A Tour for Docents of

The Presidential Yacht

Potomac

Part II -
Ship Features and Ship Terminology

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Contents

Introduction

When boarding the Potomac a docent enters a special world of ships and the sea, with much tradition and history; often a world with its own vocabulary or where ordinary words have their own special nautical meaning. This "tour" of the Potomac will give the docent background information with respect to both ship features and terminology, to be used as needed and appropriate. The situation with respect to nautical terminology has been well stated: "The natural, proper use of correct terms is much to be desired; strained efforts to effect a salty lingo are conspicuously inappropriate." [1]

Some nautical terms and usage the docent already knows, is comfortable with and will want to use. Probably among them are the following:

NOT	BUT
Steps	Ladders
Toilet	Head
In/On a Ship	Aboard a Ship
Kitchen	Galley
Ceiling	Overhead
Floor	Deck
Put Away	Stow
Take Out	Break Out
Beds	Berths/Bunks
Closets	Lockers
Tied Up (e.g. to a Pier/Dock)	Made Fast
Rope	Line
Map	Chart

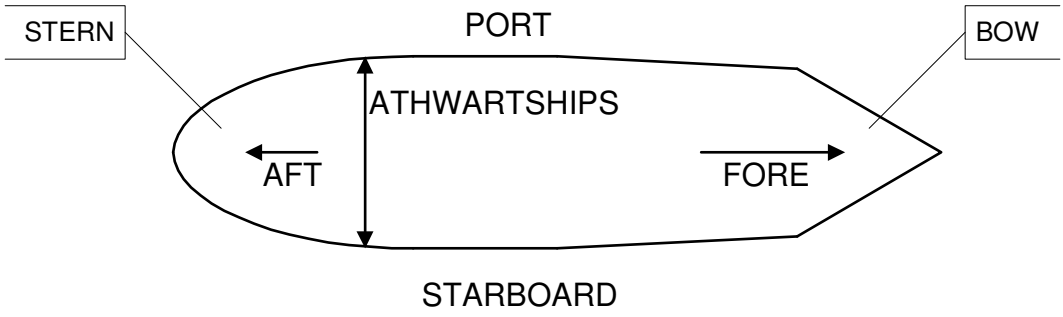
[1] The quote is from Chapman's Piloting, Seamanship and Small Boat Handling, a standard introductory work which has gone through many editions. There is an interesting connection between Chapman's book and Franklin D. Roosevelt. When FDR was Assistant Secretary of the Navy in President Woodrow Wilson's administration, he asked Charles F. Chapman, then an editor of Motor Boating Magazine, to write a manual of instruction in small boat seamanship for young men who were aiming for the Navy, the Coast Guard or the Merchant Marine.

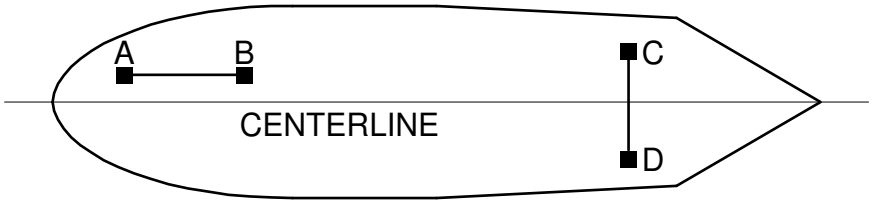
General Considerations:

There are several subjects, pertaining to the ship as a whole, which we should have a look at before starting our tour of the Potomac. These deal with directions on the ship, structural ship terms, and ship measurements.

Directions on the Ship:

The terminology of ship directions is summarized and illustrated by the following schematics:





AB is lying fore and aft; A is abaft of B, while B is forward of A
CD is lying athwartships

It may be noted that the word "starboard" (pronounced "starb'd") has nothing to do with stars. Rather, it comes from two Old English words which trace back to the time of the invasions of England by the Vikings. The first, "steor", is related to the word "steer", as in steering a ship; the second is "bord", meaning the side

of a ship. Interestingly, excavations of Viking ships show that they had their steering apparatus on the right, starboard, side of the ship.

The corresponding term for the left side of the ship used to be "larboard"; however, the possibility of mishearing and confusing the two words larb'd and starb'd led to the replacement of "larboard" by the term "port" in the mid nineteenth century.

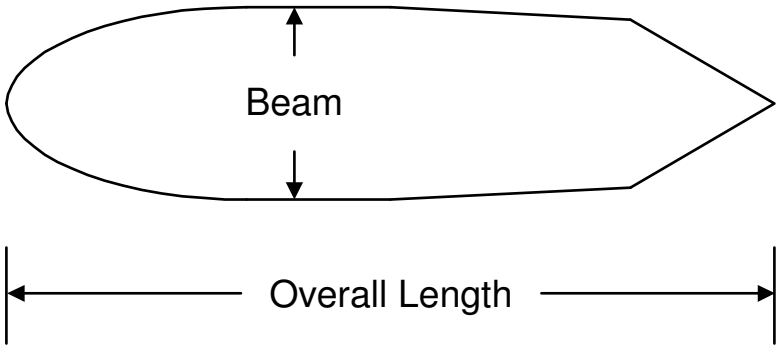
Structural Ship Terms:

The hull of a ship is the outer covering or body of the ship exclusive of masts, engines or superstructure. It includes: [1] the keel, which is the lowest continuous structural member running the entire length of the ship, and, as such, the principle member; [2] the stem, which is the extreme leading edge of the hull; [3] the frames (or ribs), which are the transverse structural members which run from the keel to the side rail and which form the shape of the hull; and [4] the sternpost, which is the aftermost member joined to the keel. The framing provides the skeleton on which the hull plating is secured. On the Potomac, which is transversely framed with bulb (i.e. rounded) angles, the frames are set 24 inches apart.

