Safe Waters

Captains Guide

CHAPTER 1

Magnetic Compass

Magnetic Compass

Introduction
A magnetic compass is a simple piece of navigation equipment, standard on most every boat. It responds to the magnetic fields of the earth, and is used to determine a vessels heading when out of sight of landmarks and in restricted visibility.

Construction
The arc of the compass card is divided into 360° and is numbered all the way around the card from 000° to 360° in a clockwise direction. Attached to the compass card is a magnet that aligns itself with the magnetic field round it. The lubbers line is a mark scribed on the compass housing to indicate the direction in which the boat is heading. The lubbers line is aligned parallel to the vessels keel. The compass card does not turn, your vessel turns around the compass card.

Variation and Deviation
A compass points to a spot called magnetic north, it does not point to the geographic North Pole.
The difference between true north and magnetic north is called variation. Variation is the angular measurement between geographic north and magnetic north. This difference varies depending on your geographic location.

A compass once placed on a boat is also influenced by another magnetic field other than the earth's. It is the magnetic influences' that are on your boat. This additional magnetic field influences your compass and is known as deviation. Deviation is the angle between magnetic north and compass north.

Deviation changes with your vessel change in heading. This is because as your boat changes heading, your rotating the earth's magnetic field with your boat's magnetic field.

You can keep track of how much deviation is present with respect to the direction of your heading by using a deviation table. This is a record of how much your compass is off (east or west of north) when you are on various headings.

When mounting your compass special care must be taken to see to it that anything capable of adversely influencing your compass' accuracy is minimized. Electrical wiring, metal objects, etc. should all be kept as far away as possible to minimize their influence on the compass.

Compass Corrections
When you are navigating, accounting for the two errors present in your vessel's compass is easy. A simple formula allows you to keep track of how much of the compass error is the result of deviation, and how much is a result of variation. Together both of these errors are called Compass Error.

The formula reads like this: “TV Makes Dull Children” (falling down add whiskey)

	T	**= True**	
+W	**V**	**= Variation**	**-W**
-E	**M**	**= Magnetic**	**+E**
	D	**= Deviation**	
	C	**= Compass**	

If we plug into our formula the known information we have, we can simply follow the steps and come up with our corrected (true) or uncorrected (compass) heading.

For example, lets say we chart a course for a trip we plan to take and we determine that we need to steer a true course of 090° to get from or starting point to our destination. If we just get underway on our boat and steer 090°, we will never reach our destination as we have not compensated for the two errors we know exist in our compass.

To begin, lets fill in the values we know. We will use the LIS Chart#12354TR, where the variation is 014°W and the deviation table given below.

Deviation Table

Hdg. Mag.	Deviation	Hdg. Mag.	Deviation	Hdg. Mag.	Deviation
000°	2°E	120°	1°E	240°	3°W
030°	3°E	150°	1°W	270°	1.5°W
060°	4°E	180°	2°W	300°	0°
090°	2°E	210°	3.5°W	330°	1.5°E

Using the above information, if we follow the formula, our work will look something like this:

	T	**=**	**090°**
+W	**V**	**=**	**014°W**
-E	**M**	**=**	**104°**
	D	**=**	**002°E**
	C	**=**	**102°**

Our true course, 090° goes next to the T (true). The variation is known, (we get that from the chart) and goes next to the V (variation). Since we are going down the formula, (from T to C) and we know according to our formula we add westerly errors when we go down, we add 090° and 014° and get our magnetic (M) answer of 104° We then go into our deviation table and look up 104°, which according to our table is closer to 090°, than 120°. (we could interpolate, but realistically it only means a difference of about 0.5°) Our deviation from our table is 2°E, and this is now subtracted (going down our formula we subtract easterly errors) from our magnetic heading, and we arrive at our compass course of 102°.

We plotted a course of 090° on our chart, but we will actually steer a course of 102° on our boat, which allows us to account for the two errors in our compass (variation & deviation). A heading of 102° will get us to our destination.

Compass Error
We now know that compass error is a combination of both variation and deviation. We may be asked to calculate total compass error in some of the USCG questions on the exam. This is relatively simple.

Any time the error is in the same direction, (both variation and deviation) all you have to do is add both numbers to get total compass error.

Variation	010°E
Deviation	003°E
CE	013°E

If the signs are different, (for example variation is Westerly and deviation is Easterly) simply take the smaller number from the larger and take the sign of the larger.

Variation	005° W
Deviation	003° E
CE	002°W

Compass Corrections--Classroom Exercise

Deviation Table

Hdg. Mag.	Deviation	Hdg. Mag.	Deviation	Hdg. Mag.	Deviation
000°	2°E	120°	1°E	240°	3°W
030°	3°E	150°	1°W	270°	1.5°W
060°	4°E	180°	2°W	300°	0°
090°	2°E	210°	3.5°W	330°	1.5°E

Variation 15°W

1. What compass course must you steer to make good a true course of 125°?

+W/-E

T _____

V _____

M _____

D _____

C _____

-E/+W

2. What is the true course to steer for a magnetic course of 315°?

+W/-E

T _____

V _____

M _____ CE

D _____

C _____

-E/+W

Use Chartlet #12354 for the following questions.

3. What is the course to steer PSC, from Bartlett Reef Light to Saybrook Breakwater Light? What is the compass error?

+W/-E

T _____
V _____
M _____ CE
D _____
C _____

-E/+W

4. What is the true course to steer between Little Gull Island Light and Saybrook Breakwater Light, if our ships compass reads 303°?

+W/-E

T _____
V _____
M _____ CE
D _____
C _____

-E/+W

5.

+W/-E

T _____
V _____
M _____ CE
D _____
C _____

-E/+W

+W/-E

T _____
V _____
M _____ CE
D _____
C _____

-E/+W

CHAPTER 2

Certificates and Paperwork

Certificates and Paperwork

USCG License
To operate a vessel with passengers for hire the operator needs to have a USCG license. These license have specific routs, such as inland, Great Lakes, or near coastal, and limitations based on whether the vessel is inspected or uninspected. Further, on the Masters level, there may be a limit on the size of the vessel, such as 25, 50 or 100 GT, and whether it is power or sail.

The license is good for 5 years, and must be on board at all times the vessel is operating with passengers, and is required to be displayed.

There is a one year grace period during which the license is not usable, but is renewable.

Vessels that are inspected to carry more than 6 passengers requires a Masters license for the operator.

If your license is revoked, only the commandant can reinstate it.

Certification
Commercial vessels certified to carry more than 6 passengers are inspected and certified by the USCG. Regulated is the design, construction, manning and operation of the vessels.

Vessels are classed based on the design and type of cargo they carry. Cargo vessels are also classed based on the hazards of the cargo to be carried.

They are also limited based on the route. For example, a vessel certified to operate on the Great Lakes or Western Rivers, cannot operate in the Atlantic Ocean. Certification can be rivers; lakes, bays and sounds; near coastal; or oceans.

Certificate of Inspection
For a vessel to get a certificate of inspection (COI), it construction, and equipment must be acceptable to the Officer In Charge of Marine Inspection (OCMI).

The COI will list:

a. manning
b. safety equipment
c. official number of the vessel
d. number of lifeboatmaen
e. route permitted and conditions of operation
f. number of passengers permitted

As well as other important information, such as hull exams, stability letter approval date and fire- fighting equipment.

These certificates must be carried on board, under glass and be posted where passengers and crew can see them.

Annual inspections are performed within 3 months before or after each anniversary date. The scope of the annual inspection is the same as the inspection for certification, but in less detail.

Documented Vessels
Documentation is a federal registration. The USCG-MIO assigns official numbers to a vessel. They are required on the vessels main beam.

The name and home port are required on the stern, and name only on both sides of the bow.

To change the name of a vessel, contact the USCG Vessel Documentation office.

Additional Certificates
Shipping Articles
This is a contract between the Master and crewmember. They are signed by each seamen, and the master.

Forecastle Card
This is a copy of the Shipping Articles. This lists duties and responsibilities of each crewmember, and is posted on the vessel. A detail of the voyage either coastwise, intercoastal or foreign must be indicated in the shipping articles.
Coastwise: between US ports, but not between Atlantic and Pacific ports.
Intercoastal: between Atlantic and Pacific ports.
Foreign: between US and foreign ports.

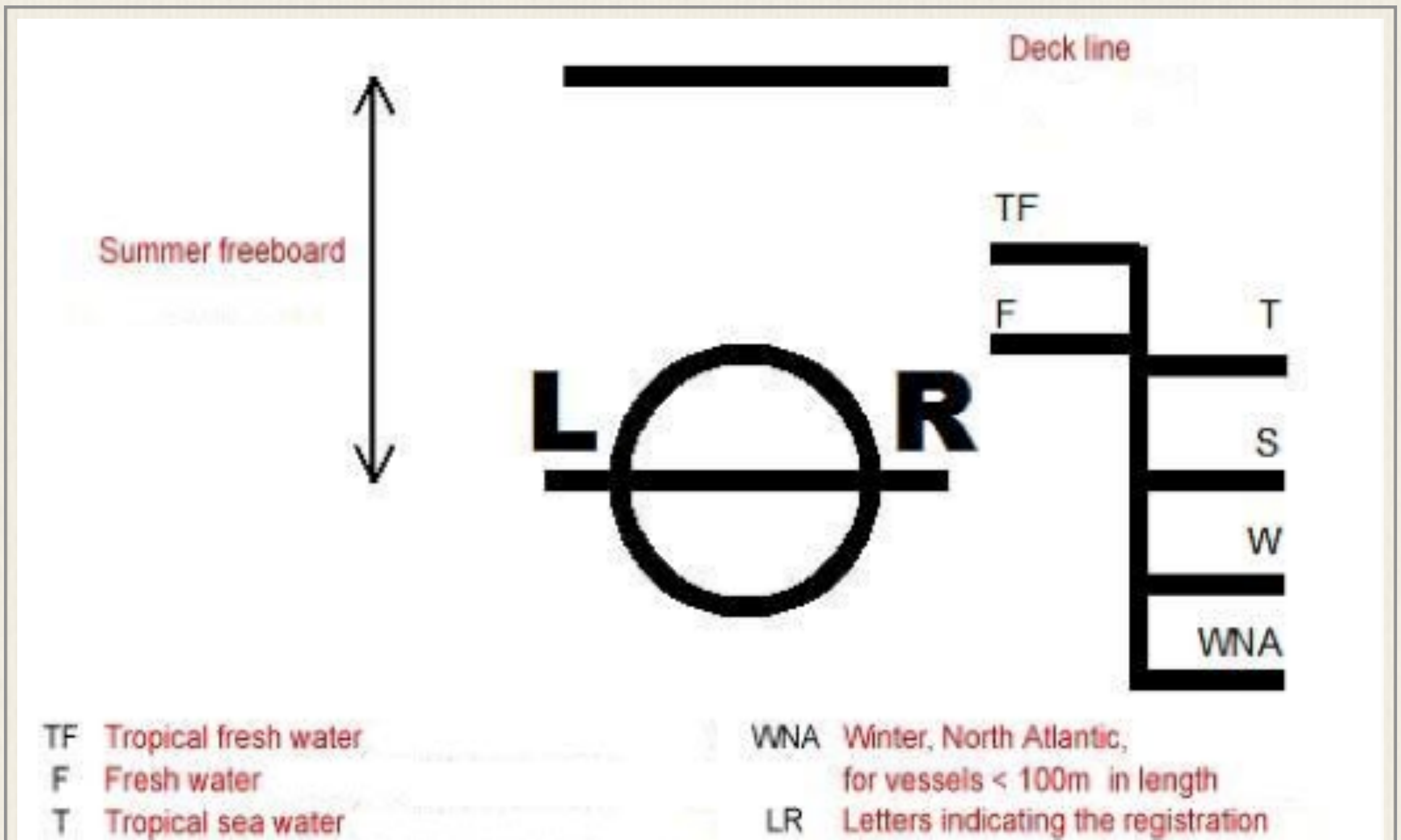
Station Bill
Lists emergency signals as well as fire, emergency and abandon ship instructions. Further, it lists crewmember responsibilities in each emergency. It must be posted conspicuously where each crewmember can see it.

Stability Letter/Booklet
Is a document attesting to the vessel having passed a stability test, or detailing how a vessel may be loaded, and to what degree. Restrictions imposed upon the vessel will be listed, and the document must be posted in a conspicuous location on the vessel.

Permit to Proceed
Is a permit issued by the USCG when a vessel must be moved for repair or to complete an inspection, and the COI has expired.

Emergency Check-Off List
Details emergency procedures in the event of rough weather, man overboard (MOB) or fire at sea. It is prepared by the Master, and posted under glass in a prominent and accessible place.

Load Line Certificate
Is valid for 5 years. It stipulates the load a vessel may carry based on the waters it will transit in route. Plimsol lines are those lines painted on the side of a vessel that are used for loading.



Shipment and Discharge of Seaman

The Master is responsible for the shipment and discharge of seaman. When a vessel is on a coastwise run and a seaman is discharged, an entry must be made in his Continuous Discharge Book. A Record of Entry is a form sent to the USCG when a discharged seaman has a Continuous Discharge Book.

International Voyages

Vessels making international voyages must have a valid SOLAS Passenger Ship Certificate.

This certificate is issued for a period of not more than 12 months. Further, the route specified on the COI and SOLAS Passenger Ship Safety Certificate must agree.

CHAPTER 3

Tides and Currents

Introduction

Tide and Current calculations is another important consideration in safe navigation. Making sure vertical clearances are adequate and that enough water exists under your vessel for navigation seem obvious necessities. Tide and currents can effect vessel navigation as well as transit times and scheduling. Careful consideration to these variables must be included in accurate voyage planning.

Tide Calculations

Tide is the vertical rise and fall of the water. The moon and sun generate the principal tidal forces. At most places the tidal change occurs twice daily. The tide rises until it reaches a maximum height, called high water, and then falls to a minimum level called low water.

The rate of rise and fall is not uniform. From low water, the tide begins to rise slowly at first, but at an increasing rate until it is about halfway to high water. The rate of rise then decreases until high water is reached and the rises ceases. The falling tide behaves in a similar manner. The period at high or low water during which there is no apparent change of level is called the stand. The difference in height between consecutive high and low waters is the range.

In a semidiurnal tide, there are two high and two low waters each tidal day, with relatively small difference in the respective highs and lows. A diurnal tide has only a single high and low water each day. These occur in a few places around the world, the Gulf of Mexico being one place in the United States.

Spring tides occur at times of new and full moon. Range of tide is greater than average since solar and lunar forces act in the same direction. Neap tides occur at times of first and third quarters. Range of tide is less than average since solar and lunar forces act at right angles.

The most important level of reference to the mariner is the sounding datum shown on charts. The depth of the water available at any time is obtained by adding algebraically the height of the tide at the time in question to the charted depth. Most NOAA charts use mean lower low water, as a reference for the sounding datum which is the average height of the lower low waters of each tidal day.

Tide Tables are published by the NOS to predict how the actual water depth may differ from the charted depth for a given time and day during the year. If you were approaching a dock on a specific day for example, the tide tables would show you this information. The first column tells you the day of the month. The next show the time, and the last the height. So on this particular day, the 1st of the month, at 0249, the height of the predicted time would be 5.6 ft. If the tidal datum on your chart showed a depth of 18 ft in a particular channel or location the actual depth of the water there would be 23.6 feet at 0249.

Day	Time	Height	
	h m	ft.	m
1	0249	5.6	1.7
Sa	0954	-0.6	-0.2
	1510	6.9	2.1
	2337	0.1	0.2

After high tide is reached at 0249, the water level would drop to a predicted low tide of -0.6 feet at 0954. Because that number has a minus sign in front of it, you would subtract that figure from the charted depth, giving you an anticipated water depth of 17.4 feet in the channel or particular location. Since the water dropped from a depth of 23.6feet to 17.4 feet, the range of the tide during that period would be 6.2 feet.

After the 0954 low tide, the water would be rising, reaching another high tide at 1510. That high tide would add 6.9 feet to the charted depth, giving you 24.9 feet in that channel or location. The range of tide between 0954 and 1510 would be 7.5 feet.

Between 1510 and 2337 the water would be dropping again to a low tide of 0.1 feet. Even though this is a low tide, the fact that the 0.1 does not have a minus sign in front of it indicates that you would add 0.1 to the charted depth of the water, giving you a predicted depth of 18.1 feet in the channel or location.

Tide Tables are published yearly in four volumes, which cover the following areas:

>Europe and the West Coast of Africa

> East Coast of North and South America

> West Coast of North and sough America

> Western Pacific Ocean and Indian Ocean

<u>Reference Ports</u>

Reference ports are major harbors and coastal locations in which the tables give the daily predictions of high and low waters. These predictions can then be corrected for the stations in the vicinity which are known as subordinate stations.

TABLE 2. — TIDAL DIFFERENCES AND OTHER CONSTANTS, 1983

NO.	PLACE	POSITION Lat.	Long.	DIFFERENCES Time High Water	Time Low Water	Height High Water	Height Low Water	RANGES Mean	Spring	Mean Tide Level
		° ' N	° ' W	h. m.	h. m.	ft	ft	ft	ft	ft
	Hudson River (8) Time meridian, 75°W			on NEW YORK, p.56						
1533	Dobbs Ferry	41 01	73 53	+1 29	+1 40	-1.1	0.0	3.4	4.0	1.7
1535	Tarrytown	41 05	73 52	+1 45	+1 54	-1.3	0.0	3.2	3.7	1.6
1537	Ossining	41 10	73 52	+1 53	+2 14	-1.4	0.0	3.1	3.6	1.5
1539	Haverstraw	41 12	73 58	+1 59	+2 25	-1.6	0.0	2.9	3.4	1.4
1541	Peekskill	41 17	73 56	+2 24	+3 00	-1.3	+0.3	2.9	3.4	1.7
1543	West Point	41 24	73 57	+3 16	+3 37	-1.5	+0.3	2.7	3.1	1.6
1545	Newburgh	41 30	74 00	+3 42	+4 00	-1.5	+0.2	2.8	3.2	1.6
1547	New Hamburg	41 35	73 57	+4 00	+4 25	-1.5	+0.1	2.9	3.3	1.5
1549	Poughkeepsie	41 42	73 57	+4 30	+4 43	-1.3	+0.1	3.1	3.5	1.6
1551	Hyde Park	41 47	73 57	+4 56	+5 09	-1.3	0.0	3.2	3.6	1.6
1553	Kingston Point	41 56	73 58	+5 16	+5 31	-0.9	-0.1	3.7	4.2	1.7
1555	Tivoli	42 04	73 56	+5 46	+6 01	-0.8	-0.2	3.9	4.4	1.7
1557	Catskill	42 13	73 51	+6 37	+6 55	-0.7	-0.3	4.1	4.6	1.7
1559	Hudson	42 15	73 48	+6 54	+7 09	-0.5	-0.4	4.0	4.4	1.6

A list of the reference ports and "sub" stations covered in a particular Tide Table appears in the index at the back of each book. If you wanted the predictions for New York, The Battery, for example, the index entry would look like this:

New State..Pages 211-214

New York, The Battery * (56)...................................1511

New York, Union Stock Yards.................................1523

Notice that New York is marked with an asterisk (*), indicating that it is a reference port. The number in parentheses (56) is the page for the New York predictions.

Turning to page 56, you would see the daily prediction of the height of the tides for New York. Although these examples are from the 1983 edition of the tables, the same techniques can be used with up to date versions of the books.

The daily predictions for January, February, and March are on page 56, with the additional months laid out in a similar fashion on following pages. Shown below is a portion of the page containing the months of October, November and December.

The time of high and low water is listed for each day of the month, along with the height of the tide at that time. On November 3rd the height of the tide at 0033 is -0.7 ft. Because it is a minus number, it would be subtracted from the charted depth of the locations at New York you were concerned with. At 0649 on November 3rd, the tide has risen to 5.5 feet, so the water depth in the area would be 5.5 feet more than the charted depth.

When you do problems you may be given a time as Daylight Savings Time, rather than standard time. Or, you may be just given Zone Description (ZD) of the time, which will vary with the location and whether you are using standard time or daylight savings time. If time is standard time, which on the East Coast of the US would be ZD+5, you just work out the problem with the times given because the Tide Tables are based on the standard time. If you are given daylight savings time (ZD+4), you must add one hour to the answer.

Subordinate Stations

Just as the times and heights of tides differ among the reference ports, they will also be slightly different at various locations in the vicinity of reference ports. High time may occur at 0830 on a given day at Sandy Hook, for example while a subordinate station 30 miles south will not experience maximum high tide until 0945.

To find the difference in time and height of a tide at a subordinate station you must use Table 2 in the Tide Tables, an excerpt of which is shown below.

The NO. (number) column is the first piece of information we have listed. This number is the identifying number for the station as listed in the index. The Place column identifies the actual location by name.

The Position column gives us the latitude and longitude of the station.

The Difference column has several pieces of important information. First we see the reference port that all the subordinate stations are based on, and the page on which the daily predictions start. Within the difference column we can see that there are differences listed for the times of high and low water and the heights of high and low water. Note that at any point a column shows 0.0 under differences, it simply means that the time or height are the same as that recorded at the reference station.

Sometimes the difference in the heights of the tides are expressed as an asterisk number, which must be multiplied by the height of the tide listed for the reference station.

Current Calculations

Horizontal movement of the water is called current. Tidal current is the periodic horizontal flow of water accompanying the rise and fall of the tide. In rivers or straits, or where the direction of flow is more or less restricted to certain channels, the tidal current is reversing; that is it flows alternately in approximately opposite directions with a short period of little or no current, called slack water at each reversal. During the flow in each direction the speed varies from zero at the time of slack water to a maximum, called strength of flood or ebb, about midway between the slacks.

Tidal currents, like tides, can be of the semidiurnal, dirunal or mixed type, corresponding to a considerable degree to the type of tide at the place but often with a stronger semidiurnal tendency. For example, along the Atlantic Coast of the US, most tides are semidiurnal. Along the Gulf of Mexico, they are almost purely diurnal. And some areas like Tampa, there is only one flood and one ebb each day when the moon is near its maximum declination, and two floods and two ebbs each day when the moon is near the equator.

