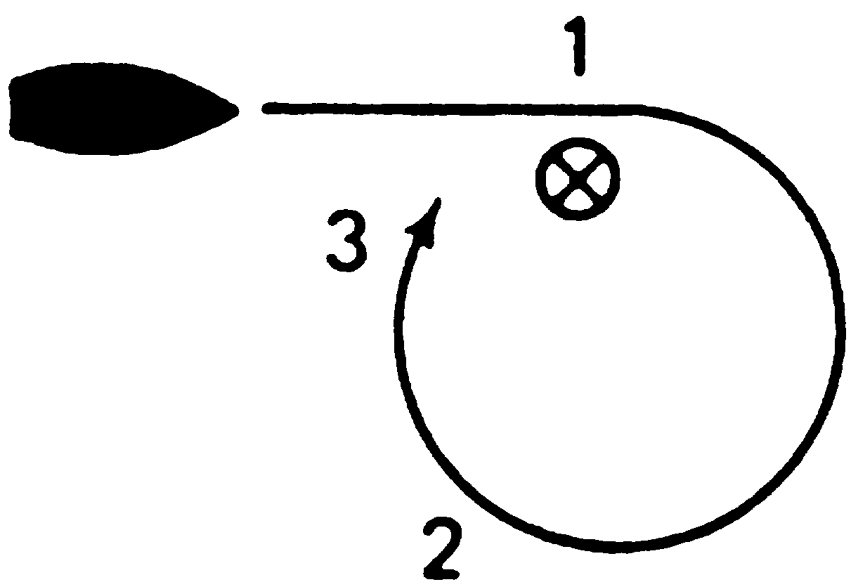


FIGURE 17-5 ANDERSON TURN

F. EPO # 6: IDENTIFY THE SELF RECOVERY AND INJURY TREATMENT TECHNIQUES IN A PERSONNEL RECOVERY SITUATION

If you are the only person on a boat and fall overboard, you must rescue yourself. If your boat has kill switches and you were attached to the lanyards, the boat should be dead in the water nearby.

If your boat is not equipped with kill switches, the boat may circle back to you. This is an extremely dangerous situation. Your only defense is to try and swim out of its path.

All marine officers should wear PFDs while underway. This is especially true if you wear a gun belt. If you are thrown overboard while not wearing a PFD, take off your gun belt and let it sink. Your gun is not worth your life.

If you can swim back to your vessel, you still have to get back onboard. You can do this using the chin and bounce.

Position yourself at the point with the lowest freeboard. Bounce two or three times as if you were doing chin-ups. Pull your upper body over the gunwale following the last bounce.

Another method is to grab a line made fast to your vessel. Fashion a bowline in the end to make a stirrup. Put one foot into the stirrup and use it like a ladder to climb on board.

Another method is to use your engine's cavitation plate as a step. The cavitation plate is located above the propeller on outboard and inboard-outboard powered boats. Place your foot on the cavitation plate. Use a cleat, the gunwale, or engine for a handhold and pull yourself aboard.

Be careful, however, the cavitation plate might be sharp and slippery. The exhaust ports of the engine might be hot.

Never attempt this with the engine engaged and the propeller turning.

Conduct a self assessment and call for assistance if needed.

G. EPO #7: IDENTIFY THE PROPER PROCEDURES USED FOR CHANGING A PROPELLER/HUB ON AN OUTBOARD ENGINE

It seems like most boat breakdowns occur at the farthest possible point away from homeport. Many times there is nothing to do but call (or wait) for help. But, some failures or problems can be repaired while underway.