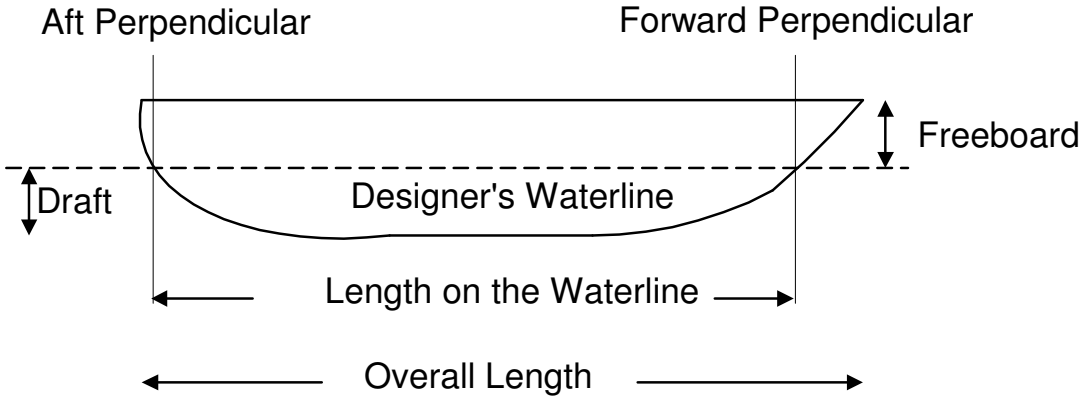
As originally built, the Electra was a riveted steel patrol boat. However, when she was dispatched to the Norfolk Naval Shipyard in 1935 for conversion to be the presidential yacht, it was decided to use welded steel for the changes and additions. The restored Potomac retains the same combination of riveted and welded construction that existed when she was the presidential yacht.

Ship Measurements:

The usual description of a ship's length and width is the overall length, measured from the forepart of the stem to the afterpart of the stern; and the beam, which is the greatest width of the vessel. The respective dimensions are 165' and 25' 3" for the Potomac.



Another length measurement often quoted is that at the waterline (or load line). In designing a ship the naval architect has to determine the safe maximum load of the ship and the equivalent depth to which the ship can be submerged when carrying that load and still float. The corresponding waterline is called the designer's waterline. Vertical lines at the intersections of the stem and stern contours (on a plan) and the designer's waterline are called the forward and aft perpendiculars, with the distance between them being the length along the waterline (or at the load line):

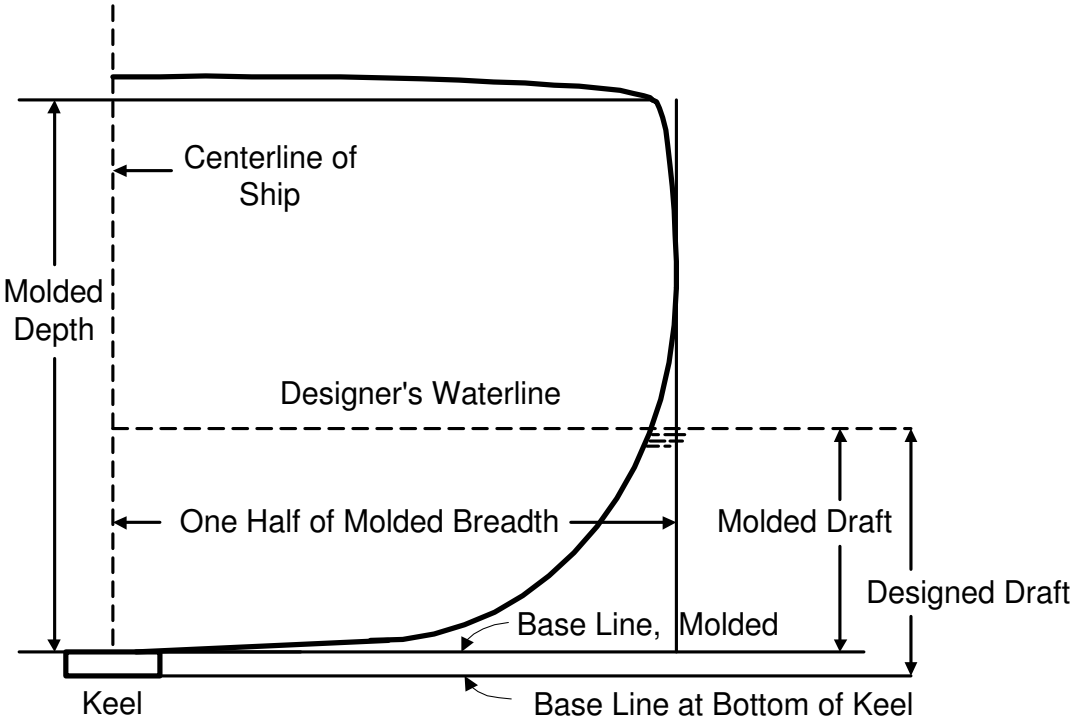


For the Potomac, the length at the waterline is 160 feet.

Freeboard is the vertical distance between the surface of the water (i.e. the waterline) and the top of the hull, and depends on the load the ship is carrying The load line represents the minimum freeboard. Draft, the corresponding distance from the keel to the waterline, is the depth of water required to float the ship. The draft of the restored Potomac is 10' 6"; when she was the president's yacht it was 8'1".

Sometimes confused with draft is another measurement, depth. Depth is measured inside the hull at the centerline of the ship from the underside of the deck to the top of the keel. The Potomac's depth is 13' 2 ½".

The following diagram, a section amidships, summarizes several of the measurement concepts[2]:



The final set of measurements deal with "tonnage" and "displacement". Gross tonnage measures the volume of the total enclosed space or internal capacity of a ship; and is measured in terms of "tons" of 100 cubic feet each.

The whole concept of tonnage arose in connection with merchant shipping in an attempt to measure the earning power of a ship when carrying cargo - the greater the volume, the greater the earning power. However, part of the space is taken up by volumes which do not contribute to earning power, such as the volume of fuel tanks, engine room, crew's quarters, etc. Accordingly, such volumes are subtracted from Gross tonnage to get the Net tonnage.

The Potomac's Gross and Net tonnage measurements are 376 tons and 276 tons, respectively.

Measurement of Gross or Net tonnage is not particularly meaningful for naval vessels. More meaningful is the displacement, which is the actual weight of the water displaced when the ship is

[2] Many of the measurements when quoted - such as breadth, draft, depth - are often molded breadth, molded draft, molded depth. The meaning of "molded" is illustrated by the diagram.

floating at any given draft[3]. The unit of measurement here is the "long ton" (= 2240 pounds). Displacement will change as a ship adds or removes fuel, stores or other items. A quoted displacement refers to a given condition of loading. For that load, the displacement can be calculated by dividing the volume of the ship which will be under water by 35 (36 in fresh water)[4]. For the Potomac, the displacement, at full load, is 416 long tons.