Tidal Current Tables give the best prediction of total current. They give predictions for the time, direction (set) and velocity (drift) of the horizontal movement of water. Following heavy rains or drought, a river's current prediction my be considerably in error.

Tide Tables for various parts of the world are published in 4 volumes, which cover the following areas.

>Central and Western Pacific Ocean & Indian Ocean
>East Coast of North and South America
>Europe and West Coast of Africa
>West Coast of North and South America.

Like the Tide Tables a daily entry consists of three columns. The first column shows the time of slack water, that period between ebb and flood when there is little or no movement of the water. The second column shows the time of maximum current, while the third column predicts the maximum velocity and indicates whether the water is ebbing (E) or flooding (F). The direction (set) of the ebb and flood current is shown at the top of each daily page. See the following illustration.

	Slack Water	Maximum Current	
	Time	Time	Velocity
Day	h.m.	h.m.	knots
1	0037	0357	4.6E
TU	0708	0957	4.0F
	1300	1619	4.4E
	1930	2219	4.0F

To read the predictions properly, you must follow the time. At the location in the example above, the predictions for Tuesday the 1st show that a slack water will occur at 0037. The water then starts moving, but does not reach its maximum velocity until 0357. The last column shows that the maximum velocity will be 4.6 knots, and the (E) means a ebb current.

Since the slack water at 0037 preceded this ebb current, it is known as "slack before ebb". After 0357, the water movement will slow until it reaches its next slack at 0708. Because this slack precedes flood current, it is known as "slack before flood". After 0708 the water movement begins to build until it reaches maximum flood (F) velocity of 4.0 knots at 0957. The water then slows, reaching another "slack before ebb" at 1300, and then builds to a maximum flood of
4.4 knots at 1619. The next slack (before flood) occurs at 1930, with a maximum ebb current at 2219, of 4.0 knots.

<u>Reference Stations</u>
As with the Tide tables, there are main ports that are used as "Reference Stations". Locations between reference stations are known as subordinate stations. Reference stations are noted in the index by an asterisk followed by the page number in parentheses. If you were to look up "The Race" in the index you would see something like this:

The Narrow, Fla..8731
The Narrows, New York Harbor*(52)......................................3386
The Race...2436-2451
The Race*(34)...2241

The page for the Race in the Current Tables is set up exactly as you see it below.

THE RACE, LONG ISLAND SOUND, 1983

F-Flood, Dir. 295° True E-Ebb, Dir. 100° True

JANUARY								FEBRUARY							
Day	Slack Water Time	Maximum Current Time	Maximum Current Vel.	Day	Slack Water Time	Maximum Current Time	Maximum Current Vel.	Day	Slack Water Time	Maximum Current Time	Maximum Current Vel.	Day	Slack Water Time	Maximum Current Time	Maximum Current Vel.
	h.m.	h.m.	knots		h.m.	h.m.	knots		h.m.	h.m.	knots		h.m.	h.m.	knots
1	0025	0341	4.1E	16	0040	0400	2.8E	1	0152	0511	4.3E	16	0121	0443	3.1E
Sa	0643	0937	4.1F	Su	0701	0942	2.5F	Tu	0822	1108	3.7F	W	0749	1037	2.7F
	1241	1606	4.7E		1242	1616	3.2E		1412	1735	4.2E		1334	1651	3.1E
	1923	2211	4.0F		1930	2209	2.6F		2047	2336	3.7F		2003	2257	2.8F
2	0119	0435	4.1E	17	0117	0438	2.7E	2	0244	0605	4.0E	17	0158	0516	3.1E
Su	0741	1029	3.9F	M	0738	1022	2.5F	W	0921	1205	3.3F	Th	0831	1120	2.6F
	1336	1702	4.5E		1320	1651	3.1E		1507	1828	3.8E		1416	1723	2.9E
	2017	2304	3.9F		2003	2248	2.6F		2141				2041	2340	2.8F
3	0214	0533	4.0E	18	0154	0514	2.7E	3		0031	3.4F	18	0240	0557	3.1E
M	0841	1128	3.6F	Tu	0818	1104	2.4F	Th	0338	0702	3.8E	F	0918	1208	2.5F
	1432	1759	4.2E		1400	1727	2.9E		1022	1303	2.9F		1502	1808	2.8E
	2113				2039	2331	2.6F		1603	1926	3.4E		2125		
									2238						
4		0002	3.6F	19	0234	0552	2.7E	4		0129	3.0F	19		0029	2.7F
Tu	0311	0631	3.9E	W	0903	1149	2.3F	F	0434	0759	3.5E	Sa	0328	0648	3.0E
	0944	1228	3.3F		1444	1802	2.7E		1125	1407	2.5F		1013	1301	2.4F
	1531	1855	3.9E		2119				1704	2025	3.0E		1556	1903	2.6E
	2211								2337				2218		
5		0101	3.4F	20		0015	2.5F	5		0230	2.7F	20		0122	2.7F
W	0409	0731	3.7E	Th	0317	0637	2.7E	Sa	0532	0859	3.3E	Su	0423	0751	3.0E
	1050	1333	3.0F		0952	1240	2.2F		1229	1517	2.3F		1115	1358	2.3F
	1633	1956	3.5E		1532	1849	2.6E		1806	2122	2.7E		1657	2015	2.6E
	2311				2203								2318		

TABLE 2. – CURRENT DIFFERENCES AND OTHER CONSTANTS, 1983

NO.	PLACE	METER DEPTH	POSITION Lat.	POSITION Long.	TIME DIFFERENCES Min. before Flood	TIME DIFFERENCES Flood	TIME DIFFERENCES Min. before Ebb	TIME DIFFERENCES Ebb	SPEED RATIOS Flood	SPEED RATIOS Ebb	Minimum before Flood knots	Minimum before Flood deg.	Maximum Flood knots	Maximum Flood deg.	Minimum before Ebb knots	Minimum before Ebb deg.	Maximum Ebb knots	Maximum Ebb deg.
		ft	° ′ N	° ′ W	h. m.	h. m.	h. m.	h. m.										
	FISHERS ISLAND SOUND Time meridian, 75°W				on THE RACE, p.34													
2406	Avondale, Pawcatuck River <51>..........	6	41 19.90	71 50.73	-1 56	-2 42	-2 17	-3 40	0.2	0.2	0.0	- -	0.6	058	0.0	- -	0.5	265
								-1 08		0.0							0.1	243
								+0 04		0.1							0.2	263
2411	Ram Island Reef, south of................	7	41 18.1	71 58.5	-0 52	-0 47	-0 41	-0 50	0.4	0.4	0.0	- -	1.3	255	0.0	- -	1.6	088
2416	Noank <51>................................	4	41 19.12	71 59.30	-1 36	-3 16	-4 10	-4 30	0.2	0.1	0.0	- -	0.5	340	0.0	- -	0.3	173
								-1 24		0.0							0.0	- -
								+0 19		0.1							0.5	162
2421	Mystic, Highway Bridge, Mystic River....	6	41 21.25	71 58.18	-2 02	-2 50	-2 07	-3 39	0.2	0.1	0.0	- -	0.5	039	0.0	- -	0.4	231
								-1 40		0.0							0.2	234
								-0 20		0.1							0.3	232
2426	Clay Point, 1.3 miles NNE of.............	15	41 17.88	71 58.53	-0 42	-0 49	-0 40	-1 15	0.5	0.5	0.0	- -	1.4	264	0.0	- -	1.9	035
2431	North Hill Point, 1.1 miles NNW of......		41 17.57	72 01.68	-1 05	-0 26	-0 18	-1 37	0.5	0.4	0.0	- -	1.5	258	0.0	- -	1.2	082
	LONG ISLAND SOUND																	
	The Race																	
2436	Race Point, 0.4 mile southwest of....		41 14.70	72 02.60	-0 24	-0 35	-0 43	-0 44	0.9	1.0	0.0	- -	2.6	288	0.0	- -	3.5	135
2441	THE RACE, near Valiant Rock...........		41 14.20	72 03.60	Daily predictions						0.0	- -	2.9	295	0.0	- -	3.5	100
2446	0.5 mile NE of Little Gull Island....		41 13	72 06	-0 30	-0 14	-0 11	-0 26	1.0	0.7	0.0	- -	3.3	002	0.0	- -	3.1	107
2451	Little Gull I., 1.1 miles ENE of.....		41 13.10	72 05.10	-0 07	-0 11	+0 01	-0 45	1.4	1.3	0.0	- -	4.0	301	0.0	- -	4.7	130
2456	Great Gull Island, 0.7 mile WSW of......		41 11.67	72 08.02	-0 51	-0 33	-0 31	-1 42	0.9	0.9	0.0	- -	2.6	299	0.0	- -	3.2	133
2461	Plum Gut..................................		41 10.00	72 12.80	-1 22	-1 30	-1 01	-2 05	1.2	1.2	0.0	- -	3.5	323	0.0	- -	4.3	126
2466	Eastern Point, 1.5 miles south of.......		41 17.8	72 04.4	-1 57	-1 50	-1 03	-1 50	0.1	0.1	0.0	- -	0.4	249	0.0	- -	0.4	055
2471	New London Harbor entrance..............		41 19.08	72 05.02	-1 22	-1 51	-2 12	-1 15	0.1	0.1	0.0	- -	0.1	348	0.0	- -	0.2	211
	Thames River																	
2476	Winthrop Point.........................		41 21.63	72 05.30	-1 17	-1 59	-0 54	-2 35	0.1	0.1	0.0	- -	0.4	012	0.0	- -	0.4	180
								-1 08		0.0							0.2	186
								+0 04		0.1							0.3	185

<u>Subordinate Stations</u>

To correct the daily predictions at the reference ports for subordinate stations, you first find the list number of the subordinate station in the index. With that number, you can find the station in Table 2 as shown. Lets say we are looking up New London Harbor entrance, #2471.

If you wanted to find the tidal currents at New London harbor, for example, Table 2 tells you that you must apply the corrections to the daily predictions for "The Race" on page 34. The time differences are applied as the (+) or (-) signs indicate. The Min. before Flood and the Min. before Ebb column are simply the corrections to the slack water predictions found on the daily pages. The speed ratios are numbers that must be multiplied by the velocity of the currents listed in the daily predictions.

Don't worry about Average Speed columns at the right hand side of Table 2. We will learn how to determine the specific speed of the current shortly.

Do pay attention to the direction section on the right side of Table 2, however. If a problem asks you for the direction (set) of the current at a specific location, use the average direction listed. At New London Harbor, for example, the direction (set) of the flood current is 348 and the average ebb currents sets in the direction of 211

Lets suppose we wanted to find the predictions for the first flood and ebb currents at New London harbor on December 26,1983. We se up a work sheet as follows, and enter the necessary information.

	min. before flood	max. flood	min. before ebb	max. ebb	speed ratio F	speed ratio E	average set F	average set E
NLH	-122	-151	-212	-115	x.1	x.1		

We then look at what reference station these corrections are used with and when we look up in the time Differences column, we see "The Race" p.34.
We move to the reference section on p.34 and look up the date, December 26, 1983. We fill in the remainder of our needed information.

	min. before flood	max. flood	min. before ebb	max. ebb	speed ratio F	speed ratio E	average set F	average set E
the Race	1103	1344	0423	0748	3.0	3.6		
NLH	-122	-151	-212	-115	x.1	x.1		
	0941	1153	0211	0633	0.3	.36	348	211

As you can see, the solution requires some simple math and very accurate record keeping. Check and double check your work to make sure you are finding numbers on the right date and the correct time.

CHAPTER 4

Weather

Introduction

Every mariner needs a concrete understanding of weather patterns and meteorology. Few decisions are made on board without the consideration of how the weather will play into the activity. Knowing where to get the information, and some basic knowledge of how to interpret it will go a long way in seeing you get to your destination safely.

The Atmosphere

Although the earth is surrounded by a gaseous envelope approximately 200 miles thick, half of the total density of this atmosphere is found in the lowest 3.5 miles, closest to the earth's surface. The pressure exerted by the weight of this mixture of gases which we will call air is therefore greatest at the surface, and decreases with increasing altitude.

The atmosphere is composed of 78% nitrogen, 21% oxygen, and 1 other gases. Water vapor may Constitute up to 4 % of the total volume of the atmosphere at any given time. Most of this is confined to the lower 5 miles. Water vapor and various small pollutants such as dust, smoke, etc., in the atmosphere serve as the nucleus for condensation and helps to form liquid droplets from invisible water vapor.

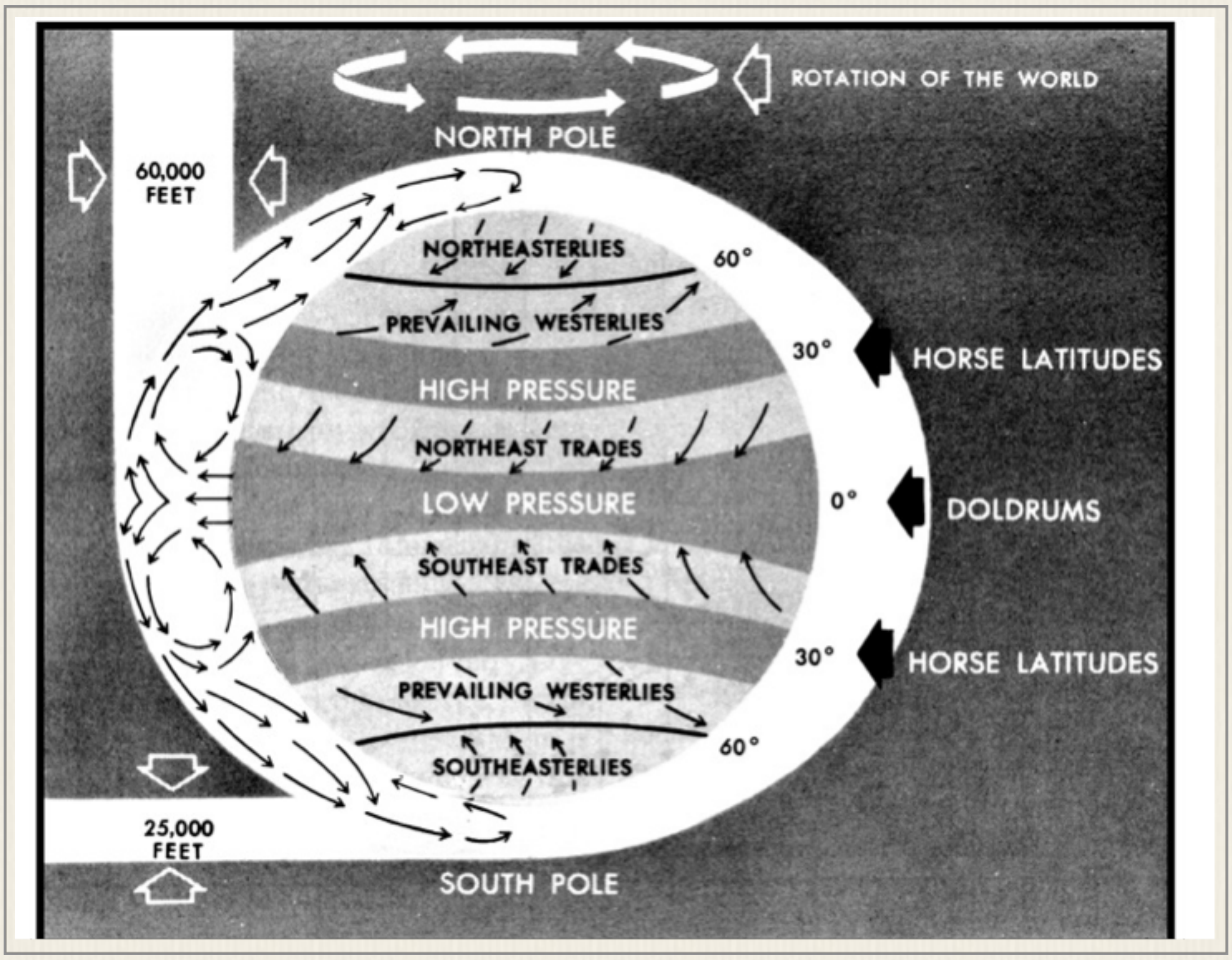
Heating and Cooling

The sun serves as the source of energy that drives the complex heat engine we call our atmosphere. It radiates electromagnetic energy in all directions, some of which is intercepted by the earth. It is this radiant energy that supplies the earth with most of its heat.

Along with the angle at which the sun's energy strikes a given surface, the color of the surface and the general properties of the surface are also important. Land masses heat rapidly during the day and re-radiate this energy rapidly at night. Water on the other hand heats and cools slowly.

The movement of air both horizontally and vertically is a direct result of this radiated heat energy. The vertical motions are caused by the warmed air rising and expanding and the descending and contracting of the same air as it is cooled. Wind is caused by differences of atmospheric pressure as air moves from areas of high pressure (usually cool areas) to areas of low pressure (which are usually warmer).

Uneven absorption of the sun's radiated energy causes temperature differences, which in turn cause pressure differences. This effect causes the general circulation of the atmosphere. The uneven heating of the earth also results from the fact that the sun strikes equatorial regions more steeply than polar regions.



<u>Elements of Circulation</u>

Temperature differences cause pressure differences. Pressure differences in turn cause the movement of very large masses of air. Because of the earth's rotation on its axis, there is an apparent deflecting force or wind flow called the Coriolis Effect. This deflection causes a pulling of the air masses towards the right in the northern hemisphere and to the left in the southern hemisphere. Generally speaking, the US lies in a zone which has been called the prevailing westerly wind belt. In this wind belt, the general pattern of the weather moves from west to east.

In this zone, a succession of high pressure systems called highs, and low pressure systems called lows, continually march across the continent from west to east bringing constantly changing weather. The high and lows are referring to the relative barometric pressures found in the centers of each of these air masses.

Wind speed is measured by an anemometer. It is usually expressed in knots although it may also be stated in terms of its effect upon waters of the open ocean. This measurement is demonstrated in the Beaufort Scale. Readings on the Beaufort Scale range from Force 1 through 12.

To the south of the prevailing westerly wind belt lie the horse latitudes. This relatively narrow wind belt affects many of our southern states during the summer months. Winds are light and variable and the weather is generally good. North of the prevailing westerlies as you approach the polar regions are the polar easterlies.

<u>Local Winds</u>

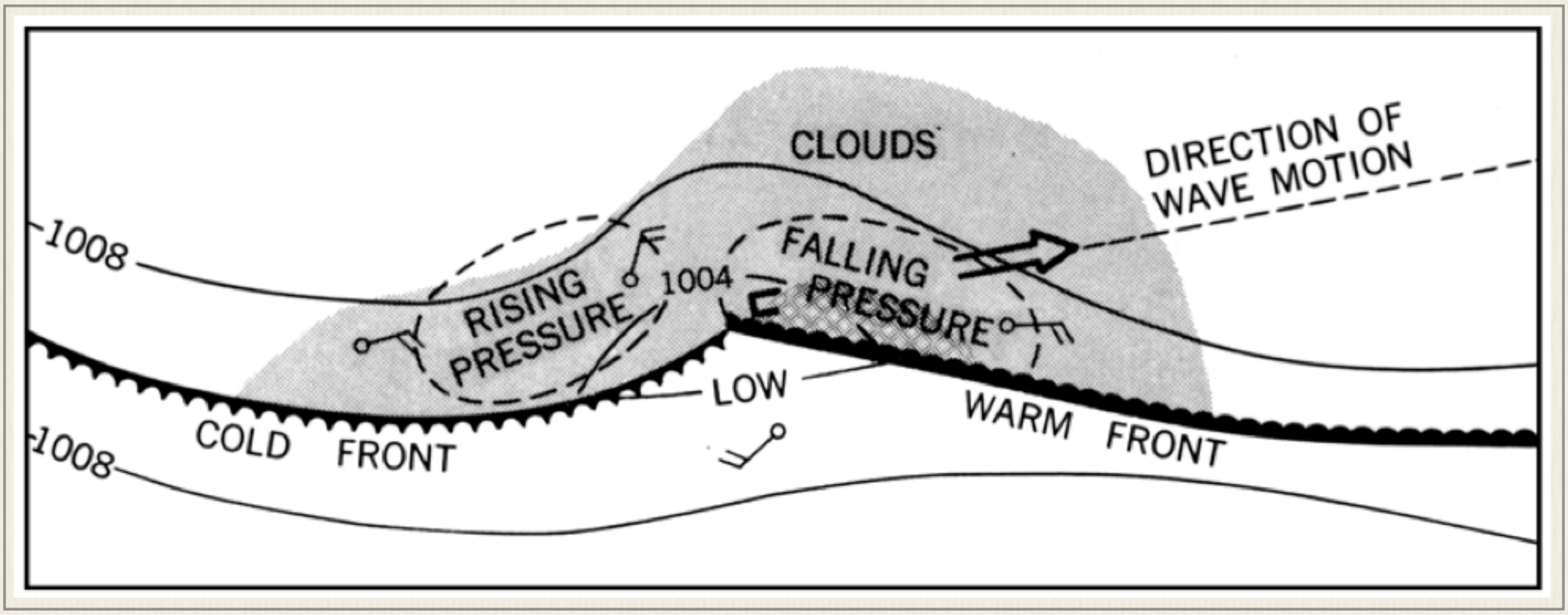
Whenever there is a large difference in temperature of adjoining air masses there will be a flow of air from the colder-denser to the warmer-less dense area. A classic example is the afternoon sea breeze where the heat from the sun causes the temperature to rise over a sandy beach and adjacent land areas. This in turn, heats the air over the land. The air starts to rise and is replaced by colder air from the adjoining water. During the night, the land areas cool rapidly and become colder than the adjoining water. This results in a flow of air from the land to the water.

Veering winds change in a clockwise direction while backing winds change in a counterclockwise direction.