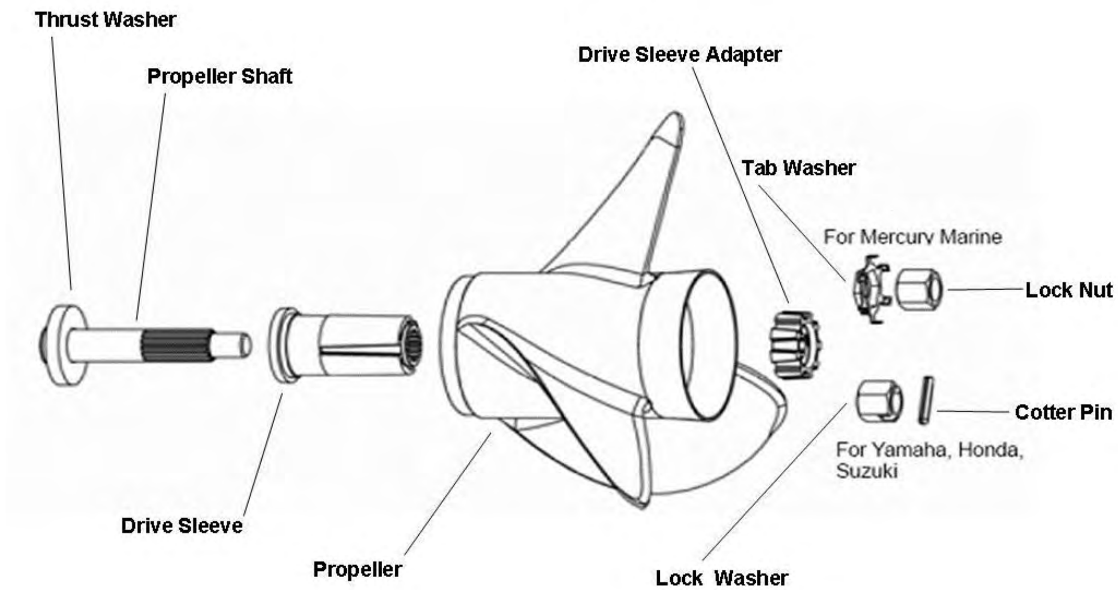
Outboards (and I/O's) often 'spin' propellers. The propeller has a rubber sleeve or a plastic insert inside the hub that is supposed to give when you strike an underwater object. The engine will rev wildly and the boat will come off plane. This is designed to protect expensive lower units. The boat can often be nursed back to the dock when this happens but it will have to be done at virtually idle speed to keep the propeller from freewheeling.

If the boat acts like it has a spun propeller:

Turn the engine off and trim the engine up.

- Try to rotate the propeller by hand with the engine in gear. The propeller should not turn. If the propeller turns by hand, the propeller hub is bad.
- Special tools will be required for changing out a propeller. If practical, pull your vessel to a dock, boat ramp, bank or to another vessel. As a last resort you will have to work over the engines. Always wear your PFD.
- Special tools required. Most manufactures make a special propeller wrench, or a socket wrench with the proper size socket, pliers, and a flat blade screw driver.
- Spare propeller or propellers on a twin engine vessel may have a regular rotation (right) and counter rotation (left) propellers.
- Spare hub and hardware from the manufacturer, designed for that particular model engine.
- Procedures for changing the propeller or hub, most hub kits come with instructions.
- Turn the engine off and trim up for accessibility.
- Be careful the engine may be hot near the exhaust ports.
- Bend the tab washer up or remove cotter key.

- Place the engine in gear or wedge a block of wood between the propeller and cavitation plate. Make sure the key switch is in the off position and pull the kill switch, to prevent engine from starting.
- Remove the lock nut.
- Remove the propeller, drive sleeve (hub) and thrust washer from the propeller shaft.
- Inspect the propeller shaft for unusual wear and for fishing line. If available apply grease to the propeller shaft to help prevent from seizing. Use all new hardware from the kit and keep the old hardware in case a part falls in the water.
- Install the new thrust washer on the propeller shaft.
- Assemble the new drive sleeve and drive sleeve (hub) into the propeller and install on the propeller shaft.
- Install the new tab washer and lock nut to the propeller shaft.
- Place the engine in gear or wedge a block of wood between the propeller and cavitation plate. Make sure the key switch is in the off position and pull the kill switch, to prevent the engine from starting.
- Tighten the lock nut and bend the tabs of the washer in place to prevent the nut from coming loose.


Thrust Washer
Propeller Shaft
Drive Sleeve Adapter
Tab Washer
For Mercury Marine
Lock Nut
Cotter Pin
For Yamaha, Honda, Suzuki
Drive Sleeve
Propeller
Lock Washer

H. DEMONSTRATE IN AN UNDERWAY LAB THE PROPER PROCEDURES USED FOR TOWING A DISABLED AGENCY VESSEL ASTERN AND ALONG SIDE.

This portion of the lesson plan is requested by the Partner Organizations as an exposure learning activity in an underway laboratory. It is not an EPO and will not be graded as such.