Ship Features - Main and Berth Decks

Going Aboard: Let's start our tour at the FDR pier, where the Potomac is docked. Strictly speaking, dock refers to the water in which the ship lies, but current usage includes the pier (or wharf)[5] to which the ship has been made fast.

Looking at the bow, you see the ship's name: Potomac. For the full period of service as a commissioned naval vessel, her proper name was the U.S.S. Potomac (AG-25).[6] Use of the prefix "U.S.S." to designate naval vessels was officially established by a 1907 Executive Order of President Theodore Roosevelt. In the naval designation AG-25, the "AG" stands for Miscellaneous Auxiliary.[7]

You also see the ship's anchors and the draft markings from which the (forward) draft can be read. We'll talk about the anchor in a little while, but first let's consider the markings in somewhat more detail.

From the bottom of one figure to the bottom of the next is one foot - the figures are 6" high and spaced 6" from the top of one to the bottom of the next. The waterline in

[3] The displacement is equal to the weight of the ship, including all that it contains. This is Archimedes Principle.

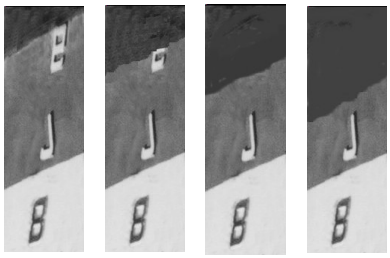
[4] Because 35 cubic feet of sea water (and 36 of fresh water) weighs one long ton.

[5] A pier extends out perpendicularly from the shoreline; a wharf runs parallel to the shore.

[6] It becomes MV (Motor Vessel) Potomac subsequently. The designation "Motor Vessel" is used in connection with ships with internal combustion engines.

[7] The only other presidential yacht to carry the AG designation was the Sequoia, AG-23. The Dolphin's was PG-24 (Gunboat); the Sylph was simply designated "converted yacht"; the Mayflower's was PY-1 (Patrol Vessel, Converted Yacht); while the Williamsburg's was AGC-369 (General Communications Vessel).

the photo, enlarged below in (a), shows that the draft was 6 feet since it was just at the bottom of the figure 6. The pictures following, (b), (c) and (d), show the markings for drafts of 6' 3", 6' 6", and 6' 9" .



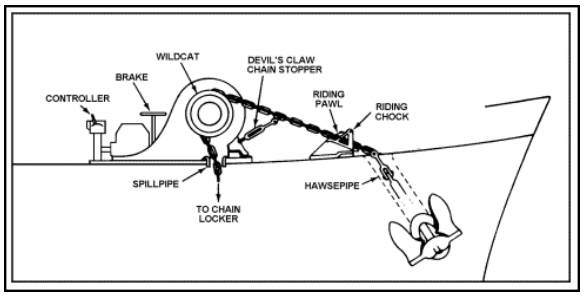
(a) (b) (c) (d)

On Deck at the Bow: Our tour of the main deck will be fore to aft, so we'll start with the anchor windlass, but let's keep in mind the fact that the windlass is just one part of the equipment used in anchoring. The other parts are the anchors, anchor cables or chain, and connecting devices. Collectively, this equipment is referred to as the ship's ground tackle.

The windlass is a working piece of machinery and docents should make sure that visitors do not push any buttons, touch any part or try to sit on it. Indeed, if the windlass is in operation only the crew is permitted to be in the bow.

The function of the Potomac's ground tackle is to provide a carefully controlled, safe means of raising and lowering the anchor. Basically, the windlass is a motor driven, horizontal shaft which has been fitted with a drum, called a wildcat, whose faces have been formed to exactly fit - and thereby securely grip - the links of the anchor cable as it comes out of, or returns to, the chain locker; together with suitable controls and brakes.

The schematic provides an overview of the Potomac's ground tackle.[8]



The Potomac's anchor cable is 450 feet in length and is composed of five, linked 90-foot sections called shots.[9] The

[8] For a more detailed discussion, see ANCHORS AWEIGH in the appended material.

[9] It is more traditional to describe a shot as being 15 fathoms.

cable is stowed immediately below in the chain locker, a compartment in the forepeak, the ship's forwardmost space formed by the angle of the bow.

The forepeak also contains other spaces: that for ballast[10] and that for the bos'ns stores are examples.[11]

The booby hatch, curved from its fore side to the top, is a raised shelter for the ladder entrance to the forward crew compartment in the berth deck. As we will see, the various ladders on the Potomac have different degrees of steepness. This is one of the steeper ones with its 70 degree angle, and is the reason we do not normally allow visitors to use it to go below.

Apparently, the booby hatch was so called because the booby, a tropical bird, would use this sheltered hatch to get protection from the cold and wind of the sea.

Next on our tour will be the crew's quarter below. However, before we do so and while still out on the main deck, face aft and note that Fire Station 1 is located on the exterior of the Commanding Officer's cabin, to starboard. Each of the six fire stations on the main deck has a 50 foot length of 1 ½" fire hose.

In the Crew's Quarters: Let's go below to the forward crew's compartment, using the outboard ladder on the port side of the forward passageway. (To enter the passageway you have to step over a raised rim - it's called a coaming.) This ladder, at an angle of 50 degrees, is less steep than the one at the booby hatch and is typical of most of the ladders the crew would use.

The transverse bulkhead you see is the collision bulkhead. The transverse bulkheads - there are 6 in the Potomac (including the collision bulkhead) - extend from the bottom of the ship to the main deck, add structural rigidity to the ship and subdivide the ship into watertight compartments. The collision bulkhead, the major watertight bulkhead, is the forward most of these and is specially strengthened and designed to help the ship remain afloat by preventing water from entering the ship's compartments.

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[10] The need for permanent ballast came about because of changes introduced with the Potomac's restoration.

[11] "Bos'n" is a contraction of "boatswain", a petty officer in charge of the deck crew.

To return to the forward passageway on the main deck by the inboard ladder from the officer's quarters, you will go through two doors which, when fully closed, make two separate watertight areas. Anyone closing up the ship must make sure that these two watertight doors are fully closed.

Standing in the passageway you see the two "restrooms". When the Potomac was the presidential yacht, there would not have been any women in the crew, and no need for a women's restroom. (Any women aboard would have been guests and would have used the facilities in the guest cabins.) What is now the women's restroom used to be the crew's showers. The men's restroom was, and is, the "head".