<u>Fronts</u>

As air masses move within the general circulation, they travel from their source regions to other areas dominated by air having different characteristics. This leads to a zone of separation between the two air masses, called a frontal zone or front, across which temperature, humidity and wind speed and direction change rapidly. It can be a warm front, cold front, occluded front

Fronts are represented on weather maps by lines; a cold front is shown with pointed barbs, a warm front with rounded barbs, and an occluded front with both, alternating. A stationary front is shown with pointed and round barbs alternating and on opposite sides of the line with pointed barbs away from the colder air.



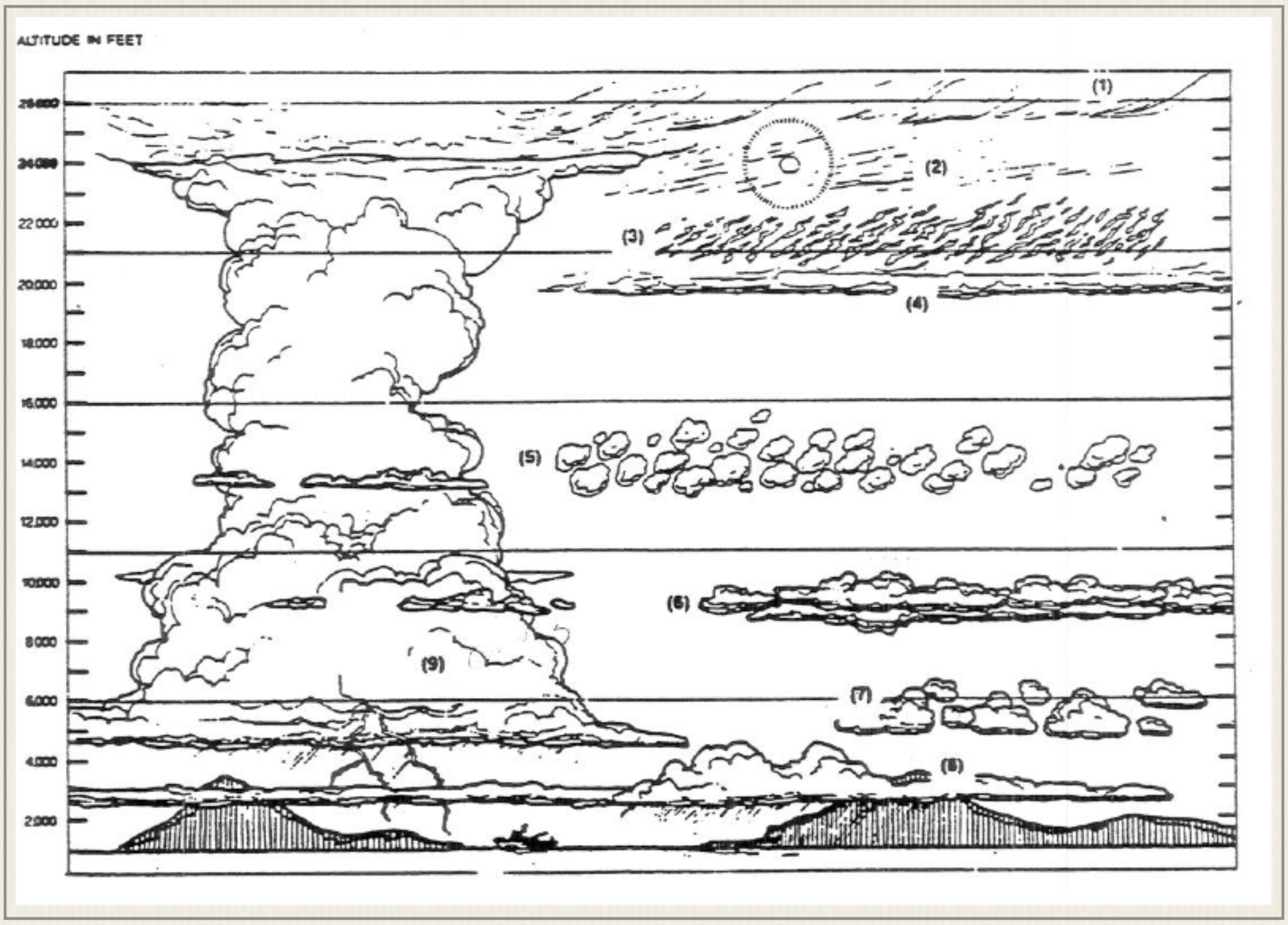
Atmospheric Pressure Measurement
The sea of air surrounding the earth exerts a pressure of about 14.7 pounds per square inch on the surface of the earth. This pressure is known as barometric pressure, and varies from place to place.

Fog
Fog is really a cloud whose base touches the surface of the earth. Fog is usually composed of drop.ets of water formed by condensation of water vapor in the air.

> Advection fog forms when warm moist air blows over a colder surface and is cooled below it’s dew point.
>
> Frost Smoke occurs when very cold air moves over warmer water. Wisps of visible water vapor may rise from the surface as the water steams

Clouds

Clouds are visible collections of numerous tiny droplets of water, or ice crystals, formed by the condensation of water vapor in the air. The shape, size, height, thickness, and nature of a cloud depends upon the conditions under which it is formed. The ability to recognize different types of clouds and knowledge of the conditions that are associated with them is useful in predicting and forecasting future weather.



1. Cirrus
2. Cirro Stratus
3. Cirrocumulus
4. Alto Stratus
5. Alto Cumulus
6. Stratocumulus
7. Cumulus
8. Nimbostratus
9. Cumulonimbus

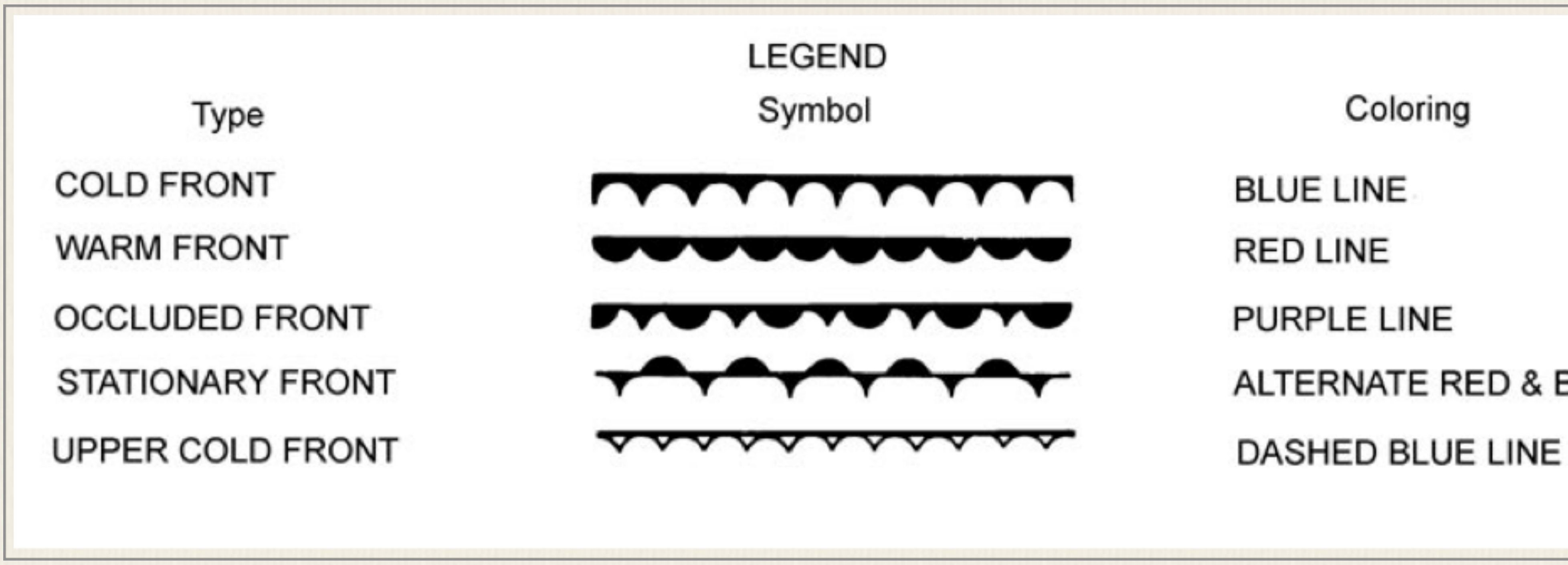
Clouds are grouped generally into three families according to their most common characteristics. High clouds which usually occur between 18,000 and 40,000 feet are composed principally of ice crystals. Middle clouds are found between 6,000 and 18,000 feet and are composed largely of water droplets. And low clouds which have a height of less than 6,000 feet, and are composed of water droplets.

Additionally, the following basic words, all taken from Latin are used to describe clouds.

>Cirrus, means curl, lock or tuft of hair
>Cumulus, means a heap, pile or an accumulation
>Stratus, means spread out, flattened or covered with a layer
> Alt, means mid level
>Nimbus, means rainy

Symbols

Symbols are used to indicate on a weather map the conditions at each observation station. After isobars are drawn through lines of equal atmospheric pressure, fronts are located and marked with symbols, as are areas of precipitation and fog. The following diagram is an example of some types of symbols.



National Weather Service

The NWS provides marine weather forecasts and warning for the United States coastal waters, the Great Lakes, offshore waters and high seas areas. Forecasts are issued four times daily, 24 hours a day. They contain information on wind speed and direction, wave heights, visibility, and a brief synopsis of weather patterns affecting the region. They are supplemented with special marine warnings and statements radar summaries, small craft advisories and tropical cyclone warnings. The principal means of disseminating marine weather services and products in coastal areas is NOAA Weather Radio. In coastal areas, the programming is tailored to the needs of the marine community.

CHAPTER 5

Communications

Introduction
All mariners are required to understand their responsibilities under FCC and USCG regulations concerning use of on board communications equipment. Communication with other vessels for navigation, in emergency situations and during emergency rescue operations mandate shipboard personnel know their ship's equipment and it's proper use. The following discussion will concern all types of communication, including shipboard radios, pyrotechnics, EPIRBS and others.

Bridge to Bridge Radiotelephone Act
The Bridge to Bridge Radiotelephone Act requires that every power driven vessel of 300 GT or more, every passenger vessel 100 GT or more, every towing vessel 26 feet or more, and every dredge and floating plant near or in a channel shall have a radiotelephone capable of operation from its navigation bridge, or, in the case of a dredge from its main control station and capable of transmitting and receiving on the frequency of 156.650, channel 13.

The primary use of this radio shall be ship to ship for safety of navigation. Secondary use will be for safety to navigation ship to shore. This channel can not be used for ordinary ships business such as ordering supplies or anything else that has nothing to do with safety to navigation.

Operating Channel 13 is for the exclusive use of the Master or person in charge of the vessel, or the person designated by the Master or person in charge to pilot or direct the movement of the vessel, who shall maintain a listening watch on the designated frequency.

No person may use the services of, and no person may serve as a person required to maintain a listening watch unless he can speak English.

Log Keeping
A station log shall be maintained during the hours of service of ship stations using radiotelephony, in which the entries required by this section shall be made. Pages of the log shall be numbered in sequence and each page shall include the name of the vessel and the radio call sign of the station. All entries which show transmitter operation shall be made and signed by the licensed operator (or person designated by the Master).
A daily entry of the ship's position.
All test transmissions, including the frequency used.

A daily statement concerning the operating condition of the required radiotelephone equipment, as determined by either normal communication or test communication.

Pertinent details of all installation, service, or maintenance work performed which may effect the proper operation of the station. The entry shall be made, signed and dated by the responsible licensed operator who supervised or performed the work, and unless such operator is regularly employed on a full time basis at the station and his operator license is properly posted, such entry shall include his mail address and the class, serial number, and expiration date of his operator license.

Transmission Power

Each non-portable transmitter, and each portable transmitter having more than 1 watt carrier power, shall have provision for readily reducing the carrier power to a value of not less than 0.75 watt and not more than 1 watt. The maximum power of all transmitters shall be not more than 25 watts.

Radiotelephones
The radiotelephone will be the most common method of communication you will use aboard ship.

Most radiotelephones today are transceivers with the transmitter and receiver in one unit. There are two basic types of radios commonly found on ships and boats. They are VHF (Very High Frequency) marine radios which are short range radios, SSB (single side band) marine radios which are long range radios.

Each of these radios can be set to various frequencies which are expressed in Hertz per second (cycles per second). Frequencies used in marine radios range from a few thousand KHZ kilo (thousand) Hertz to a couple of hundred mhz mega (million) Hertz.

Two examples would be 156.8 mhz and 2182khz.
When setting the frequency of VHF radio we change channels. VHF marine channel 16 is 156.8 mhz. Our VHF radios give us many channels to choose from, you would have to look up the corresponding frequency. Many channels have specified uses. Some of them are for distress, urgent messages, safety of navigation and weather.

An example of some VHF radiotelephone frequencies can be found at the end of this chapter.

Distress and Calling
The frequencies used for distress and calling are VHF Channel 16 (156.8mhz) and SSB 2182 khz.

Working Frequencies
The frequencies used by the US Coast Guard for urgent and safety messages are VHF Channel 22 and SSB 2670.

Distress Call
A vessel that is threatened by a grave or imminent danger and requests immediate assistance will issue a Maday call (spoken three times). Such a call has absolute priority over all other transmissions. Any station which hears a distress call must stop any transmission that could possibly interfere with the distress traffic, and monitor the frequency used by the distress caller.

Urgent Call
When transmitting an urgent call, if help is need but no life is in danger, use the words, Pan-Pan, three times preceding the information, then switch to a working channel.

Navigational Safety Call
When a transmission concerning navigational safety is to be transmitted, precede the information with the word security spoken three times, then switch to a working channel.

Bridge to Bridge
A ship’s working frequency, channel 13, uses only one watt of power, and is for transmissions concerning navigational safety.

Protocol
Indicate you have received a transmission with the word ROGER.
If you will comply with a request, answer WILCO.
When a response is necessary, end a transmission with the work OVER.
End a transmission, with the word OUT.

International Code of Signals
The purpose of the International Code of Signals is to provide ways and means of communications in situations related essentially to safety of navigation and persons, especially when language difficulties arise.

Methods of Signaling
Various methods can be used to send messages. Flag signaling, flashing light, sound signaling, radiotelephony are just some methods that can be used effectively.

Flag signaling: A set of signal flags consists of twenty six alphabetical flags, ten numeral pennants, three substitutes, and the answering pennant.

Flashing light: The Morse symbols representing letters, numerals, etc., are expressed by dots and dashes which are signaled either singly or in combination.

Radiotelephony: Use of radio transmission of signals warrant the operator to comply with established Radio Regulations of the International Telecommunication Union.

Sound signaling: The International Rules of the Road detail emergency and maneuvering signaling, sound requirements for vessel operators.

Pyrotechnics: In emergency situations pyrotechnics may be your best method of signaling another vessel. There are numerous types available including parachute flares, flare guns, collision warning flares, smoke signals, and hand held flares.

EPIRB: Modern emergency signaling has improved tremendously with the introduction of 406 MHz EPIRBS. These emergency locator beacons transmit on their own frequency and are capable of identifying the sender as well as provide a "homing" signal so it can be located.

SART: Search and rescue transponder. Utilized to detect a life craft by X Band Radar.

CHAPTER 6

Watchstanding

The watch standing officer is the masters representative, and his or her prime responsibility at all times is the safe navigation of the ship. The office must comply with all regulations for preventing collisions at sea, be familiar with the handling of the vessel and ensure a proper lookout.

An examination of the current literature will reveal that the main factor contributing to ship collisions and groundings has been the failure to maintain an adequate navigational watch.

You are the Master's representative.
The Master of a vessel relies on your skills and judgment to carry out his/her orders, your duty onboard is to fulfill those orders in a manner consistent with the best practices of the Merchant Marine.

Preparation
In order to be an efficient watch stander familiarity with the passage plan is essential. The watch officer will read and sign the standing orders (or if at night, the night orders) prior to his first watch and be familiar with the chart being used for the passage. A prudent watch officer will allow time for his/her eye sight to adjust if coming on watch at night. The use of a check off list that ongoing and relieving watch officers use and sign will help ensure nothing gets overlooked.

COLREGS:
The International Regulations For Preventing Collisions At Sea (1972) are the set of regulations and rules set forth by the International Maritime Organization and the United States Coast Guard that govern how vessels will interact with one another at sea or on any rivers, bays, and harbors that vessels transit to, from or through. The book which contains these regulations is commonly referred to as the "Rules Book" or COLREGS which stands for "collision regulations". The book contains 38 "rules" and four Annex sections.

Proper Lookout
One can make an easy argument that the most important duty on board a vessel at sea is that of keeping a proper lookout. Regardless of your rank onboard a vessel, when keeping a lookout, you are the eyes and ears of your vessel and thus you hold the responsibility of everyone on board and the vessel itself.

In today's Maritime industry we are aided in our responsibilities as lookouts, navigators, vessel operators and so on by an ever growing array of technological advancements and electronic equipment. Yes, these advancements and equipment greatly aid us in insuring the safe, efficient operation of a vessel but we should never solely rely on this equipment to replace are eyes and ears from focusing on what's outside those wheelhouse windows.shall be undertaken or assigned which could interfere with that task.

Lookout Guidelines

>Remain Alert

>Remain on station until relieved.

>Remain Standing.

>Avoid Distractions - Talk only when required by your duty.

>When reporting speak clearly.

>Repeat your report until acknowledged.

>Understand all your responsibilities.

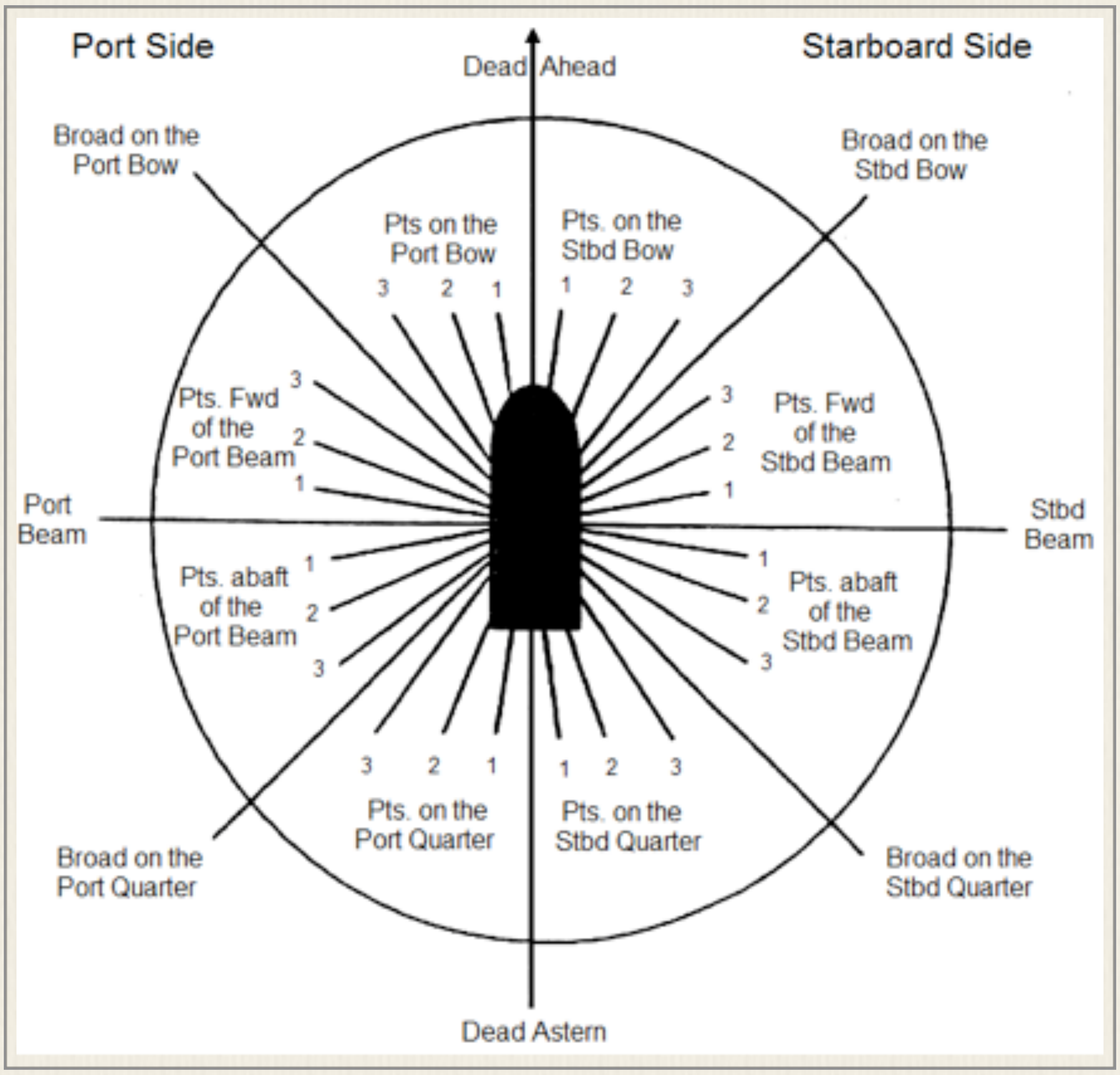
>Report everything you see & hear. / Report an object when first sighted.

Night Watch Standing

Difference between night/day vision
Night time conditions represent a different set of challenges in the working environment than those encountered during the day with clear or good visibility. Not only is your ability to physically see what is in the waters surrounding your vessel greatly reduced but judging distances and deciphering what the surrounding objects and lights are becomes a challenge.

Lights are easier to pick up if not viewed directly.
Your peripheral vision can detect dim or variations in a light better than focusing on an area trying to detect a light source.

Allow an adjustment time before watch standing.
Before assuming your watch, spend time in the wheelhouse letting your eyes acquire their night vision.
Avoid looking at bright lights or instruments for a prolonged period.
Use a small colored flashlight or penlight instead of a regular flashlight in the wheelhouse.