Towing a disabled vessel requires a high degree of awareness. It also requires the vessel operator to know the capacities and limitations of the particular components within the towing operation.

Towing astern – Rig a bridle between the tow vessel’s aft cleats or transom lifting eyes. Leave enough slack to ensure the bridle is well aft of the engines when pulled tight.

Towing alongside – Secure the disabled vessel alongside the tow vessel with a bow line, stern line, tow strap spring line and a backing quarter spring line. These lines should be made up with no slack and the bow and after running spring line should be secured first. To prevent damage, rig fenders between the vessels were contact will be made.

Agency vessels are not normally equipped for towing. Most of the time one will have to improvise and use what is available. Mooring lines, fenders, and an anchor and line can be used to tow a vessel. All towing will be conducted at a speed, which is not detrimental to the crew or equipment.

When towing over a long distance or in unprotected waters towing astern is the preferred method. In rough conditions a longer tow line will absorb stress caused by the seas. The longer line will also provide a better ride for both vessels.

If the tow vessel is not equipped with a tow line, the disabled vessel’s anchor line may be used. The tow vessel’s anchor line should not be used in case an emergency arises during the tow.

A bridal can be made using a mooring line secured between the tow vessel’s transom lifting eyes, or aft cleats. Make sure the bridal is long enough to clear the engines and to prevent fouling in the propellers.

Towing astern procedures:

- Rig a bridle between the tow vessel’s transom lifting eyes. If the aft cleats have backing plates, they can also be used.

- Connect the towline to the bridal using a bowline.

- Pass the towline to the disabled vessel, making it fast to the trailer eye bolt with a bowline. A big eye loop in the bowline allows for greater accessibility to tie and untie the knot.

- Coil or fake the towline to prevent tangling.

- SLOWLY maneuver the tow vessel away from the disabled vessel. It is always best to have two persons aboard the tow vessel, one to operate the vessel and the other to tend the tow line. Tending the line will prevent from fouling in the tow vessel's propeller.

- The vessel being towed should have their engine centered so the towed vessel will track straight.

- Towing along side is used primarily when maneuvering a disabled vessel to a dock. Secure the disabled vessel alongside the tow vessel with a bow line, stern line, towing strap spring line and a backing quarter spring line. These lines should be made up with no slack. The stern of the tow vessel should be well aft of the disabled vessel for better maneuverability. To prevent damage, rig fenders between the vessels were contact will be made.

- If previously towing stern, completely break down the tow while both vessels are in a safe area. Have the crew of the disabled vessel rig lines and fenders on the side of their vessel which will be against the dock. Preferably, these lines and fenders should be rigged the same as the ones between the two vessels. Remember your best control of the tow is into the wind and or current.

Towing alongside:

- Slowly approach the disabled vessel passing the bow line (#1) from the tow vessel to the disabled vessel and connect it to the disabled vessel's bow.

- Pass the tow strap spring line (#2) from the tow vessel to the disabled vessel and connect it to the disabled vessel's stern cleat. Position the tow vessel's stern well aft of the disabled vessel. After securing lines #1 and #2, maneuver the tow vessel slowly forward. This will cause the disabled vessel to lie alongside the tow vessel.

- Pass the backing quarter spring line (#3) from the tow vessel to the disabled vessel and connect it to the disabled vessel's forward cleat. Pass the stern line (#4) from the tow vessel to the disabled vessel and connect it to the disabled vessel's stern. Secure lines #3 and #4, removing slack in all of the lines.

- With the disabled vessel ready to moor, slowly make your approach to the dock.

REFERENCES

Chapman Piloting Seamanship & Small Boat Handling, 66th Ed.
.New York, Hearst Marine Books, 2009.

Sargeant, Frank. The Complete Idiot's Guide to Boating and Sailing,
New York, New York: Alpha Books, 2005.

"Post Summit Training, Las Vegas, Nevada, April 20-21, 2000.

U.S. Coast Guard, Boat Crew Seamanship Manual, Washington D.C.:
COMDTINST M10470.10F , January 2007