The term dates back to the days of sailing ships; and references were always to the plural "heads". There were two areas - one to lee and one to windward - in the prow of a ship, i.e. at the head of the ship. (The crew was expected to use the leeward one!) The heads were floored with grated openings which also allowed the sea to help in keeping the areas clean.

Going Aft: If we go aft along the starboard side, you will see a storage locker for children's lifejackets under the ladder to the boat deck; on the port side, in a corresponding locker, are lifejackets for adults.[12] Right next to this locker are the fill lines for the Potomac's two fuel tanks.[13] The fuel tanks themselves are located in the berth deck below.

Back on the starboard side, you can see how the end of a docking line, after passing through a chock, is wound around a pair of bitts - the low cylindrical objects mounted as a pair on a footing - in a figure eight pattern. Also, you will often see short lengths of line on the dock, or line ends on deck, "flemished down", i.e. laid down in a completely flat coil resembling a small rug.

In the Radio and Engine Rooms: Mounted on the bulkhead of the radio room are six, 4 foot long general purpose type nozzles, called applicators, for attachment to the hoses at the fire stations. Depending on the situation at hand, either a solid stream or a fog can be produced.

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[12] This used to be a cold storage locker when the ship was the U.S.S.Potomac.
[13] The fuel capacity is about 7500 gallons.

While still in the radio room, notice the four plugs in the deck near the radio equipment. The smaller ones have the emergency shut off valves for the fuel tanks; the larger ones allow for sounding the tanks to measure the amount of fuel in them.

Before entering the engine room, notice the cylinders of carbon dioxide in the midships passageway; they are part of the engine room fire suppression system.

Although we will go into the engine room on our tour, this is an area into which visitors will not normally go on theirs.

The Potomac is propelled by twin screws, each driven by its own Enterprise, 6 cylinder reversing diesel engine.[14] These engines, donated by Crowley Maritime, are from a World War II tug and, at 440 HP each[15], are somewhat less powerful than those which were on her when she was the presidential yacht.[16] The engine on the starboard side is connected to a right handed propeller; that on the port side to a left handed propeller. A propeller is right handed when, with the engine turning ahead, its upper half revolves from port to starboard; and left handed when it revolves from starboard to port.

Although the propulsion machinery control is from the wheelhouse, the engine room is fully manned when underway, and there is backup by engine order telegraph simulating that on a 1940's ship. When underway, the Potomac's speed is about 10 to 12 knots (12 to 15 miles per hour).[17]

Outboard along the bulkhead are the air compressors and, in the corners, the generators. The raised, open space above the engines, called the fidley, allows more air, light and ventilation for the engine room. You can also see that there is an engine room escape hatch in the fidley, reached by a vertical ladder.

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[14] A diesel engine is an internal combustion engine, as is a gas engine. Both produce a power stroke in the cylinder by an explosion of a mixture of fuel and air. However, while the explosion in a gas engine is brought about by a spark, in a diesel engine it is caused by the heat of highly compressed air igniting a spray of fuel.

[15] This is shaft HP at 400 RPM.

[16] The Electra was built with two Winton, 6 cylinder diesel engines, at 670 HP each. These were retained in her conversion to the U.S.S. Potomac.

[17] See Bells, Points and Knots for a discussion of knots as a measurement of speed.

The Saloon and Fantail: On the way to the saloon, note the locations of Fire Stations 2 and 3. They are just abaft the midships passageway, on the port and starboard sides respectively. Then, just as you are about to enter the saloon, look up to see Fire Stations 4 and 5; again, on the port and starboard sides respectively.

One of the features of the saloon is the 6" brass clock which strikes the appropriate number of bells at the hour and half - hour.[18] When the Potomac was the presidential yacht, there were several more of these striking clocks aboard: in the President's cabin, the fantail, the Commanding Officer's quarters and in the wheelhouse.

While in the saloon, look at the elevator which allowed President Roosevelt to move in an unrestricted fashion between the main and boat decks. Although it is now an electric elevator, its dimensions are the same as when it was hand operated - a relatively small 4 feet deep, 3 feet wide and just under 7 feet in height.

We'll pause on the fantail to note three things. The first is Fire Station 6. The second is the raised escape hatch which provides access to, and egress from, the steering gear room below by means of a vertical ladder. Finally, the fantail is a good place to observe the camber, the slight curvature of the deck which helps water to run off. It is easily seen if you trace the intersection of deck and bulkhead.

Ship Features - The Boat Deck

Forward to the Wheelhouse: When we were in the saloon, we looked at the President's elevator. Now, looking at the elevator once again from the boat deck fantail, pause to consider what a neat bit of engineering was involved in installing it in the after smoke stack. The elevator has to move straight up and down, but the smoke stack is inclined to the vertical by about 5 degrees. The elevator had to be large enough to accommodate the President, yet still fit into the angled smoke stack. Clearances are very small !

As you know, the boat deck fantail was added in the conversion of the Electra. Its weight tends to make the ship top heavy and roll from side to side, especially in bad weather out in the open sea. But it was the installation of a 50 caliber gun on the fantail with its

[18] See Bells, Points and Knots for a discussion of bells as a measurement of time.

additional weight (added just before the President boarded the Potomac for the start of his trip to the Atlantic Conference) that would lead the Navy, later after the President's death, to declare the ship "unseaworthy".

As we go forward, let's stop at the two Chris Craft donated by Alan Furth. Although these are of the same vintage as those here when the Potomac was the presidential yacht, there is one significant difference: President Roosevelt had a swivel seat built into one for his ease and comfort when out fishing.

Look up now and, at the masthead, you will see one of the five navigation lights which the Potomac is required to carry.[19] Each of these five - the stern or overtaking light, the masthead light, the light on the forward mast, and the two sidelights - are of a specified color and have a specified visibility arc (an arc of the horizon over which the light will shine in an unbroken manner):

		Visibility Arc	
Light	Color	Degrees	Points
Stern	White	135	12
Masthead	White	225	20
Foreward Mast	White	225	20
Port	Red	112.5	10
Starboard	Green	112.5	10

Navigation lights allow the Potomac and any other ship meeting, crossing or overtaking her at night to determine their relative positions. "Rules of the Road" (which, of course, apply day or night) will determine which of the two has "privilege", and thereby is in a stand-on situation keeping course and speed; and which has the "burden", and thereby is in a give-way situation altering course and speed to avoid a collision.

The "rescue" (utility) boat is to port as we move forward, with the whaleboat on the starboard side. A whaleboat, with its distinguishing feature of a double prow, is designed to move and turn swiftly; this is what commended its use as a lifeboat and utility boat.