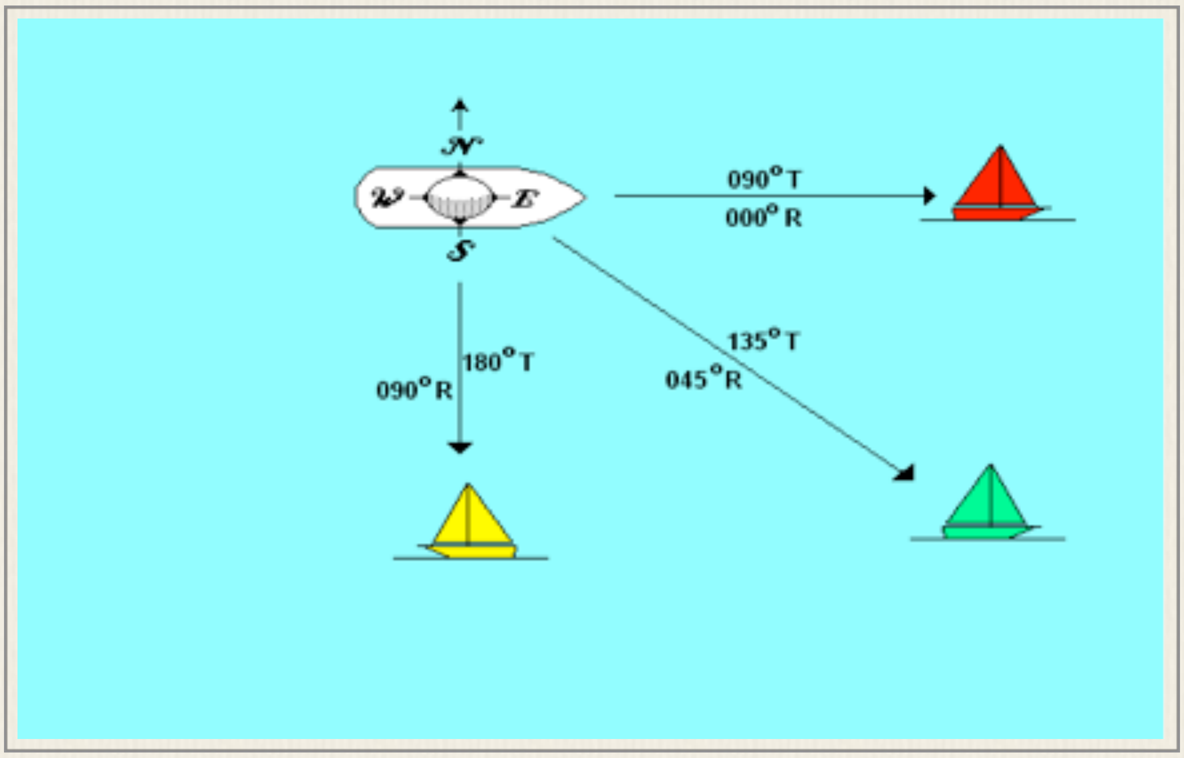


The Point System.
Relative bearings by "Points of the Compass" (N, S, E, W, NW, NNW, etc.) are rarely used aboard Merchant Vessels today. In order to use the Points of a Compass for reporting, the lookout must first know the heading of the vessel at the given time of the sighting.

The "Points of a Compass" are separated by 11-1/4°, for a total of 32 points. Today, most Merchant Vessels use a Relative Bearing Point System when reporting other vessels, landmarks, etc. This Point System also uses 32 Points (11-1/4° per point) but heading is not a factor. The Lookout reports the object, relative to its location in relation to the vessel.

Relative Bearings.

Relative bearings are taken with the vessel's heading or Bow acting as the reference point or 000º and measured clockwise through 360º. The bearing is dependant on the heading of the vessel. This method provides for a quick and accurate way to find a target or point of land in relation to the vessel's heading. True bearings are measured from true North and remain the same regardless of the vessels heading. Since charts are made with North being the reference point relative bearings must be changed to true bearings to be plotted.



<u>Converting from Relative to True</u>

True Bearing = Relative Bearing + Heading

Relative Bearing = True Bearing - Heading

>In order to plot a relative bearing, it must be converted to a true bearing. Here's how:

>Take your vessel's compass course (the course at the time the relative bearing was taken) and correct it for compass error.

>Take this true vessel heading and add it to the relative bearing of your target.

>This is the target's True bearing, unless it happens to equal a number greater than 360°. In that case, subtract 360° to get the true bearing.

Deck Watch

Prior to taking over the deck watch, the relieving officer shall be informed of the following by the officer in charge of the deck watch as to:

>The depth of the water at the berth, the ship's draft, the level and time of high and low waters; the securing of the moorings, the arrangement of anchors and the scope of the anchor chain, and other mooring features important to the safety of the ship; the state of main engines and their availability for emergency use.

>All work to be performed on board the ship; the nature, amount and disposition of cargo loaded or remaining, and any residue on board after unloading the ship.

>The level of water in bilges and ballast tanks.

>The signals or lights being exhibited or sounded.

>The number of crew members required to be on board and the presence of any other persons on board.

>The state of fire-fighting appliances.
>Any special port regulations.
>The Master's Standing and Special Orders.
>The Mate or Barge Captain's Standing and Special Orders
>The lines of communication available between the ship and shore personnel, including port authorities, in the event of an emergency arising or assistance being required.
>Any other circumstances of importance to the safety of the ship, its crew, cargo or protection of the environment from pollution.
>The procedures for notifying the appropriate authority of any environmental pollution resulting from ship activities.
>Relieving officers, before assuming charge of the deck watch, shall verify that:
>The securing of moorings and anchor chain are adequate.
>The appropriate signals or lights are properly exhibited or sounded.
>Safety measures and fire protection regulations are being maintained.
>Their awareness of the nature of any hazardous or dangerous cargo being loaded or discharged and the appropriate action to be taken in the event of any spillage or fire.
>No external conditions or circumstances imperil the ship and that it does not imperil others.

CHAPTER 7

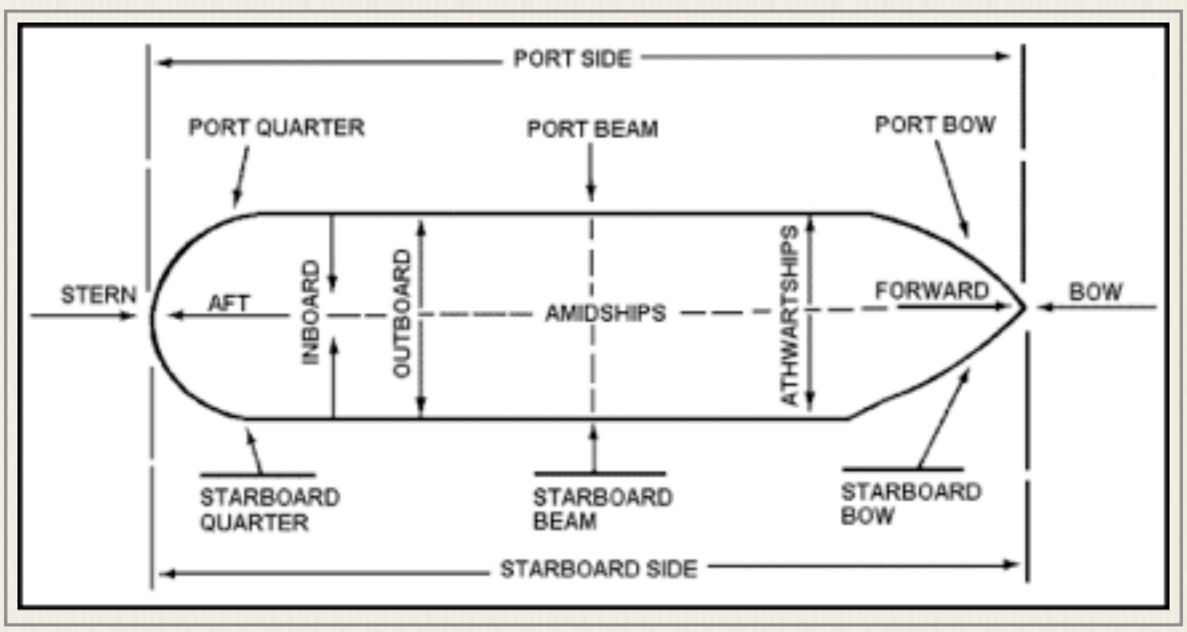
Ship Construction

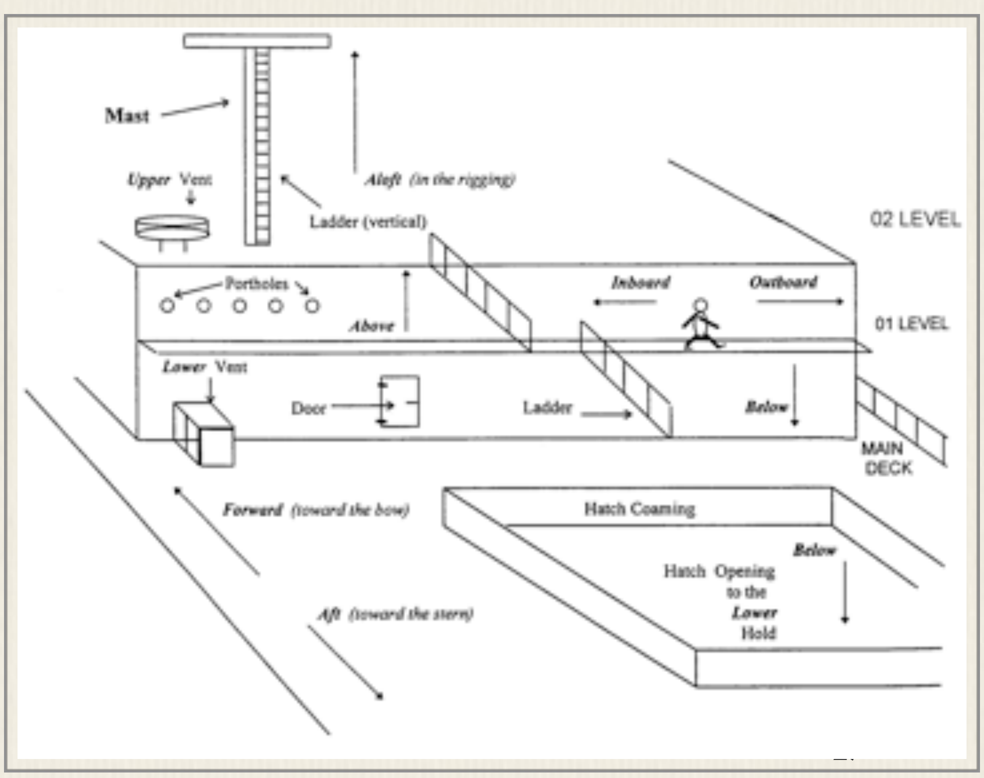
Introduction

In this chapter you will learn some of the more common terms used to express directions and locations aboard ship. In addition you will learn the major structural features and terminology associated with a ship.

Ship Terms

Lengthwise direction of a ship is fore and aft; crosswise is athwart ships. The front of the ship is the bow; the rear is the stern. To move forward toward the bow is to go forward; to move toward the stern is to go aft. Anything that is more toward the bow than another object is forward of it, and anything that is more toward the stern is abaft (behind) the other object.





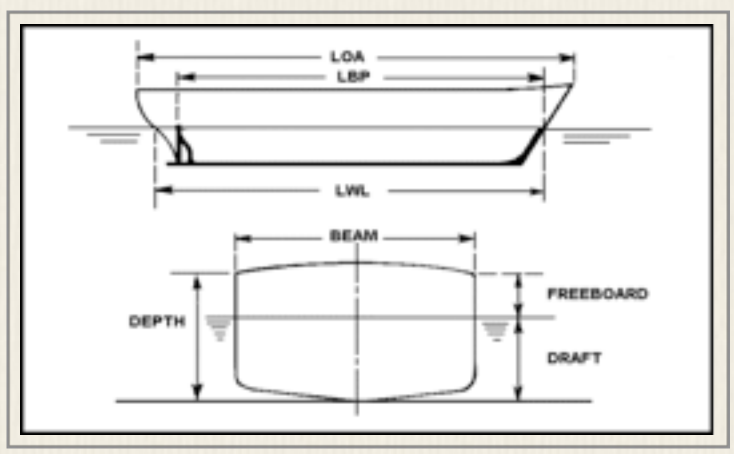
A ship is divided lengthwise in half by a centerline. When you face forward along the centerline, everything to your right is to starboard; everything to your left is to port. Fixtures and equipment take the name of the side which they are located, such as the starboard gangway, the port anchor and so forth.

When you go toward the centerline, you go inboard. An object nearer the centerline is inboard of another object. The section around the midpoint area is called amidships, (also called the waist). The extreme width of a ship, usually in the mid-ship area is its breadth.

You never go downstairs in a ship; you always go below. To go up is to go topside. However, if you climb the mast, stacks, rigging, or any other area above the highest solid structure, you go aloft. An object in front of a ship is ahead of it. An object to the rear is astern, never “in back”. Cooking is done in the galley, not in the kitchen.

Dimensions
A ship’s size and capacity can be described in two ways, linear dimensions or tonnages. Each is completely different yet interrelated.

Linear dimensions are used to expressed size in feet and inches. A ship is a three dimensional structure having length, width, and depth.



A ship’s length is measured in different ways for ship’s officers, for architects and designers, and for registry. The more commonly used length measurements—length overall, length between perpendiculars, and length on Load Waterline are discussed as follows.

A ship’s Length Overall [LOA] is measured in feet and inches from the extreme forward end of the bow to the extreme aft end of the stern. Watercraft operators must be familiar with this and similar dimensions to safely maneuver the ship. The dimension is commonly found in lists of ship’s data for each vessel.

A ship’s length is sometimes given as Length Between Perpendiculars [LBP]. It is measured in feet and inches from the forward surface of the stem, or main bow perpendicular member, to the after surface of the sternpost, or main stern perpendicular member. On some types of vessels this is, for all practical purposes, a waterline measurement.

Breadth
A ship’s extreme breadth, is the most outboard point on one side to the most outboard point on the other at the widest point on the ship. This dimension must include any projections on either side of the vessel. The beam, is the measurement of this point. Like length overall, this measurement is important to a ship’s officer in handling the vessel.

Depth

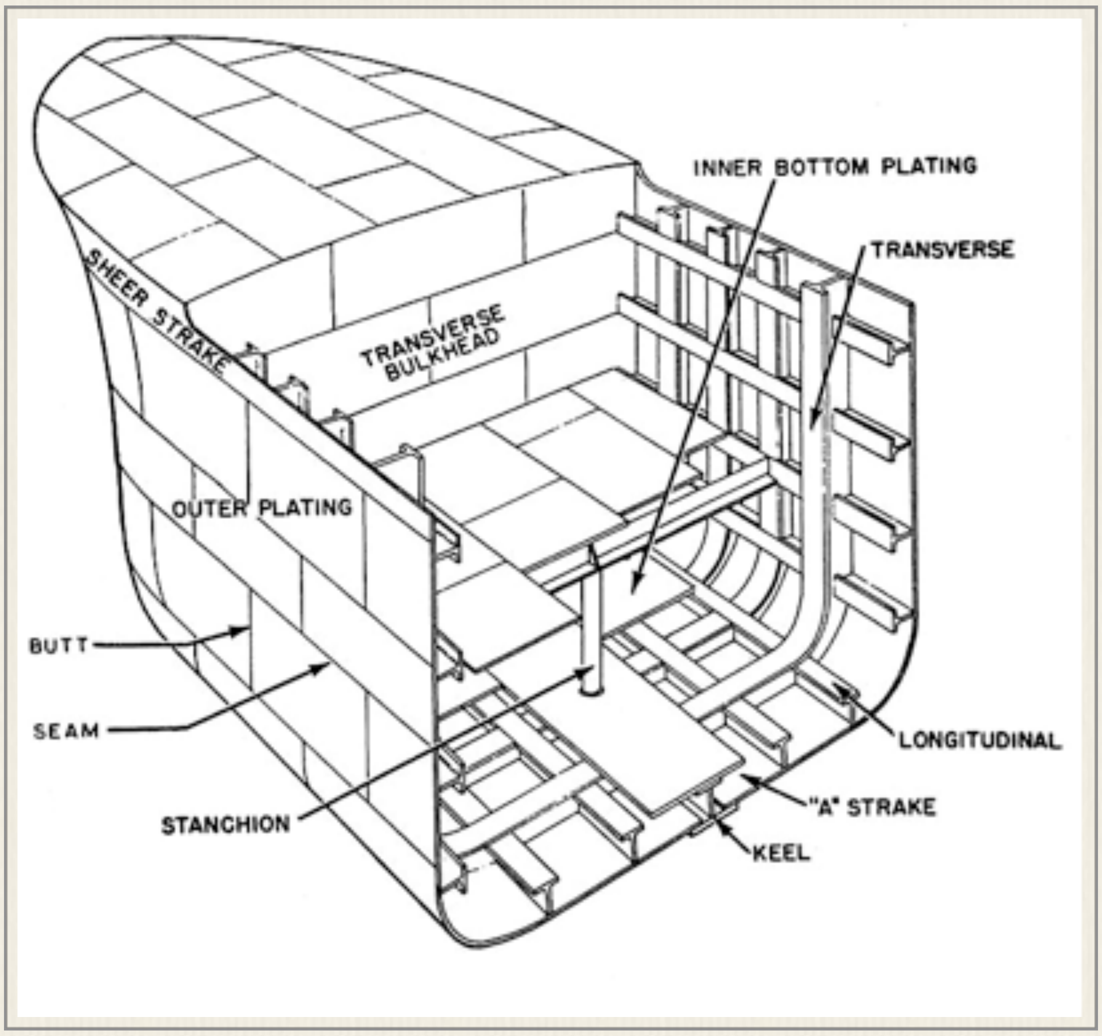
The depth of a vessel involves several very important vertical dimensions. They involve terms like freeboard, draft, draft marks, and load lines. The vessel's depth is measured vertically from the lowest point of the hull, ordinarily from the bottom of the keel, to the side of any deck that you may choose as a reference point, but is usually the main deck. The term "depth" is where the measurement is taken from the bottom—from the keel upward.

Waterline

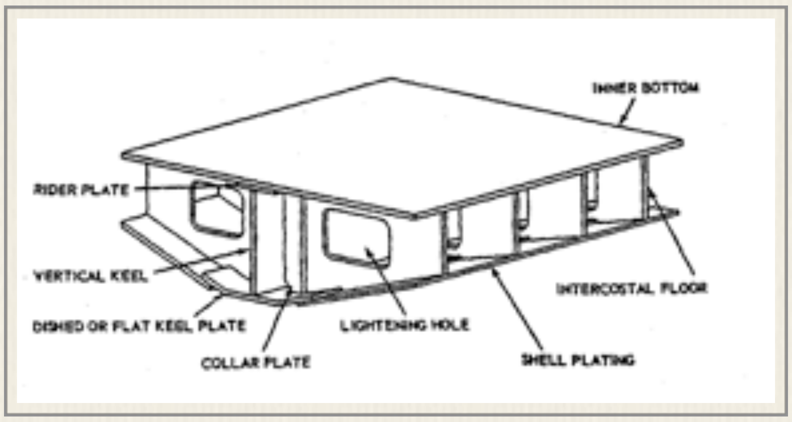
The water level along the hull of a ship afloat is the waterline. The vertical distance from the bottom of the keel to the waterline is the ship's draft. Freeboard is the distance from the waterline to the main deck.

Structural Terms

The purpose of this section is to define some of the terms related to ship construction. Not to tell you how a ship is built. All the terms necessary to understand the major structural characteristics of the hull, decks, and superstructure are given.



The figure depicts a hull structure of a ship and should be referred to during the explanation of structural terms. The hull is the supporting body of a ship.
It may be likened to an envelope. Inside the hull are strengthening members to prevent the envelope from collapsing. The hull also contains partitions that form machinery, berthing, messing and other spaces.



Detailed view of a ships bottom.

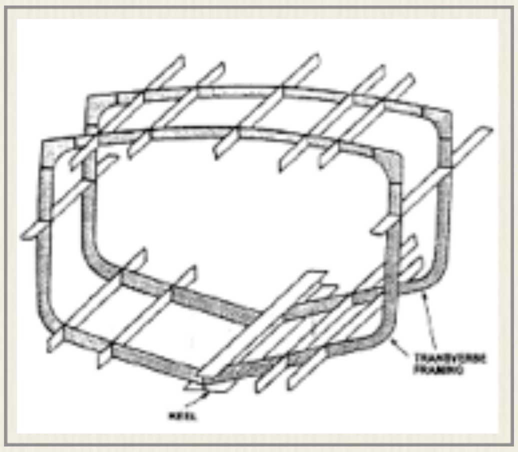
Keel

The keel is the backbone of the ship. The keel of most steel ships does not extend below the ship's bottom; hence, it is known as a flat keel. Its usual shape is that of an I-beam. All other members used in constructing the hull are attached, either directly or indirectly, to the keel.

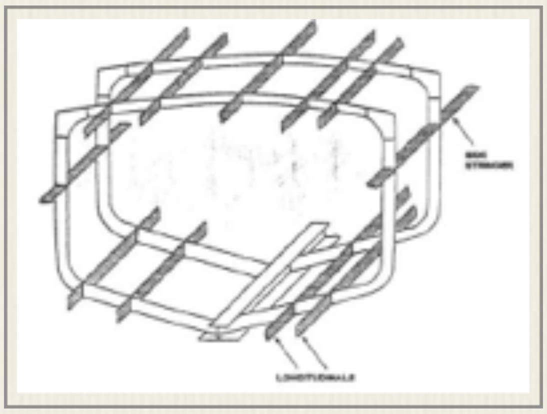
Framing

A vessel may be either transversely or longitudinally framed. In transverse framing, the ribs or frames of the ship run athwart ship and when placed in position give the principal shape or contour. Transverse frames are not all the same distance apart; amidships, where there is the greatest strain, they are spaced more closely. The transverse frames are cut or notched where they connect on the shell, to allow the longitudinals to pass through.

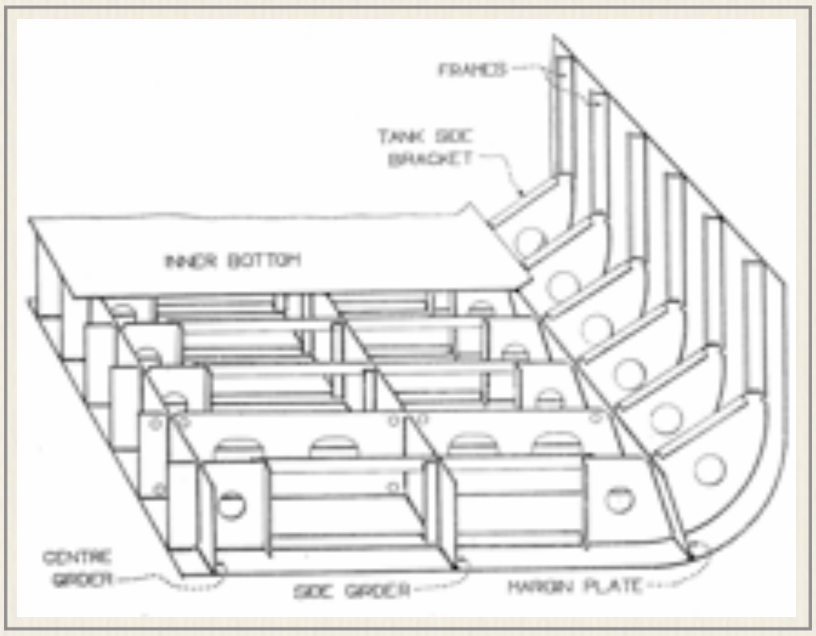
Transverse Framing



Longitudinally Framing



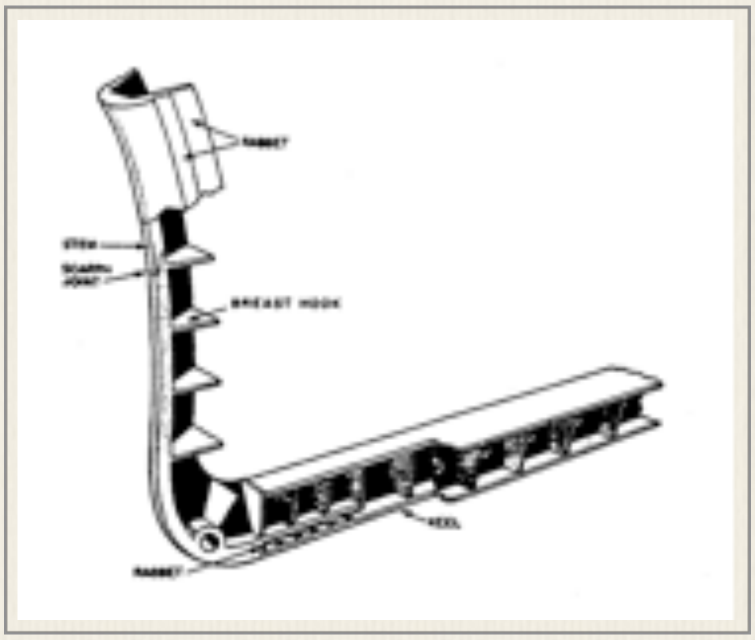
A longitudinally framed ship uses webb frames which are usually spaced farther apart. This type of framing is utilized in tanker construction, which necessitates large open spaces for cargo storage.



Additional Structures

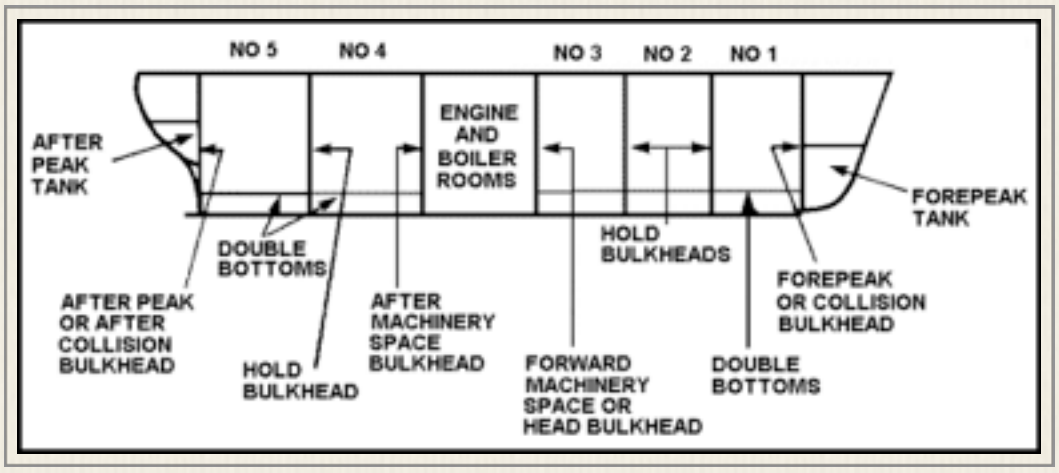
The athwart ships structure consists of transverse frames and floors. The floors run outboard from the keel to the turn of the bilge (where the bottom turns upward) where they are attached to the transverse frames, which then extend upward to the main deck.

Frames running parallel with the keel are longitudinals. From the turn of the bilge up the sides they are also called stringers. The network of floors and longitudinals resembles a honeycomb and is know as cellular construction, which greatly strengthens the bottom of the ship. When the honeycomb is covered by plating, double bottoms are formed. The space between the inner and outer bottoms (known as tanks) is used for liquid stowage. Planks laid upon the tank tops are called ceilings.



Stem
The forward end of the keel which is extended upward is called the stem. The after end of the keel has a similar extension called the sternpost. The part of the stem above water is the prow; the forward edge of the stem is the cutwater.

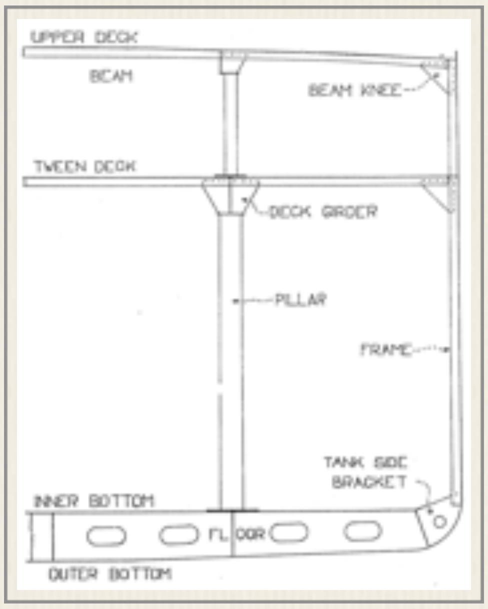
Bulkheads
The interior of a ship is divided into compartments by vertical walls, called bulkheads, which run both transversely and longitudinally. Most bulkheads are merely partitions, but spaced at appropriate intervals are transverse watertight bulkheads. These bulkheads extend from the keel to the main deck and from side to side to provide extra stiffening and partitions the hull into independent watertight sections. The outer tanks usually are filled with oil or water; the inner tanks called voids, are empty. The innermost bulkhead is called the holding bulkhead. If a torpedo were to hit the ship, the outer tanks although ruptured, would absorb enough energy from the explosion that the holding bulkhead would remain intact thus preventing flooding of vital spaces.



Strakes
The plates which form the ship's hull are fastened to the framework in longitudinal rows and are called strakes. The keel forms the center strake. Strakes are lettered beginning with the A-strake on either side of the keel, and extending up the main deck. Some of the strakes also have names. The A-strake is called the garboard strake; the strake along the turn of the bilge is the bilge strake; the uppermost strake is the sheer strake. A protecting keel running along the bottom near the turn of the binge is called a bilge keel. Its purpose is to reduce rolling of the ship.

Decks
The "floors" of a ship are called decks. They divide the ship into layers and provide additional hull strength and protection for internal spaces. The under surface of each deck forms the overhead of the compartment below. Compartments are the "rooms" of a ship. Some compartment are referred to as rooms, such as wardrooms, staterooms, engine room, and others. Generally speaking, you do no use the word "room". You never refer to the space where you sleep, for instance, as the bedroom nor where you eat as the dining room. These spaces are called the berthing compartments or space, and the mess deck.

A steel deck is made of steel plaiting (strakes) running fore and aft. The outboard strake in the deck plating is composed of stringer plates which are welded or riveted to the side plates of the ship, and therefore, adds additional strength to the ship's sides. Decks are supported by athwart ships deck beams and by fore and aft deck girders.



Further deck support is provided throughout the ship by vertical steel pillars. Pillars are mounted one above the other or one above a strength bulkhead. Decks usually are slightly bowed from the gunwale to the centerline to provide for drainage of water and to strengthen the deck. The arch so formed is called camber.

A deck or part of a deck exposed to the weather is called a weather deck. Bulwarks are sort of solid fence along the gunwale of the main (weather) deck. The bulwarks are fitted with freeing ports to permit water to run off during heavy weather.

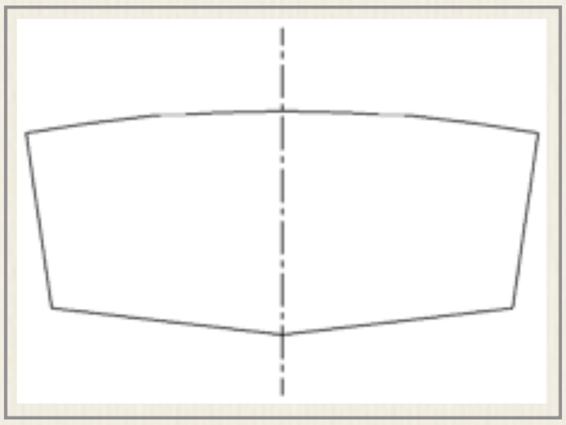
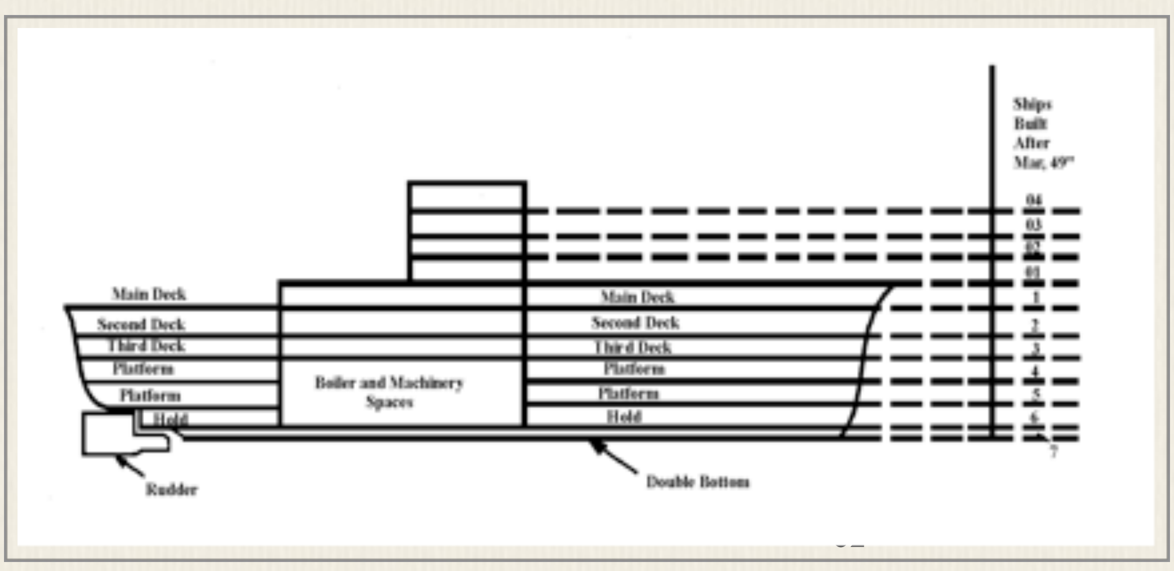


Illustration of camber

Compartments:
The individual rooms on a vessel are called compartments. Depending on the vessel they are named for what they are used for or they can also be designated by their location using deck, frame, and athwart ship position. Frame numbers tell you where you are in relation to the bow of the ship; the numbers increase as you go aft. The third number in the bull's-eye reflects compartment numbers in relation to the ship's centerline. EVEN numbers are to PORT, and ODD numbers are to STARBOARD. The numbers increase as you travel outboard.

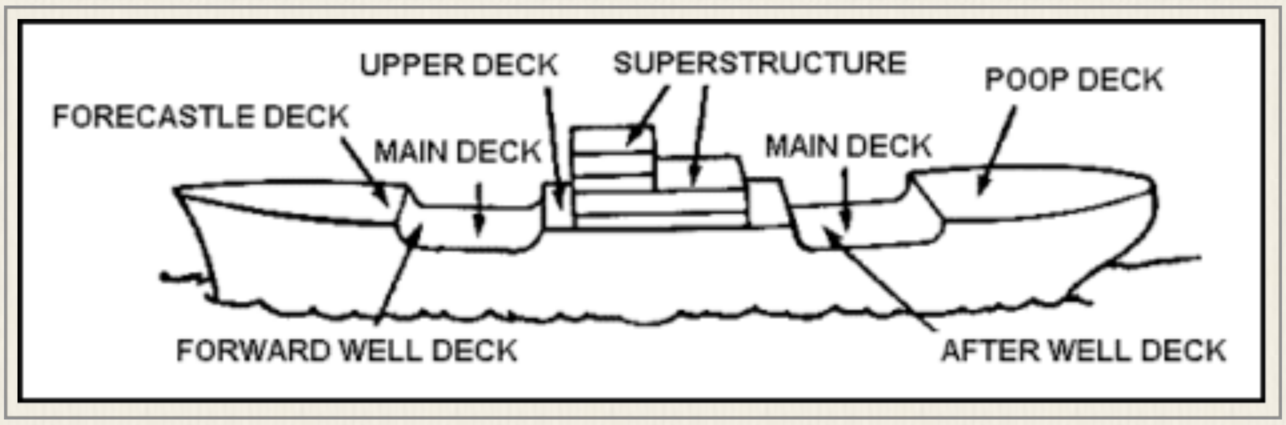
Freeing ports:
These are holes in the bulwarks or toe rail that allows water to run overboard from the deck. They are also called "scuppers."



Main deck:
The main deck is first continuous deck on the ship, above the keel. Often times this will also be the weather deck but this is not always the case.

Companionways
Stairs on a vessel are called ladders. An enclosed ladder leading from one deck to another is referred to as a companionway.

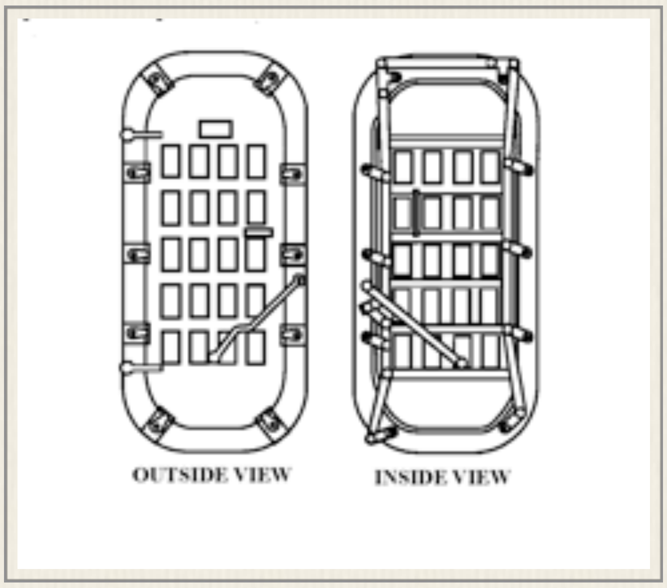
Names of decks.
Decks above the main deck are numbered 01, 02, 03, etc. and are referred to as levels. The Main Deck may also be referred to as the first deck. Below the main deck, there are the, second, third decks, etc extending down toward the keel.



Well deck:
This is the deck space between either forecastle and bridge or bridge and poop.

Superstructure deck:
Any deck located above the main deck is a superstructure deck. The superstructure is any part of the ship that projects above the main deck. The entire Superstructure is often referred to as the House on a Merchant Ship.

Doors and Hatches
Access through bulkheads is provided by doors, and through decks by hatches. Watertight doors, as the term implies, form a watertight seal when properly closed. All doors leading to weather decks are of the watertight variety, as are those in structural (watertight) bulkheads. The doors are held closed by fittings called dogs, which bear up tight on wedges. A rubber gasket around the edge of the door presses against a knife

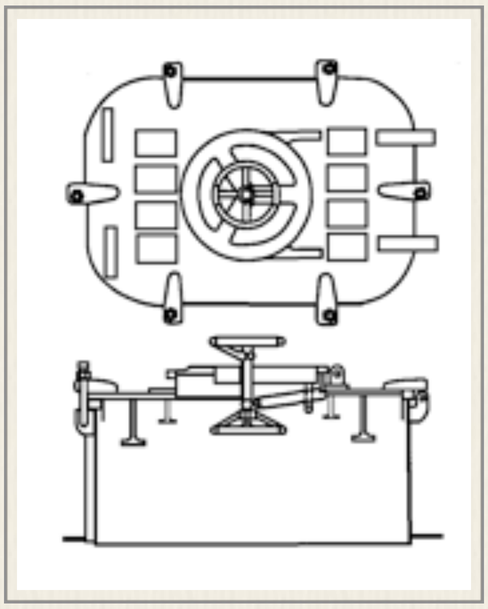


Watertight bulkhead door

edge around the door frames, forming a watertight set when all dogs are properly seated, or dogged down. Some doors have individually operated dogs, while others are quick-acting types, where a hand wheel or lever operates all the dogs at once.

Hatches

Hatches, are horizontal openings for access through decks. A hatch is set with its top surface either flush with the deck or on a coaming raised above the deck. Hatches do not operate with quick-acting devices but must be secured with individually operated dogs or drop bolts.



Hatch with raised coming

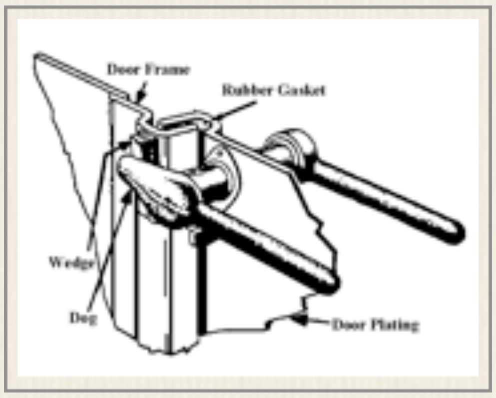
The figure shows a typical hatch with an escape scuttle, which is a round opening with a quick acting closure. An escape scuttle may also be found in the deck (or overhead) of a compartment that otherwise has only one means of access.

Manholes of the hinged type are miniature hatches provided in decks for occasional access to water, fuel tanks, and voids. Bolted manholes are merely sections of steel plate that are gasketed and bolted over deck access openings. Manholes are also found in bulkheads, but are not as common as deck manholes.

Dogs

Watertight doors and hatches must be dogged and un-dogged properly to prevent springing. First, you should set all the dogs opposite the hinges. Pressure should be just sufficient to keep the door shut. Next, set the two dogs on the hinge side, then the remaining ones. Tighten all the dogs hand-tight. Last, follow the same sequence, tighten the dogs with a dog wrench. When you open a door, loosen all dogs, starting with those on the hinge side of the door, then remove the dogs from the wedges.

A watertight dog



Miscellaneous

Stacks (never chimneys or funnels) are the large pipes that carry off smoke and gases from the boilers. The wider lower section of a stack is an uptake

Masts are used to support radio and radar antennas, signal halyards, signal lights, and booms. Stays and shrouds, together with other wires used for similar purposes on stacks, masts, etc., are known as the ship's standing rigging. Lines or wires used for hoisting, lowering, or controlling booms, boats, etc., are known as running rigging.

The top of the mast is called the truck. A small sheave at the truck admits the truck halyards. The top of the foremast is the fore truck, and the top of the mainmast is the main truck.

Bridge
Located in the superstructure is the space from which the ship is controlled while underway-the bridge. It is from the bridge that the ship is controlled by the captain.

Ship Stability

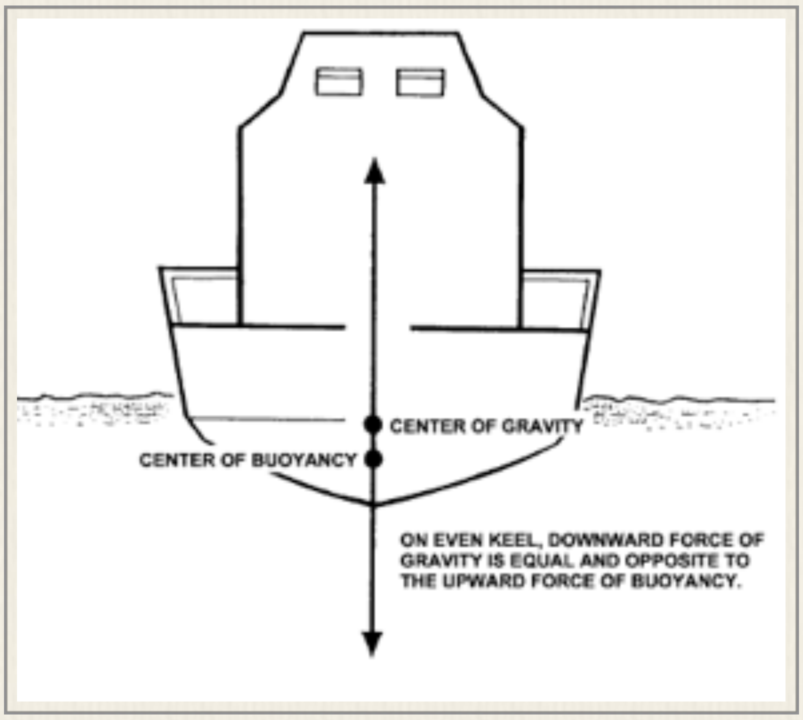
Introduction
The objective in this section is to introduce the seaman to basic stability principals. He or she needs to develop an understanding of the forces that act on a vessel and how they affect that vessel. The prudent crewmember understands these basic concepts and how they relate to activities onboard their vessels.