[19] These requirements are for ships over 150 feet in length.

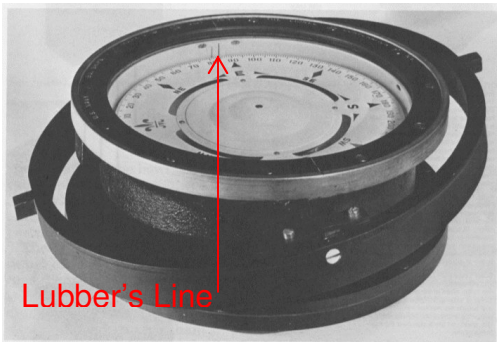
All of the boats on the boat deck have fully operational facilities for launching; however, no use of them is contemplated. Their purpose is to achieve the look of the Potomac as presidential yacht.

In the Wheelhouse: Notice the structure just aft of the wheelhouse. It is the emergency generator. Above it there is a 12 inch diameter ship's bell.

Entering the wheelhouse you see a radar scope, the steering wheel, a binnacle containing the compass and the engine controls. Because a hydraulic steering system has now replaced the original winch and cable system, the present steering wheel does not need to be as large as that which was originally on the U.S.S.Potomac.

The binnacle is rigidly secured to the deck so that the lubber's line of the compass gives a true indication of the heading of the ship. The protective hood contains lights for illuminating the compass at night.

The compass mounted in the binnacle is a 7 ½ inch Standard Navy compass. In addition to showing degrees, Cardinal and Semi-Cardinal points are indicated also.[20]



Since a compass is nothing more than a freely rotating magnet, it will point to magnetic north rather than true north. The angular difference between the two, although varying depending on location, is known and can be tabulated. However local magnetic influences on the ship also cause errors (deviation). To minimize these, the binnacle has various correctors: [1] a system of permanent magnets placed below the compass chamber and in the vertical axis; [2] a pair of arms projecting horizontally from the compass chamber that support two iron spheres (called quadrantal globes; and [3] an attachment for securing a vertical soft iron rod or "Flinder's Bar".

[20] See Bells, Points and Knots for a discussion of points as a circular arc measurement.

Although deviation can be minimized (but not eliminated), and though it will vary with the ship's bearing, it can be measured and recorded for use by the ship's pilot.

Today, though the ship can be steered using the wheel, the steering device on the engine control stand is used more often. Steering control can be transferred from one to the other by the switch in the box labeled Steering Mode Selector.

The Potomac's two engines operate independently of one another. Thus: one or the other can be stopped; they may be set to different speeds; or one can be set to ahead while the other is set to backing. As a result there are many different combinations and permutations of the settings, with differing effects on the direction of motion of the ship. Part of the special art and science of piloting is a mastery of these effects. A summary of these effects follows:

(a) One engine stopped: The stern swings to the side of the engine not stopped, if set ahead; to the opposite side if set astern (to backing).

(b) Unequal speeds: The stern swings to the side of the engine at higher speed, if both set ahead; to the side of the engine at slower speed if both set astern. The greater the difference in speed, the sharper the turn.

(c) Screws in opposite directions: The bow turns to the side of the screw backing, the stern to the side of the screw set ahead.

On the Bridge: The last stop on our tour is outside, on the bridge.[21] You can see three searchlights mounted atop the wheelhouse - one on the centerline, one to port and one to starboard - as well as the Potomac's port and starboard navigation lights, which are mounted at the sides.

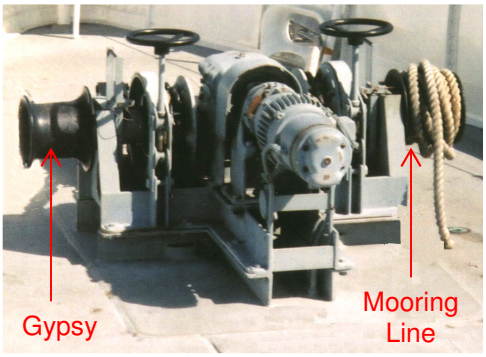
[21] The bridge is the entire athwartships structure; a wheelhouse is an enclosed area on the bridge from which the ship is controlled. So, when in the wheelhouse, you are on the bridge; but when on the bridge, you may or may not be in the wheelhouse.

At each bridge wing you will see a flat circular plate. This is where a pelorus would have been placed. A pelorus (sometimes called a dumb compass) is a simple device for finding the relative direction (bearing) of ships or other objects.[22] It consists of a compass card, i.e. a circle whose circumference is marked out in degrees and/or points and aligned parallel to the centerline of the ship, together with a freely rotating sighting vane.

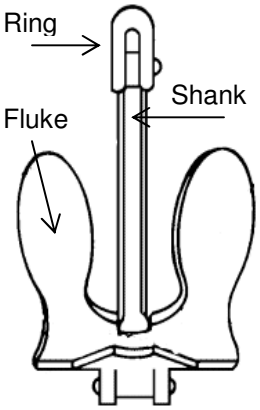
[22] See the diagram Relative Directions for the naming of directions.

ANCHORS AWEIGH

When the Potomac is docked, she is made fast by her mooring lines. To keep the bow mooring line taut, the inboard end is wrapped around a small auxilliary drum, called a gypsy, fitted at the end of the windlass. The gypsy has its own controls so it can be independently operated.