What is Stability?
Stability is defined as the ability of a vessel to return to its original condition or position after it has been disturbed by an outside force.

When a vessel is heeled over in reaction to some external influence, it will either return to an upright position or continue to heel over and capsize. The tendency of a vessel to remain upright is its stability. The greater the tendency to remain upright, the more stability the vessel achieves.

Gravity
The center of gravity is the point at which the weight of the vessel acts vertically downwards. Generally the lower the center of gravity, the more stable the vessel.

The center of gravity of a vessel is fixed and does not shift unless weight is added, subtracted, or shifted. When weight is added, the center of gravity moves toward the added weight. When weight is removed, it moves in the opposite direction.

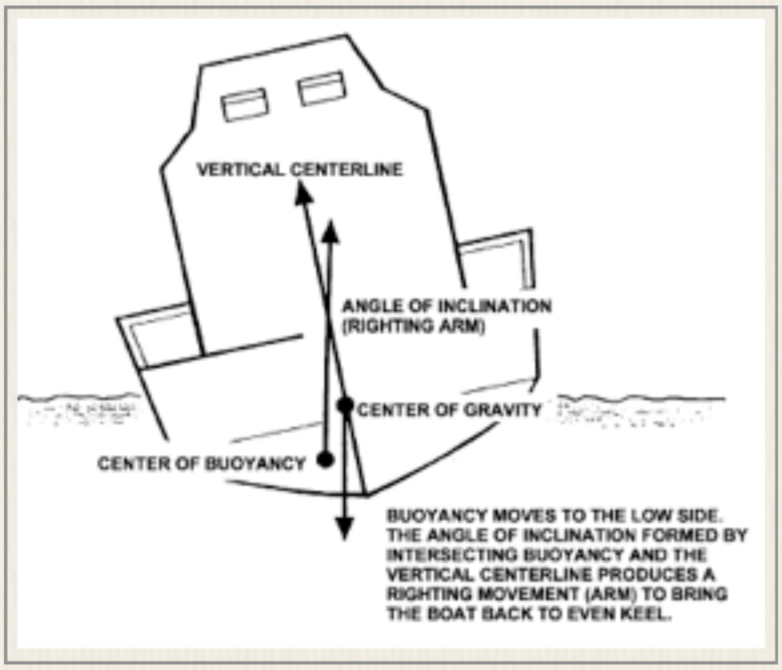


Buoyancy
The buoyancy is the upward force of water displaced by the hull. This is what keeps a vessel afloat, but may be overcome if too much weight is added. It is the point on which all upward/vertical force is considered to act, and lies in the center of the underwater form of the hull.

Equilibrium
When a boat is at rest, the center of buoyancy acting upwards is below the center of gravity acting downwards. At this point a vessel is considered to be in equilibrium. Equilibrium is affected by moving of the center of gravity, or center of buoyancy or by some outside forces such as wind or waves.

Roll
When a vessel rolls, the force of the center of gravity will move in the same direction as the roll. The downward force of gravity is offset by the upward force of buoyancy and causes the boat to heel. When the vessel heels, the underwater volume of the vessel changes shape causing the center of buoyancy to move.

The center of buoyancy will move towards the part of the hull that is more deeply immersed. At this point the center of buoyancy will no longer be aligned vertically with the center of gravity. The intersection of the vertical line through the center of buoyancy and the vertical centerline is called the metacenter. If the metacenter is above the center of gravity, the center of buoyancy shifts so that it is outboard of the center of gravity. The forces of buoyancy and gravity will then act to bring the vessel back to an upright position. If the center of buoyancy is inboard of the center of gravity, the forces of buoyancy and gravity will tend to roll the vessel further towards capsize. See the diagram below.



Types of Stability
A vessel has two types of stability:
>longitudinal
>transverse
Since a vessel is longer than it is wide, the longitudinal plane is more stable than its transverse plane. Of the two, the transverse stability is what we are most concerned with.

Transverse stability tends to keep a vessel from rolling over. The way a vessel rolls is a direct indication of her stability.

>A concentration of weight high in the vessel results in a very slow roll. The vessel is said to be in a tender or cranky condition and she has a weak tendency to return to her upright condition. Stability is poor.

>A concentration of weights down low in the vessel results in a very quick roll. The vessel is said to be stiff and she has a marked tendency to return to her upright position. Stability is excessive.

A vessel which rolls too fast creates stresses on the upper parts of the vessel and creates an uncomfortable condition.

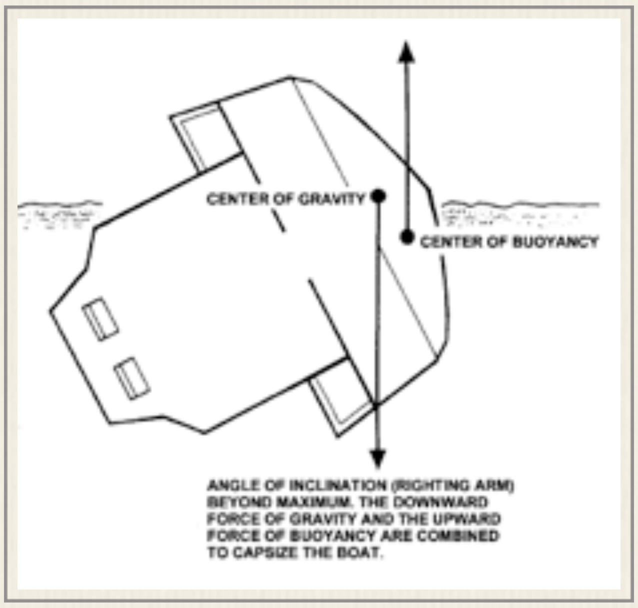
A vessel which rolls too slowly has poor stability and might capsize under certain conditions, such as heavy weather.

When weight is added above the center of gravity, increasing the distance from the center of buoyancy, stability is decreased. If the center of gravity is raised enough the boat will be come unstable and capsize.

Moment and Forces
The force that causes a vessel to return to an even keel, or upright position, is called the vessel's moment. Both static and dynamic forces can reduce stability and moment. Moments and the internal and external forces that act to increase or decrease the righting moment, are important factors in determining the stability of a vessel at any given point in time.

Righting Moment and Capsizing
A righting moment is the force causing a vessel to react against a roll and return to an even keel. Generally, the broader the vessels beam, the more stable that vessel will be, and the less likely it is to capsize.

As a vessel heels, the center of buoyancy moves to the lower side of the underwater hull forming an angle of inclination. This change provides greater righting movement up to a maximum angle of inclination. Too much weight added to the side of a vessel that is heeled over can overcome the forces supporting stability and cause the vessel to capsize. See the following diagram.

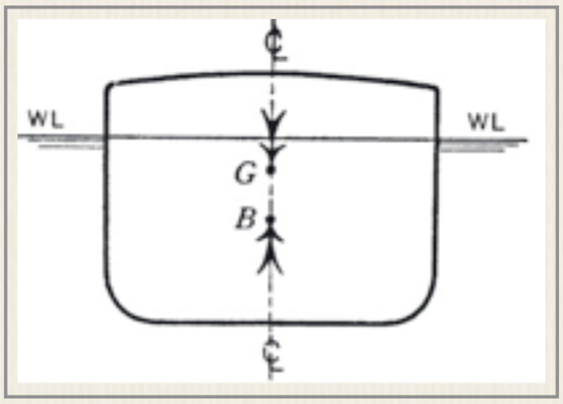


Static and Dynamic Forces
Unless acted upon by some external force, a vessel that is properly designed and loaded remains on an even keel. The two principle forces that affect stability are static and dynamic forces.

>Static forces are caused by placement of weight within the hull, or a flooding condition
> Dynamic forces are caused by actions outside the hull such as wind and waves.

The Centers of Gravity and Buoyancy
The condition of a vessel is determined almost solely by the location of two points:

1. Center of Gravity (G)—the point at which all vertically downward forces of the vessel can be considered to act. In other words, the ship will behave as though all of its weight were acting downward through this point.



2. Center of Buoyancy (B)—the point at which all the vertically upward forces of support (buoyancy) can be considered to act, or, the center of volume of the underwater portion of the vessel. In other words, the ship will behave as if all of its support is acting up through this point.

Initial Stability
Having to compute the righting moment by looking up righting arms in the static stability curves/tables is not very meaningful to the ship's officer other than to indicate that the vessel would return to an upright position.

Need to know what the relative tendency of the vessel will be to return to the upright position for small angles of inclination (0-10 deg.). In other words, you want to know how your vessel will roll.

To satisfy this need, we need to know the position of the vessel's transverse metacenter (M).

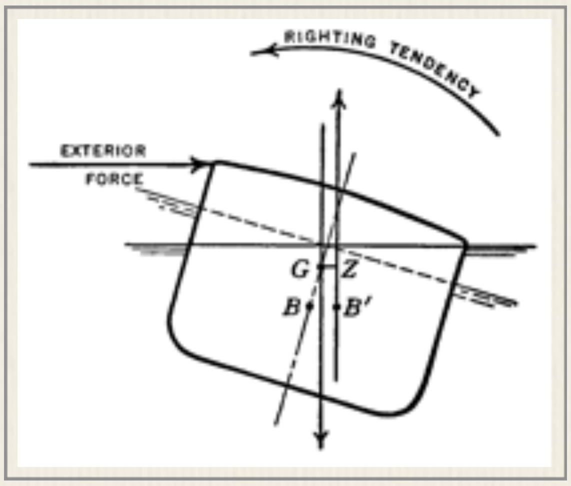
Transverse Metacenter (M)—is the point through which the center of buoyancy, B acts vertically upward as the vessel is inclined and B shifts to the low side.

ONLY HOLDS FOR ANGLES LESS THAN 10 DEGREES

For angles greater than 10 deg., M moves in the path of a curve.

For small angles of inclination we can examine three cases. In each, the vessel is inclined to the same angle and is the same. The only difference is how the vessel is loaded so that the position of the center of gravity changes.

Positive Stability G below M



When the vessel is inclined due to an external force, the center of buoyancy shifts its position to the new geometric center of the underwater body.

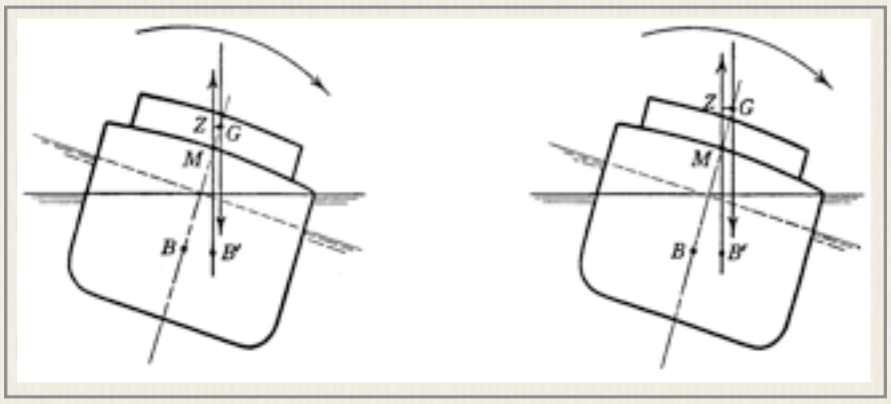
The forces of buoyancy and gravity, while still equal in magnitude, are no longer directly opposite each other and form a couple to right the ship.

low G, large righting moment
higher G, smaller righting moment

Neutral Stability G coincides with M

In this case G has risen to a point where it now coincides with M. If the vessel is given a small angle of list, B will move to the new center of the underwater volume.
Since at small angles, B moves in an arc around M it is also moving in an arc around G.There is no displacement of the lines of action of the forces of G and B which means that no righting arm will be developed.As a result, the vessel will remain in whatever position it has reached when the external force is removed.

Negative Stability G above M



In this case G has moved above M so that when the ship is inclined due to an external force, the couple set up by the forces acting through B and G is such that the vessel continues to move in the direction of the initial force even if the force is removed.

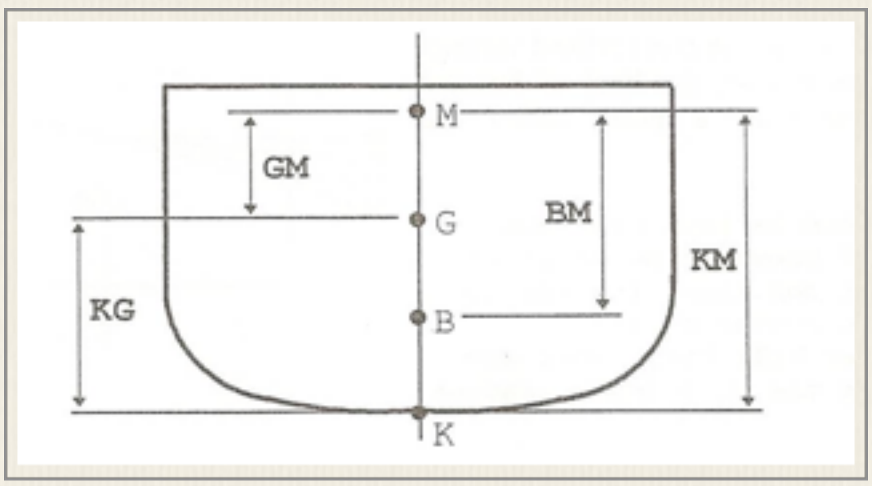
When G is above M, upsetting arms are developed for at least the first few degrees of heel. The ship will list to either side until it reaches some angle where a further list will cause positive righting arms to be developed.

remember, M is fixed in position for small angles of heel.
At larger angles, it moves so the vessel may reach a point where B has moved back under G.

Whether the ship will capsize depends upon its overall stability, which must be determined by graphic methods.

The metacenter (M) may be further expressed as that point to which G may rise and still permit the vessel to possess positive stability. Therefore, the distance between G and M is related directly to the length of the righting or upsetting arm.

Metacentric Height (GM) is the distance between G and M and can be used as a measure of the initial stability of a vessel.



GM cannot be used as a measure of stability at all angles because M does not remain in the same position for all angles of inclination much beyond 10 degrees.

For the ship's officer, stability is mainly a problem of finding the position of G. The position of G above the keel (KG) is compared with the distance of M above the keel (KM)

KM—KG=GM

Additional Topics Related to Stability and Trim

Free Surface—a condition that exists when a liquid is free to move in a tank or compartment of a vessel and causes a virtual rise in the vessel's center of gravity.

The liquid may be fuel, potable water, ballast, or loose water from fire fighting or flooding.

If compartment or tank is only partially filled it is said to be slack and this liquid will have a free surface.

As the ship rolls, the liquid in slack tanks will shift to the low side causing the ship's center of gravity to shift as well.

Note: The amount of liquid in the tank or compartment does not affect the free surface effects, nor does the tanks position in relation to the centerline. It is therefore important in order to reduce the effects of free surface care must be taken to limit the number of tanks left slack at any one time.

If the tank or compartment is almost empty when the ship is upright and the tank or compartment is broad, the surface on which the liquid rests will be partially uncovered at some angle of heel, and the liquid will collect in the low corner of the space. This situation is referred to as pocketing. A similar situation occurs when the tank or compartment is nearly full.

If a tank is almost full or almost empty, pocketing will occur almost immediately, eliminating free surface effects even on initial stability.

Longitudinal Stability

Trim is defined as the difference between the forward and after drafts. If the draft aft is greater than the forward draft, then the ship has a trim by the stern. If the draft forward is greater than the draft aft, then the ship has a trim by the bow, (or head).

Center of Floatation is the point about which a vessel trims. In other words, the ship inclines (fore and aft) about a transverse axis passing through the geometric center of the water plane. It is also referred to as the Longitudinal Center of Floatation (LCF).

Trim changes can be produced by the fore and aft movement of weights already in the ship and by adding or removing weights forward and aft of the LCF.

a weight added, or removed, at the LCF will change the draft but will not affect the trim.
an addition or removal of weight away from the LCF will not only change the draft but the trim as well.

a weight added forward of the LCF will produce a change of trim by the bow and a weight added aft of the LCF will produce a change of trim by the stern.

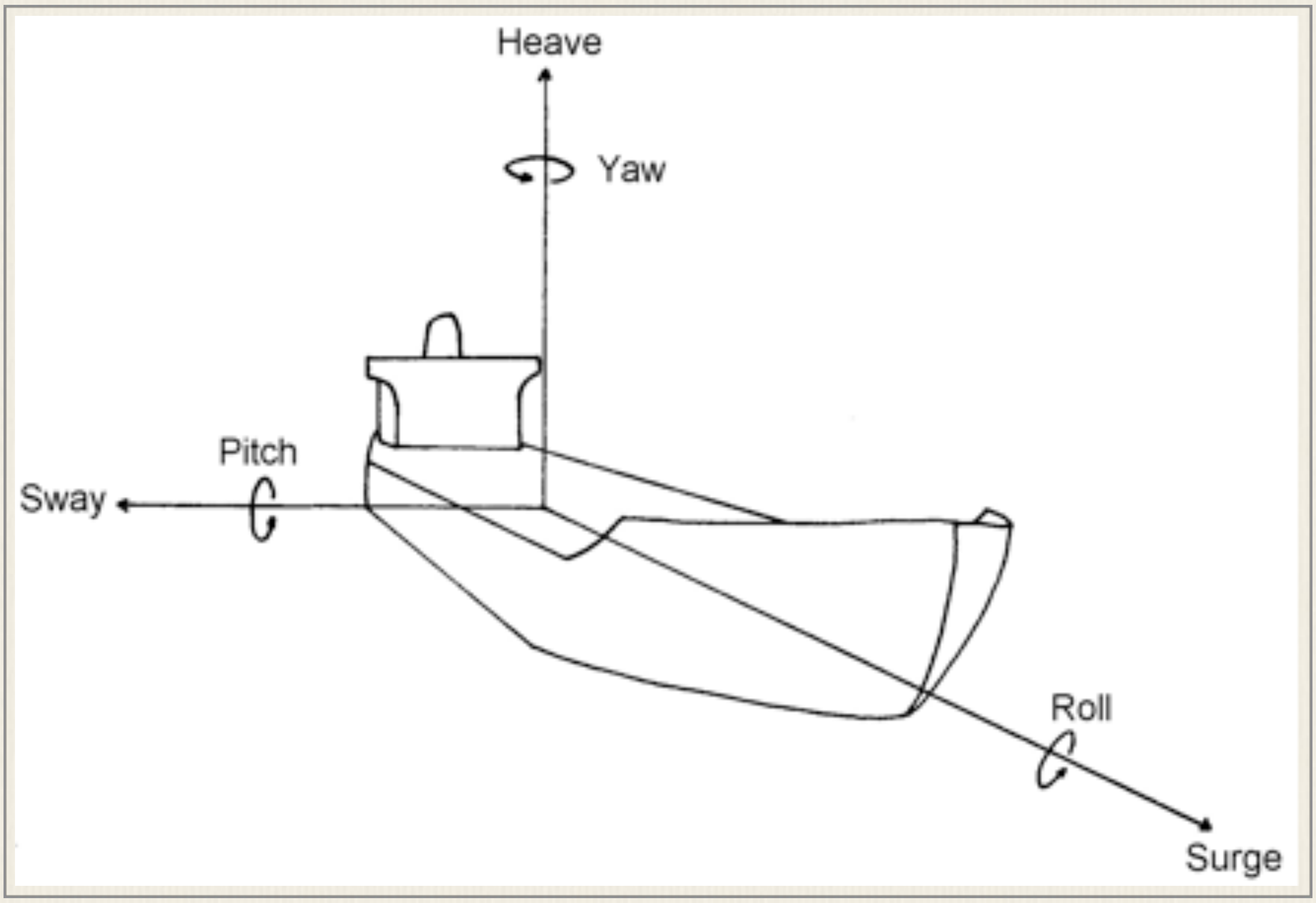
Moment to Change Trim One Inch is the moment necessary to change the trim of a vessel by one inch and is found in the vessel's Trim and Stability Booklet.

Draft Marks on the vessel's hull are 6 inches high, with 6 inches between numbers. If the water line rises to the bottom of the number, for example 4, then the draft at that point is 4 feet. If the water rises to a point midway up the #4 then the draft is 4 feet, 3 inches. If water reaches the top of the #4, draft is then 4 feet 6 inches.

Conclusions

The prudent crewmember will constantly watch for any loss of stability in their own vessel. Being aware of cargo weight and placement, external conditions such as wind and seas, water in the bilges or any condition that may adversely affect the vessels stability should be reported to the bridge immediately. Maintaining watertight integrity is critical, and keeping watertight openings such as doors and hatches properly secured is essential to the safety of the vessel. Keeping scuppers and freeing ports clear to minimize water on deck helps decrease the likely hood of stability related problems.

Motions of a Ship

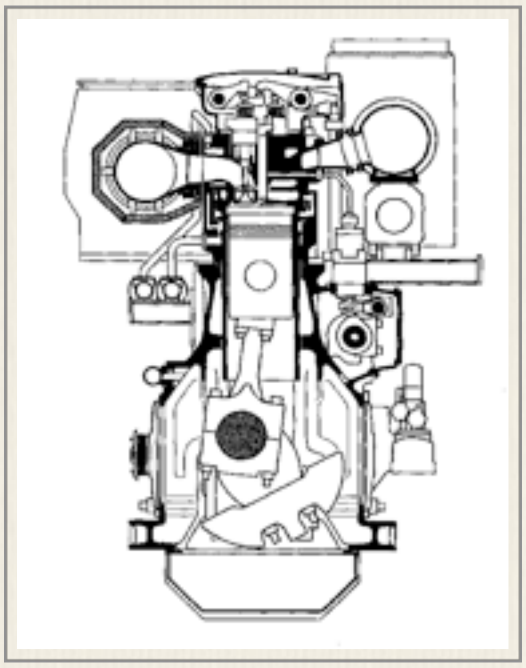


CHAPTER 9

Engineering

Introduction
In this section we will take a look at the mechanical aspects of the vessel. Various mechanical components and their maintenance will be examined along with activities such as fueling procedures that need to be understood by the master.