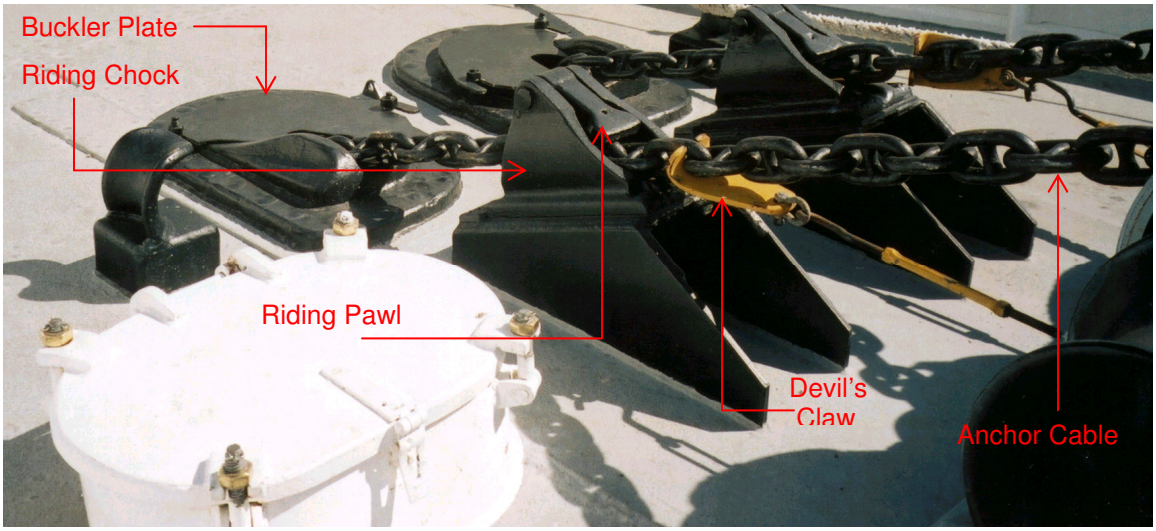
The inboard ends of the other mooring lines are wrapped around bitts. [This is the source of the expression "bitter end" – the bitter end was reached when there was no more line to be played out.]



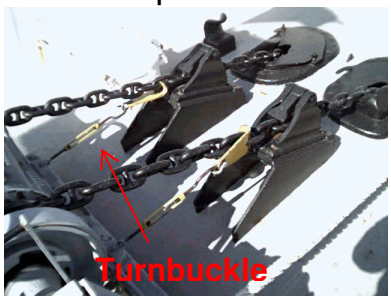
Away from the dock, the Potomac is held at rest in the water by one of her anchors. The Potomac's anchors are standard Navy stockless anchors. That is, they do not have a stock - the horizontal cross piece seen, for example, in naval designs or insignia and older anchors.

When the anchor is not in use, the shank goes through an opening – the eye of the ship - into the hawse pipe where it is stowed. The hawse pipe, extending from the deck to the eye, leads the cable down and forward where the outboard end of the cable is attached to the anchor ring by means of a swivel piece. (The swivel piece is formed from several special links, a swivel and a shackle.) When the ship is underway, the hawse pipe opening on the main deck is

covered by a heavy steel plate, the buckler plate, to prevent water from coming up the hawse pipe and spilling on deck.

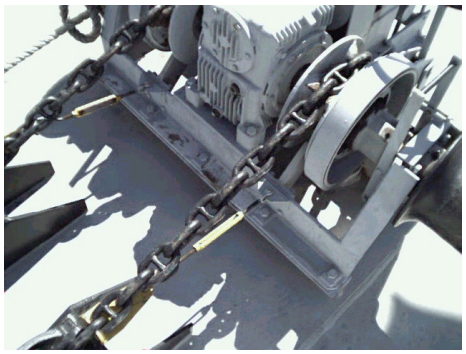


Situated between the buckler plate and the windlass is the riding chock. The riding chock has two functions: [1] it serves as a "fairlead" for the cable – that is, as a device that keeps the cable moving in an unencumbered straight line to or from the windlass, and [2] to hold the riding pawl. The riding pawl, a hinged metal tongue, has two positions – open or closed.[23] It is lifted to the open position when the anchor is being dropped so that the cable may run out freely. When the cable is being taken in, it is in the closed position and simply bounces over the incoming cable. However, if an emergency arises it will act as a stopper by catching on a link, holding the cable and preventing the cable from running out. The pawl remains in the closed position when the windlass is not in operation, as in the photo above.



Also acting as a stopper when the windlass is not in operation is the devil's claw. The claw is placed on one of the links of the cable; a turnbuckle, secured at one end to the windlass and hooked to the base of the claw at the other, provides the tension necessary if the claw is to act as a permanent stopper, since the claw cannot be released under tension.

[23] It may be useful to think of the pawl as being an epaulet on the chock's shoulder; indeed, the two words derive from the same French word for shoulder.



Adjacent links of the cable are turned 90 degrees to each other, as the photo clearly shows. Looking down on the cable, the pattern could be described as … wide, narrow, wide, narrow, … The wildcat, a sprocketed wheel, repeats this pattern in its indentations and, when engaged, is what enables the cable to be securely gripped as the cable is paid out or taken in. When the wildcat is disengaged, it turns freely and the only control is the brake.

For the safety of the ship it is important to know how much of the anchor cable has been paid out. A color system quickly provides this information: Each of the detachable links that joins one shot to another is painted with a different color. Links on each side of the detachable link are painted white - the number depending on which shots are being joined. Links of the next to last shot are painted yellow; those of the last shot, red.

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The phrase “anchors aweigh” that has been used for this discussion of the Potomac’s ground tackle refers to the event that would be so noted in a ship’s log. It derives from “weigh”, an archaic word meaning to heave, hoist or raise. "Aweigh" means that the action has been completed. The entry is duly made when the anchor is pulled from the bottom. [The Navy’s marching song, “Anchors Aweigh”, was composed in 1906 and first played at that year’s Army – Navy football game; it was later adopted as the official song of the U.S.Navy]

BELLS, POINTS AND KNOTS

An Excursus On Some Nautical Measurements

BELLS: To mark the passage of time on board ship, the day (twenty - four hours) was divided into six cycles, or watches, of four hours each. Within each watch, the passage of each half - hour was marked by the sounding of the ship's bells - one after the first half-hour, two after the second, etc. until the cycle was completed with the sounding of eight bells.

The cycles, as they shaped the day at sea, are set out in the tables appearing on page 23 .

Even after the advent of reasonably accurate clocks, the passage of time on board a ship might well have continued to be measured with sandglasses. Although sandglasses were normally supplied to ships in four sizes: half - minute, half - hour, hour and four hour, the half - hour sandglass was the main means for measuring time. As mentioned, every time a half - hour glass emptied, the ship's bells were sounded.

POINTS: Each of the thirty - two named directions of the compass is referred to as a "point". The system of naming the points can be seen from following a sequence of divisions of a circle. The first division produces North and South; the second East and West. These four points are the Cardinal points. The third division bisects the angles beween the Cardinal points to give the Half - Cardinal points: NE, SE, SW and NW.

Bisecting the angles between the Cardinal points and the Half - Cardinal points in the fourth division yields eight more points: NNE, ENE, ESE, SSE, SSW, WSW, WNW and NNW. Note the naming scheme in this division - the point just created is named by joining the names of the Cardinal Point and the Half - Cardinal point (in that order) marking the angle being bisected.

Sixteen points, defining eight angles, have now been produced. The fifth division bisects these eight angles to give the remaining sixteen points of the compass. Each of these points lies between a Cardinal or Half - Cardinal point and a point produced in the fourth division. These last sixteen points are named by reading <u>from</u> the Cardinals or Half - Cardinals <u>to</u> a Cardinal direction, using the word

"by" to express the from/to relationship. Thus the names are: N by E, NE by N, NE by E, E by N, E by S, etc.

The result of all of this, the 32 named pointrs of the compass, is shown in the accompanying illustration on page 24. Before the introduction of modern navigational equipment, one point represented the approximate accuracy by which a course could be changed by a helmsman. As equipment improved, a ship's course could also be changed by half and quarter points. Since a circle has 360 degrees and there are 32 points of the compass, each point is equal to 11□ 15'; each half point to 5□ 37.5'; and each quarter point to 2□ 48.75'.

Use of compass points for navigation has practically vanished today. There are tell tale traces of the use of points, however, such as the otherwise peculiar looking requirements with regard to the visibility arcs of navigational lights on ships.

KNOTS: The speed of a ship is measured in knots, with a speed of one knot being equal to one nautical mile per hour. The nautical mile, itself, is defined as the length of one minute of arc. Because the Earth is not a perfect sphere, the arc length when measured at one latitude will differ somewhat from that measured at another, with the greatest measured difference being between the one at the equator and the one at a pole. To overcome this, the average of the two extreme measurements is used, giving 6077 feet as the length of a nautical mile. (Sometimes a rounded up number, 6080 feet, is used.)

Since a statute mile is 5280 feet, the nautical mile is greater by about 15%. So a ship, such as the Potomac, which made about 10 to 12 knots travelled at a speed of about 11 ½ to 14 miles per hour.

The term "knot" derives from the way a ship's speed used to be measured. The principle is simple: Let a line play out for a specified interval of time; then measure the length and divide by the time interval. The measurement becomes even simpler if the time interval is fixed in advance, because then the line can be marked out by knots spaced in such a way that the number of knots counted is equal to the speed of the ship.

Specifically, the spacing of the knots was 47 feet 3 inches and the log line was played out for 28 seconds.

[1 knot =1 nautical mile / 1 hr = 6077' / 3600 sec = 47' 3" / 28 sec]

Selecting 28 seconds for the fixed time interval may seem strange - and it is. Actually, when this method was first used every ship had a half - minute sandglass, so the selected time interval was 30 seconds. However, measuring the length of one minute of arc could not be done as accurately as was to be the case later and an incorrect number was used; using that erroneous measure and the 30 seconds produced the 47' 3" interval between the knots on the log line.

When the correct length of a nautical mile was found to be 6077', a choice had to be made. Either keep the 30 second time interval and determine a new spacing for the knots on the log line - which would mean having to get new lines; or keep the lines with their 47' 3" spacing, calculate what new time interval was needed and make new sandglasses. The second approach was taken, and new 28 second sandglasses, were added to ships.

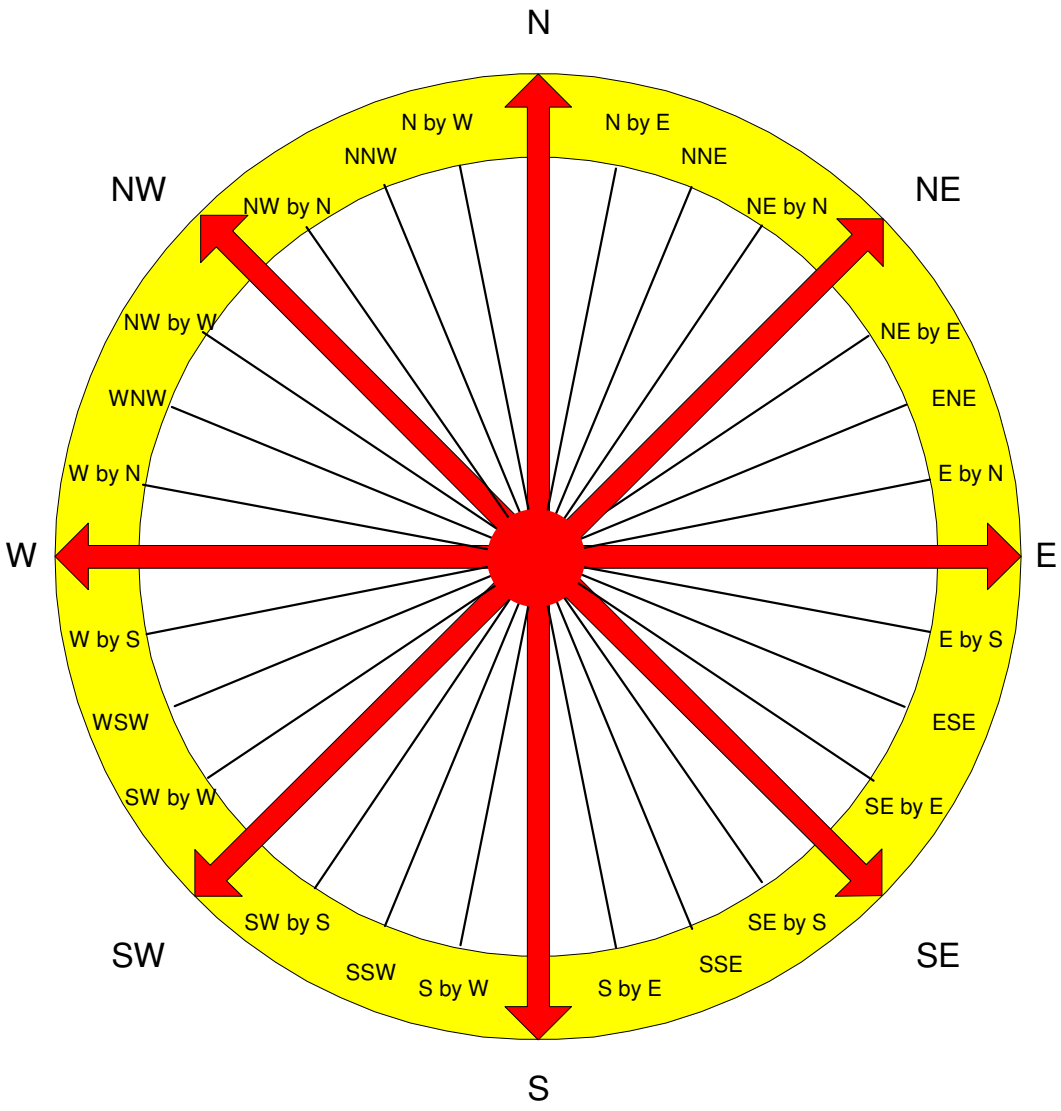
THE DAY AT SEA

WATCH	FROM	TO
Midwatch	midnight	4:00 AM
Morning	4:00 AM	8:00 AM
Forenoon	8:00 AM	12 noon
Afternoon	12 noon	4:00 PM
Evening	4:00 PM	8:00 PM
First	8:00 PM	midnight