Propulsion
The power plant converts chemical energy of the fuel into mechanical energy to propel the ship. Most modern commercial ships of small to moderate size use diesel engines.



Typical marine diesel engine.

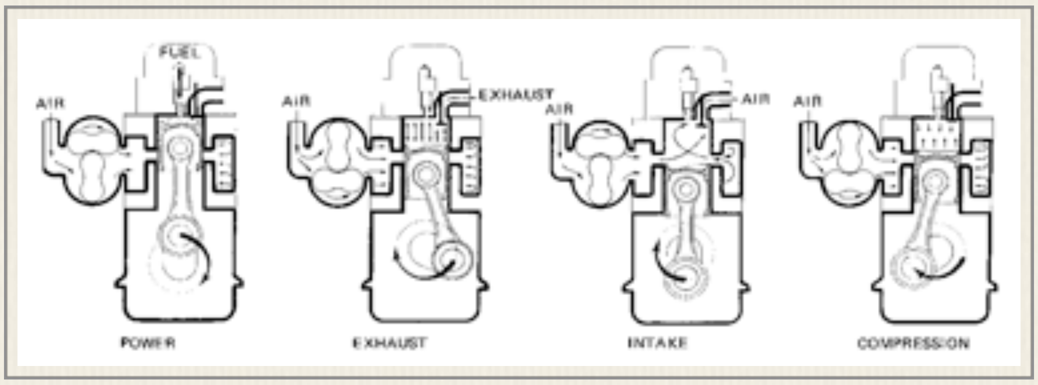
Diesel Engine
Over the last decades many designs of diesel engines have emerged. They may be two stroke or four stroke, natural aspiration, turbo charged or inter-cooled. Further, they may be in line, v-designed, or opposing cylinders and either high, medium or low speed.

High and medium speed engines are manufactured in both two and four stroke designs while all low speed engines are of two stroke design.

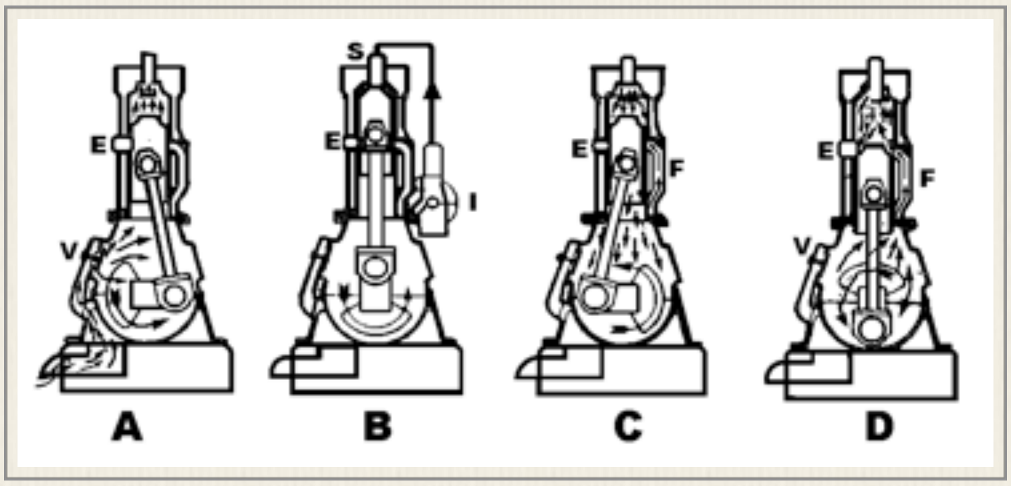
The manner in which the engine works, and the configuration of the pistons are secondary to the fact that the torque the engine produces is transmitted to the propeller shaft, usually through a reduction gear, turning the propeller. This creates thrust, which moves the vessel.

Propulsion used on large ships usually couples the engine directly to the propeller shaft, eliminating the reduction gear. These large engines are started by directly injecting air into the cylinders. Besides having a limited number of restarts for maneuvering, there is usually a minimum speed that they can be run at. This is somewhere around 30 RPM, which translates into about 7 or 8 knots. There are no propeller speeds between 0 and 30 RPM available for maneuvering. In addition, it can take up to 4 minutes to go from full ahead to full astern.

The stroke sequence of both two and four stroke engines are shown in the following diagram. In both, the heat generated by compression causes ignition.



Four stroke engine stroke sequence



Two stroke engine compression sequence

Starting Systems
There are three types of engine starting systems that may be found on board marine engines, compressed air, electric and hydraulic.

<u>Compressed Air Starting System</u>
Most large diesel engines are started when compressed air is admitted directly into the engine cylinders. This forces the piston down turning the engine crankshaft. This air admission process continues until the pistons are able to build up sufficient heat from compression to cause combustion to ignite the fuel, which will start the engine.

Smaller engines will have a reserve tank of compressed air which will be piped to the pneumatic starting motor. Normally in a system like this there will be a pressure reducing valve and a relief valve installed in the line between the starter and the accumulator (air storage tank) to reduce the air pressure, and protect the starter in the event of over pressurization.

<u>Electric Starting System</u>
This type of system utilizes storage batteries to turn a small electric motor that spins the engine rapidly enough to generate enough heat through combustion to start the engine. The motor is designed to carry extremely heavy loads but, because it draws a high current, tend to overheat quickly. Allow it to cool for several minutes between starts.

<u>Hydraulic Starting System</u>
Hydraulic starter systems are used on some smaller diesel engines. There are several types of hydraulic starting systems, but most installations consist of the following components:

hydraulic starter motor
piston type accumulator
manually operated hydraulic pump
reservoir for hydraulic fluid

Hydraulic pressure is provided in the accumulator by the manually operated hand pump or from the engine driven pump when the engine is running. When the starting lever is operated, the control valve allows hydraulic oil from the accumulator to pass through the hydraulic starting motor, cranking the engine.
Once the engine starts, the starting lever is released, spring action disengages the starting pinion and closes the control valve. This stops the flow of hydraulic oil from the accumulator. The starter is protected from the high speeds of the engine by the action of an overrunning clutch.

<u>Protection Devices</u>
over-speed trip
crankcase pressure detector
low oil level indicator
low oil pressure alarm
low water level
air filter vacuum switch
high and oil temperature switches
turbocharger oil pressure switch
lube oil pressure switch
lube oil pressure alarm
engine temperature switch
low clutch air pressure switch
gear cooler water pressure switch
low fuel pressure switch

Safety Precautions

- Keep engine room clean and free from oil spills, grease and dirt as much as possible

When checking fluids on a hot engine, do not use hands to clear dip sticks.

Ensure no tools are carelessly left lying around equipment where they might cause personal injury or damage to equipment.

Anyone working around engine and equipment should be aware of shut down controls and fuel cutoff valve.

When the engine is being rotated with a turning bar the manual injector control lever must be held in the "no fuel position" and the cylinder test valves are to be backed out two or three turns. No one should stand in line with any open test valves

Before starting the engine after using a turning bar, be certain it has been removed from the flywheel.

Do not work on any switches, relays, or other high voltage electrical equipment without first stopping the engine and opening the control power switch.

Following engine shut down due to activation of the crankcase pressure detector, do not open any handhold or top deck covers to make an inspection until engine has been stopped and allowed to cool off for at least two hours. Action of the pressure detector indicates the possibility of a condition within the engine such as an overheated bearing, that may ignite the hot oil vapors with an explosive force if air is allowed to enter.

No one but authorized personnel should be permitted in the engine room.

Fuel

<u>Gasoline</u>
The main difference between gas and diesel is volatility. Gasoline has a flash point of -45°. At that point it will explode, but will not sustain combustion.

When fueling, keep the fueling nozzle in contact with the filler pipe to guard against static spark. Do not overfill tanks, leave room for expansion. A safe fuel system will be liquid and vapor tight.

Gasoline fuel tanks must be vented into the open air. Gas engines need to air vents, a natural supply and mechanical exhaust. Also needed is a shut-off valve at the tank or in the fuel supply line at the engine.

Gas vapors are heavier than air and will gather in the lowest areas of the vessel, mainly the bilge. Inboard gasoline engines need a backfire flame arrestor on the carburetor.

Keep hatches and doors closed during fueling, and open hatches and ventilate the bilge's after fueling. Always check for fuel leaks prior to starting any engine.

Check the oil and any obstructions before starting any gas or diesel engine.

After machinery is put in motion you should check for water, fuel or oil leaks, operating pressure and temperatures and cooling water system operation.

On inspected vessels the engine, engine head and exhaust manifold.

Drip Collectors are used under the carburetor of gas engines.

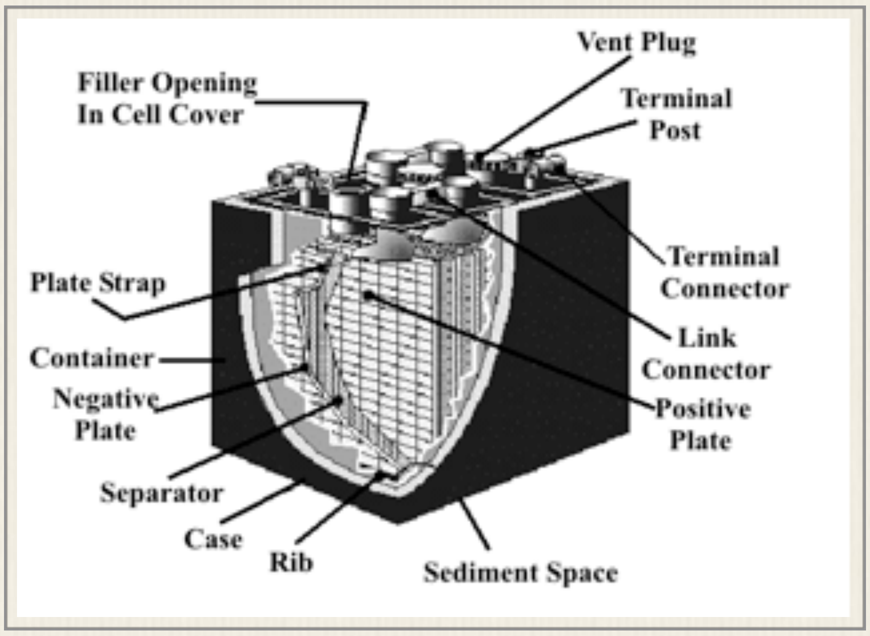
<u>Diesel</u>
Fuel in a diesel engine is ignited by the heat of compression. The normal way to shut off a diesel engine is by turning off the fuel. If a diesel runs out of control, most have emergency shut downs on the air intake, which will cut off the air to the engine.

Al exhaust systems should be periodically checked to see they are tight and that exhaust gases do not enter a vessel. Inboard exhaust systems will have water pumped into the system to cool them. Checking for water flow is an important start up practice.

Fuel vents in a diesel propelled vessel are fitted with flame screens, which allow the passage of vapor, but not flame.

Engine rooms should be inspected periodically while underway to insure problems are not developing.

Other Related Systems
<u>Batteries</u>
Charging batteries will result in the formation of hydrogen, an extremely explosive gas. Ventilation of battery spaces is critical to prevent flammable gas accumulation.



Batteries should be filled to ¼" from the top of the filler plugs, and be kept covered to prevent accidental shorting.

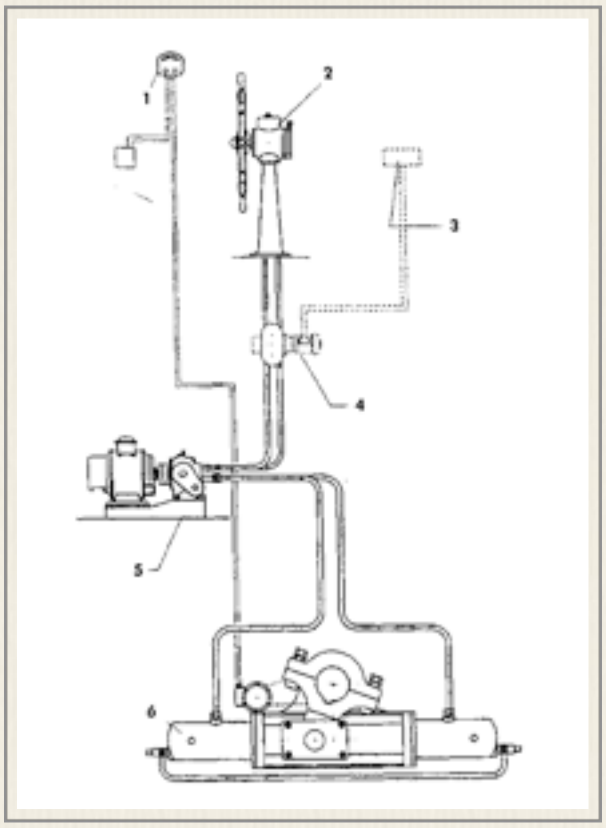
Acid batteries shall be located in a lead-lined tray, or suitable container.

Bilge Systems
Bilge drainage or limber systems are designed to remove water that collects within the ship's hull, below the waterline. The system consists of the suction lines that run throughout the length of the ship and the bilge pumps.

Vessels served with this type of bilge system must be kept free of trash and debris to prevent clogging the suction piping. Machinery spaces usually have oily water separators to prevent oil being pumped overboard.

The bilge drainage system must be maintained in first class working order at all times as it can be of critical importance in a flooding emergency.

Steering Gear
Because the steering engine is so critical to the maneuvering and safety of the ship, the Master needs to have a basic understanding of the particular system on his vessel. Like all other mechanical systems, there are a variety of types, and differing designs of steering gears.



Basic, cable actuated steering may still be found on small or older vessels. Hydraulic couplings are more common, and larger vessels may have electric/hydraulic systems. Redundant systems, provide a back up of one system in the event of failure.

There may be a number of alarms in this system, both visual and audible on the navigational bridge. They may warn the bridge in the event of a motor failure, loss of hydraulic pressure or power loss.

Even if an engineer is onboard, the deck department should conduct periodic inspections of the steering gear assembly and components.

Steering gears (along with whistles, controls and communications systems) must be tested before getting under way.

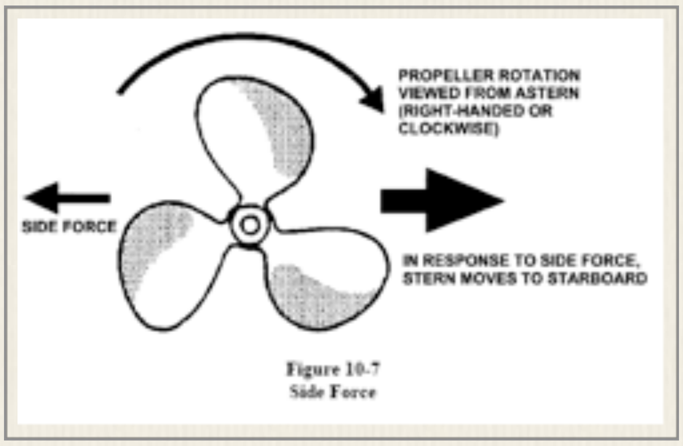
Miscellaneous
Circuit breakers and fuses are used to protect electrical circuits.

Prop shafts pass the through the hull at the stuffing box.

Water tanks should not be located low in the bilge, and should have screens on them to keep out bugs.

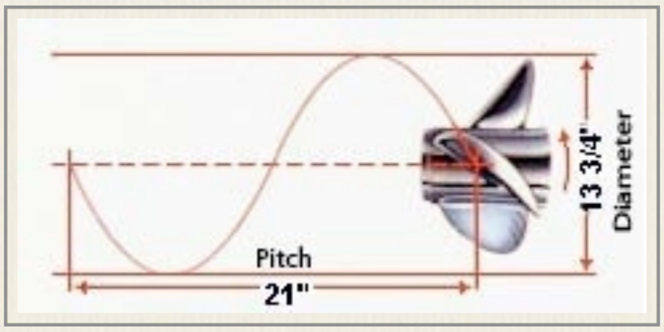
Vessel handling

A ship propeller operates in much the same way as the airplane propeller. In the ship propeller, however, each blade is very broad (from leading to trailing edge) and very thin. The blades are usually built of copper alloys to resist corrosion. Although efficiencies as high as 77 per cent have been achieved with experimental propellers, most ship propellers operate at efficiencies of about 56 per cent.



A ship's propeller

Pitch:
Pitch angle is what allows the propeller to produce thrust. This is the angle formed between the blade and a plane perpendicular to the shaft axis. Pitch is the distance that the screw would advance along the shaft axis in one revolution. A pitch of 17 inches, for example, would theoretically move the vessel 17 inches along its course for each revolution of the propeller.

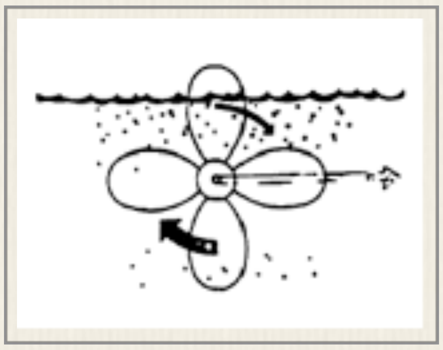


Propeller Pitch

Slip:
The theoretical speed predicted by the pitch is never actually achieved by the propeller alone, and the difference between the speed predicted by the propeller pitch and the actual ship's speed is know as apparent slip.

Cavitation:
Cavitation is the effect caused when air is drawn down into the water by a propeller, resulting in loss of power, overspending of the engine and propeller, and pitting of the metal surfaces of the propeller. To stop cavitation, reduce engine RPM's.

Unequal Blade Thrust:
When a vessel is not deeply loaded or has little or no way on, the upper arc of the propeller is working in a medium of lesser density. This is due either to the blades breaking the surface or drawing air from the surface. Since this means the lower arc of the propeller is working in a denser fluid, there is more thrust produced. In a right handed propeller this effect tends to move the stern to starboard. Which is known as transverse force or prop-walk.



Force Factors

A spinning propeller sets up a lower pressure in front of the propeller and higher behind the propeller, thus producing lift and thrust. This thrust is what pushes a vessel ahead. Propeller thrust not only effects the vessels fore and aft movement but also can walk a ship side to side as well.

On some large vessels, and many tugboats, shrouds or nozzles have been placed around propellers to provide greater efficiency. Kort nozzles or ducted propellers can be significantly more efficient than un-ducted propellers at low speeds, producing greater thrust in a smaller package. It may produce as much as 50% greater thrust per unit power than a propeller without a duct.

Rudder Force:
A rudder is simply a foil placed behind the propeller to create transverse lift. Just like any other foil shape, (think airplane wing), the lift, or force, is only generated when there is movement around the foil. Thus a rudder has little effect at slow speeds. When a vessel is dead in the water or nearly so, giving short bursts of power with the rudder hard over is an easy way to turn a vessel around.

Turning the rudder at an angle to the direction of the ship's way creates a force on the rudder; this in turn makes the stern move. Going ahead with headway and right rudder forces the stern to go left. Going astern with sternway and rudder right, forces the stern to go right.

The rudder is placed directly astern of the propeller so it is acted upon by the jet of water discharged from the screw. Since the rudder is located aft, it is the stern that moves. The bow only follows.

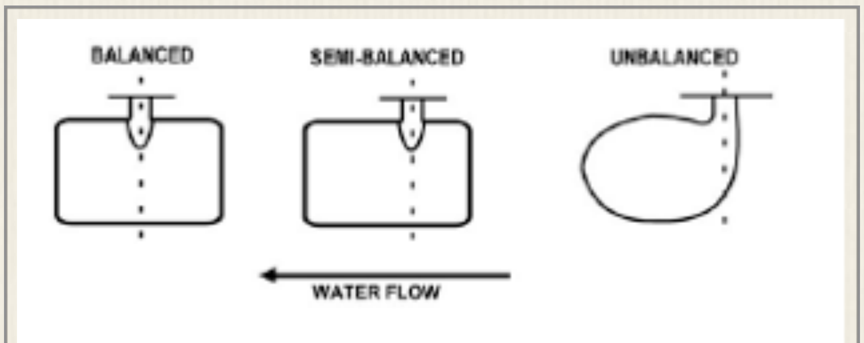


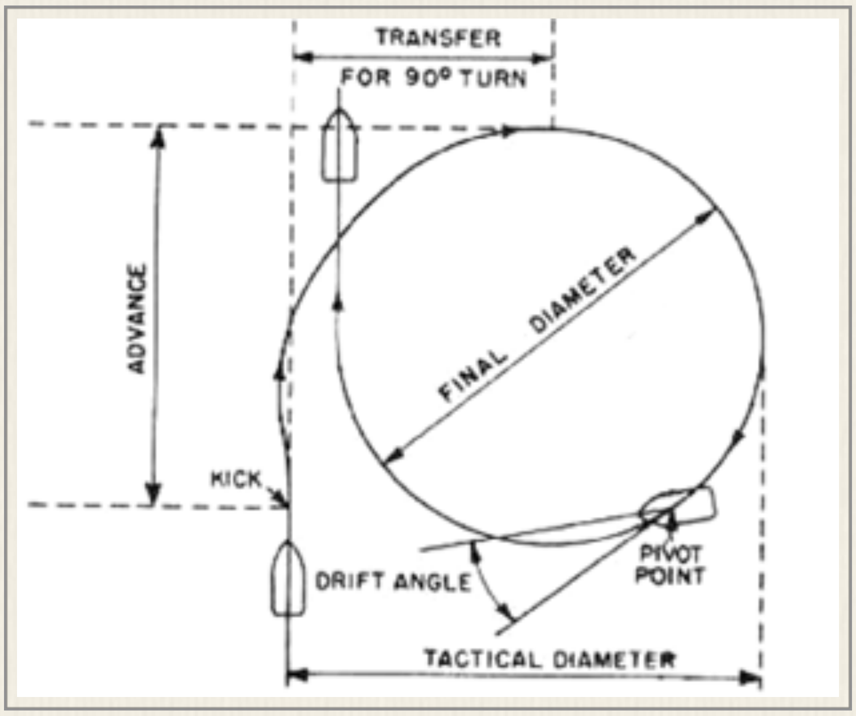
Figure 8-6
Rudder Types

Screw Current:
Screw current is developed by the ship's propeller when turning ahead or astern. A discharge screw current is created when a vessel is going ahead; the propeller ejects the water in a spiral column. Suction screw current is created when going astern, the propeller sucks water into the blades. As a general rule of thumb the discharge current is stronger than the suction current. This is an important fact to remember especially when docking or undocking. The mariner must realize that a heavier bell is needed astern, compared to an ahead bell, to create a proportional effect to the vessel.