CYCLE OF BELLS (Afternoon Watch as example)

TIME (civilian)	TIME (naval)	NUMBER OF BELLS
12 noon	1200 hours	eight bells
12:30 PM	1230 hours	one bell
1:00 PM	1300 hours	two bells
1:30 PM	1330 hours	three bells
2:00 PM	1400 hours	four bells
2:30 PM	1430 hours	five bells
3:00 PM	1500 hours	six bells
3:30 PM	1530 hours	seven bells
4:00 PM	1600 hours	eight bells

THE 32 POINTS OF THE COMPASS



NAVIGATION LIGHTS

Every ship whose length is 150 feet or more, such as the Potomac, is required to have five navigation lights which must be displayed when underway at night. Two of these, the steaming lights, are placed on masts, with the second abaft of and higher than the first. For the Potomac, the lower light is on the main mast and the second on the mizzenmast.

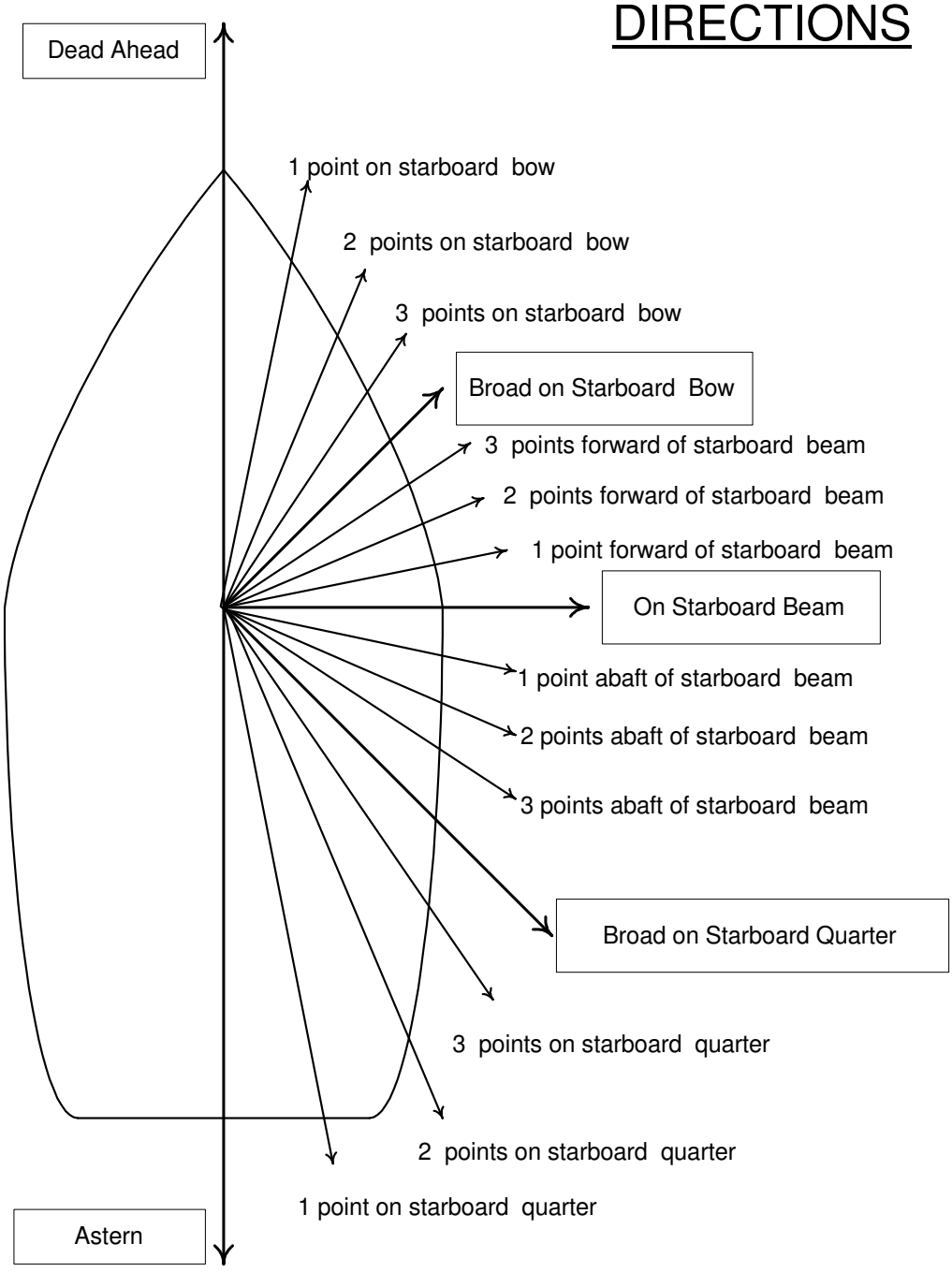
The second pair of lights are located to port and starboard, respectively. These are the bow or sidelights. The fifth navigational light is at the stern and is referred to as the overtaking light.

Each of these lights has a specified color: the steaming and overtaking lights are white; the port bow light is red, while the starboard one is green.

Each of these lights also has a specified visibility arc:for the port and starboard lights, it is 112.5 degrees; for the steaming lights, it is 225 degrees; and at the stern, it is 135 degrees.

The choice of 112.5 degrees for the visibility arc of the sidelights, as well as the choices for the other lights, may seem to be a little strange. In fact, these choices are a reflection of the time when ships used points of the compass, rather than degrees, for navigation. Restated in terms of points, the visibility arcs are: 10 points for the sidelights; 20 points for the steaming lights; 12 points for the overtaking light.

RELATIVE DIRECTIONS



Direction of vessels or other objects on port side of ship have same names, with "port" replacing "starboard"