Turning Circle

The term "handling characteristics" refers to the way a vessel responds to engine and rudder orders. Coast Guard regulations require that US merchant ships post data on handling characteristics where they can easily be seen by bridge watch standers. On smaller craft the data may not be formalized, but they do exist even if only in the mind of the captain. A mariner must know his ship's handling characteristics - how she will respond to a given order under existing conditions, and what order must be given to achieve a desired result.

The standard method of finding a ship's turning characteristics is to turn her in a number of complete circles under varying conditions and to record the results for each. The variables used are: right and left rudder of specified angles, speeds of different value, and differences in draft and trim. Most course changes are not as much as 360°, but by studying the complete turning circle, the ship's behavior for turns of any extent can be determined.



The Turning Circle

A vessels turning circle is the path followed by the pivot point of a ship making a turn of 360° or more at a constant rudder angle and speed. For the ordinary ship, the bow will be inside, and the stern outside, this circle. A vessel's turning circle varies with rudder angle and ship's speed. A high speed will obviously increase the turning circle, but a very low speed (approaching bare steerageway) will also increase the turning circle due to reduced effectiveness of the rudder.

Advance:

Advance is the distance gained in the direction of the original course. The advance is measured from the point where the turn has commenced and will be maximum when the ship has turned through 90°.

Transfer:

Transfer is the distance gained at right angles to the original course when the ship has turned through 90°. Transfer is also measured from the point at which the turn has started.

Tactical Diameter:

Tactical diameter is the distance gained to the right or left of the original course when a turn of 180° has been completed.

Final Diameter:

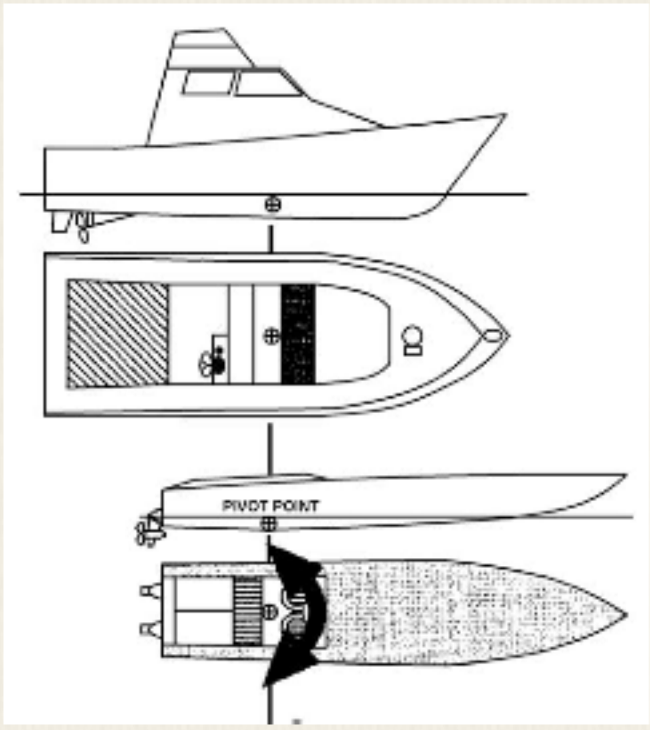
Final diameter is the distance perpendicular to the original course between tangents drawn at the points where 180° and 360° of the turn have been completed. If the ship continues turning indefinitely with the same speed and rudder angle, she will keep on turning in a circle of this diameter, which will always be less than the tactical diameter.

Standard Rudder:

Standard rudder is the amount of rudder angle necessary to cause the ship to turn in the standard tactical diameter at standard speed.

Kick:
Kick is the distance the ship moves sidewise from the original course away from the direction of the turn after the rudder is first put over. The term is also applied to the swirl of water toward the inside of the turn when the rudder is put over to begin the turn.

Pivot Point:
The pivot point, (PP) is the spot, (a vertical axis) about which the ship rotates during a turn. In general, with the ship going ahead, it is about one-third of the way aft from the bow. It can shift, however, in accordance with the various forces that affect a ship. Some of the forces that affect the position of the pivot point are the ship's speed, anchors, mooring lines, and tugs.



Pivot point

Propeller Direction/Twin Screws
While single-screw vessels are more affected by propeller direction, twin screw ship need not worry as much. The normal design for ships is for the starboard (right-hand) propeller to turn clockwise and the port (left-hand) propeller to turn counter-clockwise when viewed from astern looking forward. This means that at the top of the turning circle the blades are moving away from each other (outwards).

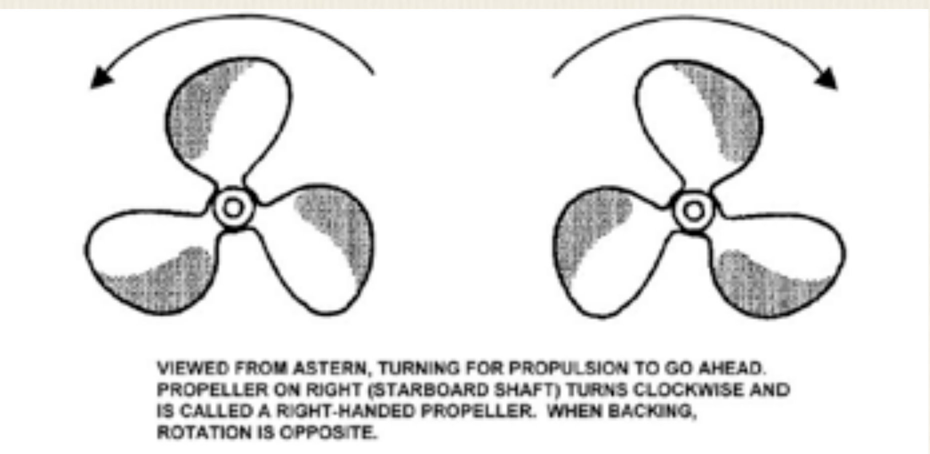


Figure 10-4
Twin Propulsion

Having them turn in the opposite directions outboard, which although can give better slow speed maneuvering, is generally less efficient. The presence of 2 propellers working in unison can significantly improve slow speed maneuverability. By putting one prop in reverse and the other forward, very large turning moments can be created with hardly any forward motion. Opposing propellers give greater control and cancel “side force” increasing maneuverability.

Single Screw Vessel Handling
Ship handling is both art and science. It involves combinations of variables so numerous and complex that no amount of detailed predetermined instruction can bring a ship through a canal or dock it. Each time a ship moves, the precise influences acting on her are different from the way they were at any other time; and the ship responds to every one of these influences.

Characteristics or factors, such as the power, propeller, rudder, and design of a ship affect handling in various ways. For illustrating the effects of these factors, it will be assumed that the sea is calm, there is neither wind nor current, and the ship has a right-handed propeller.

A vessel will respond to the direction of rotation of the propeller first, and then after there is way on, to the position of the rudder. With no way on, the rudder will have no effect.

When backing, the sidewise pressure is opposite to that exerted when the ship is moving forward. The discharge current from the propeller reacts against the hull. This current is rotary; therefore, when the propeller is backing, the current strikes the hull high on the starboard side and low on the port side. This current exerts a greater force on the starboard side and tends to throw the stern of the vessel to port.

With rudder amidships, the vessel will back to port from the force of the sidewise pressure and the discharge current. When the rudder is put over to starboard, the action of the suction current against the face of the rudder will tend to throw the stern to starboard. Unless the ship is making sternway, this force will not be strong enough to overcome the effect of the sidewise pressure and the discharge current, and the stern will back to port

Casting:
The expression to *cast* means to turn a ship to a particular heading in her own water. Ships turn in this manner when getting under way together in a crowded anchorage and also when headed in the wrong direction. Single vessels in restricted anchorages often have to turn in their own water because of nearby anchored vessels or a restricted maneuvering space.

Evaluating Conditions:
With docking, and undocking the same evaluation of conditions needs to be undertaken when getting underway. The mariner should get out of the bridge and feel the wind, check its direction by looking up at the stack gases, and look over the side to check the current. No matter how many instruments you might have to supply such information, it's still important that you use your own senses and get a feel for existing conditions before planning this or any other maneuver.

Even the most careful plans may have to be altered after the lines are let go since it is difficult to determine which of several conflicting forces will most affect the ship. Often the ship handler lets go expecting to be set off the pier by wind, only to remain hard alongside due to subsurface current. If this occurs, take time to re-plan the undocking before touching the telegraph. More accidents occur because of inappropriate action than delayed action.

Use of Spring Lines
Mooring lines can be of the greatest assistance in making or clearing a pier. A spring line makes an angle with the dock and leads toward amidships. If it is a bow spring, it will lead aft; if it is an aft spring, it will lead forward. Spring lines are among the most useful for handling vessels alongside docks, whether for mooring, warping, undocking, or springing a ship away from the dock. The bow spring gets the brunt of the work in docking a ship.

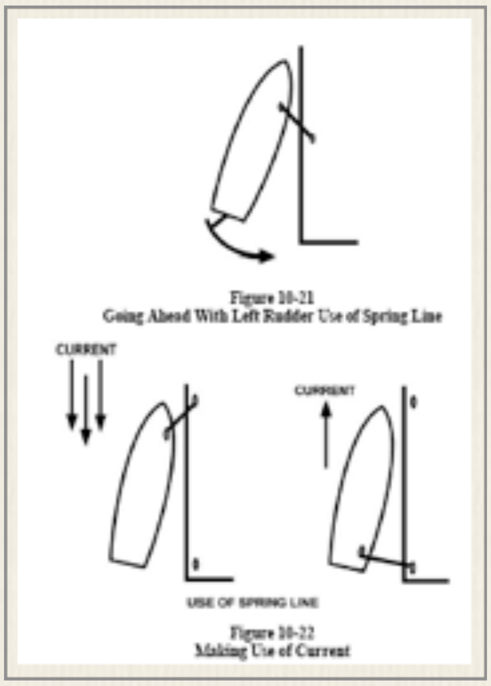
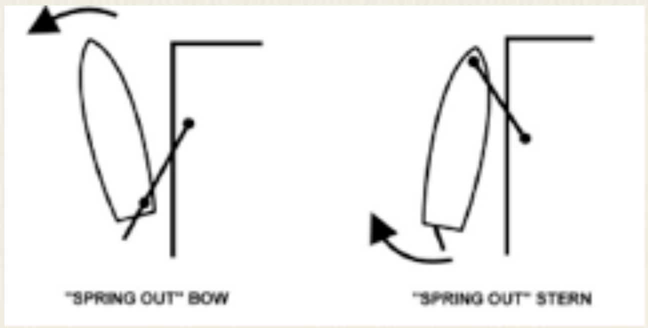


Figure 10-21
Going Ahead With Left Rudder Use of Spring Line

Figure 10-22
Making Use of Current

Spring lines are just as useful in undocking as they are in docking. If used to get away from a pier depending upon currents and wind, an after bow spring held as the last line can be the most helpful. Once all lines are aboard and the aft bow spring is left, slowly come ahead on the engine with rudder hard over in the direction of the pier, (hard right if starboard side to and hard left for port side to). As the spring takes a strain the bow of the vessel will begin to swing into the pier and the stern will swing out away from the pier. Once the stern is clear, the spring line can be slacked off and taken aboard, and the vessel backed out into clear water



Use of spring lines getting away from a dock

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Effects of Wind on Vessel Maneuvering:
As the ship slows, she begins to feel the wind and become more difficult to steer as the rudder becomes less effective. The freeboard or "sail area" that the ship presents will be the principal factor determining how much effect the wind will have on steering, although the ratio of the ship's draft to freeboard will also be important.

Ships of most configurations will normally head up into the wind at increasingly larger angles as the ship loses headway. When finally dead in the water, the ship will usually want to lay beam to the wind, or close to it. With sternway, the ship will want to back into the wind. Be aware, though, that every ship will behave a little differently, depending on the trim, freeboard, and ship structure.

In docking maneuvers wind should be treated as a aid to be used rather than a hindrance. A wind blowing on the berth can ease a vessel alongside if the ship handler stops her a few feet off the berth.

Twin Screw Vessel Maneuvering:
Many vessels have twin propellers, and some even have four. Providing a ship with an even number of opposed propellers eliminates many of the troubles found in single-screw ships. As long as the propellers are driving together, the side forces (depending on the direction of rotation) are cancelled out, whether the screws are turning ahead or astern. On the other hand, if the propellers are opposed, one turning ahead and the other astern, the side forces then augment each other. In addition to the augmented side force with the screws opposed, we obtain a torque or twisting effect on a ship, because the shafts are displaced from the centerline.

Figure 10-4
Twin Propulsion

Effects of Transverse Force:
Transverse force causes the ship's stern to move sideways in the direction of the propeller rotation. A ship's upper blades exert force opposite to that of lower blades but lower blades are moving in water of greater pressure. The greater pressure on lower blades causes them to act as they are walking on bottom and pushing the stern to side. In most twin screw installations, opposing propeller action cancels out transverse force.

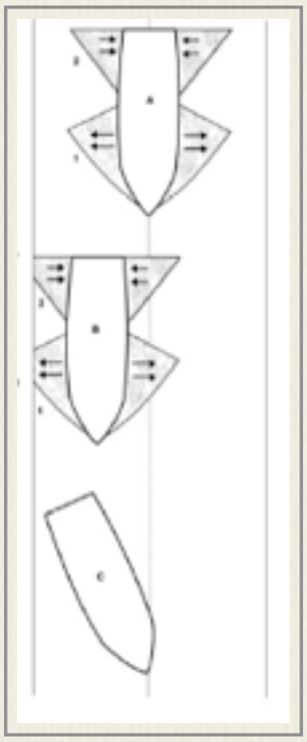
Effects of Losing One Engine:
When a twin-screw vessel loses one engine, torque forces increase and need to be compensated for.

When the twin-screw ship is going ahead on one screw only, there is a tendency to veer to the side opposite from the screw in use. This tendency is, of course, caused by the side force and the offset position of the driving screw. At low speeds, the tendency is quite marked, but at higher speeds this tendency can be overcome by the use of a moderate amount of rudder.

When backing with only one screw, a stronger turning effect is noticed. In this case we have not only the normal side force and torque due to the offsetting of the propeller, but also a strong additional side force caused by the helical discharge current.

Bank Cushion and Stern Suction
In extremely narrow channels, a vessel moving through the water will cause the wedge of water between the bow and the nearer bank to build up higher than on the other side. This bow cushion or bank cushion tends to push the bow away from the edge of the channel.

As the stern moves along, screw suction and water needed to fill-in where the boat was, and creates stern or bank suction. This causes the stern to move towards the bank. The combined effect of momentary bank cushion and bank suction may cause a sudden shear toward the opposite bank. Bank cushion and bank suction are strongest when the bank of a channel is steep. They are weakest when the edge of the channel shoals gradually and extends in a large shallow area.



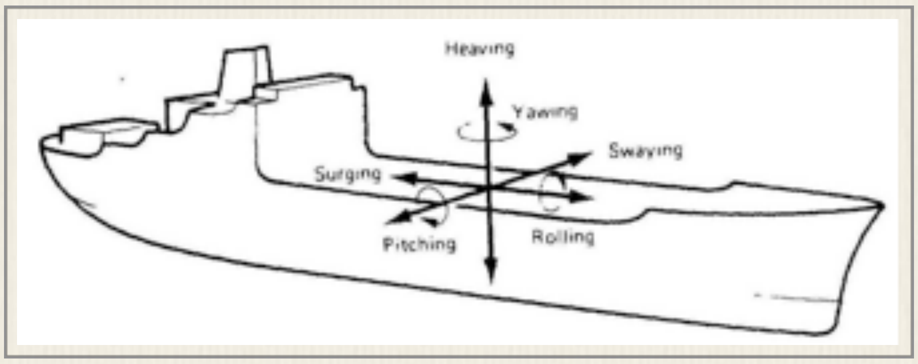
<u>Bank Cushion and Bank Suction</u>

The magnitude of the bank suction effect is influenced by a number of factors:

- The distance of the vessel from the bank
- The magnitude of the forces increases with decreasing depth.
- Shallower bank slopes also help to reduce bank effects.

Bank cushion occurs only when operating in close proximity to the bank. A single-screw boat going at a very slow speed with its starboard side near the right bank may lose control if sheer occurs. To bring the boat under control, increase speed and add a small amount of right rudder

The Natural Movement of a Vessel Upon the High Seas:



A ship at sea or lying in still water is constantly being subjected to a wide variety of stresses and strains, which result from the action of forces from outside and within the ship. The forces may initially be classified as static and dynamic. Static forces are due to the differences in weight and buoyancy which occur at various points along the length of the ship. Dynamic forces result from the ship's motion in the sea and the action of the wind and waves. A ship is free to move with six degrees of freedom – three linear and three rotational.

The three linear axis's are surge (forward/astern), sway (starboard/port), and heave (up/down). And the three rotational movements are roll (rotation about surge or longitudinal axis), pitch (rotation about sway or transverse axis), and yaw (rotation about heave or vertical axis).

All or most of the motions can occur simultaneously and have their effect on the efficient operation of a vessel. While the ship's officer cannot completely control these motions, there is much that can be done to diminish or alleviate their effects.

Pitching:
Pitch: to plunge with alternate fall and rise of bow and stern.

The most severe pitching is experienced when headed directly into the seas. In this case the bow is carried up by the oncoming wave, and then the ship plunges into the trough as the wave passes. The resonant period of the ship in pitch is often matched by the waves, and, from the point of view of possible damage, pitching is equally as important as roll. When a ship buries her bow under tons of water while bucking into a rough sea, there is a tremendous stress on her hull.

While pitching can be very damaging, it can also be controlled. A vessel may simply have to alter course by as little as 10° or slow down. On some vessels adding ballast forward is also a possible remedy.

Rolling:
Roll: rotation of the vessel about a longitudinal axis causing alternate rise and fall of port and starboard sides.

The way a vessel rolls is a direct indication of her stability. A concentration of weight high in the vessel (a top heavy condition) results in a very slow roll. The vessel is said to be in a ***tender*** or ***cranky*** condition and she has a weak tendency to return to her upright condition. In other words, the stability is poor. A concentration of weights down low in the vessel results in a very quick roll. The vessel is said to be ***stiff*** and she has a marked tendency to return to her upright position. It this case, her stability is excessive.

A vessel which rolls too fast creates stress on the upper parts of the vessel and creates an uncomfortable condition. A vessel which rolls too slowly has poor stability and might capsize under certain conditions, such as heavy weather.

A vessel's rolling characteristics rely directly on its transverse stability, and the two factors most associated, the center of gravity and center of buoyancy.

Yawing:
Yaw: rotary oscillation of ship about a vertical axis causing a swing of the ship's head.

Yawing is especially prevalent with a following sea. Unless the ship is advancing exactly at right angles to the waves, the wave profile differs on the two sides of the ship, and in general the longitudinal position of the center of pressure on one side of the ship is not the same as that on the other. This results in a couple producing rotation of the ship about a vertical axis. The direction of this couple changes as the waves move past the ship, so that the rotary motion becomes an oscillation having the same period as the apparent period of the waves. Yawing from this source has its maximum amplitude when the ship's course makes an angle of about 45 or 135 deg to the direction of advance of the waves, for then the difference of the static pressure on the two sides of the ship is greatest.

Broaching:
Broach: to veer or yaw dangerously in a following sea so as to lie broadside to the waves.

Ships are longer than they are wide, which reduces drag and allows the vessel to ride through waves more comfortably and safely. The drawback is that the ship is in danger of capsize when waves are side-on (beam sea or broadside to the waves). Broaching (turning of the ship to broadside) is the biggest risk for a ship in heavy seas, and loss of power (hence loss of control) can be a serious risk. So for a drifting ship, broaching risk must be addressed. Most broaching incidences on sizable ships occur when they have lost power. There is a long history of fishing vessels broaching under power in very rough seas.

Pitch-Pole:
Pitch Pole: when a boat is thrown end-over-end into the rough seas.

A following sea can be dangerous. With insufficient bow buoyancy, a large wave approaching from behind can tend to lift the stern and drive the bow into the water. This can result lose of control and even capsize.

Vessel Squat:
As a ship increases speed, she sinks appreciably with respect to the mean surface of the water, this change in mean draft is know as sinkage. Both her bow and stern ride lower in the water as her velocity is increased. This change may occur equally forward and aft or may be greater at the bow or the stern, the resulting change in trim being called squat.

As a vessel enters shallow water the flow of water becomes increasingly restricted due to the reduced clearance both under and around the hull. The greatest factor in determining squat is a vessel's speed.

Head-Reach:
Head reach is the distance that a ship will travel from the point where action is taken to stop it to the point where it is dead in the water. This distance can be several miles for large vessels of considerable tonnage but modest horse- power. Stopping distance changes geometrically as ship size increases, so it is important that the ship handler think even further ahead when altering speed or maneuvering

MOB Recovery
In maneuvering for a man overboard, if the situation allows, the stern should be swung away from the man in the water and the screw on that side stopped. Normally the bridge is not aware of the man in the water until too late for such action.

At all cost, the person overboard should be kept in sight. Someone on board should be directed to do this and perform no other duty.

Williamson Turn:

Purpose:
The Williamson Turn is a maneuver used to bring a ship or boat under power back to a point it previously passed through, often for the purpose of recovering a man overboard.
The Williamson Turn is most appropriate at night or in reduced visibility, or if the MOB is out of sight, but is still relatively near.

The turn works well and is especially useful as ship size increases. Little astern maneuvering is required to stop the ship and pick up a person or object on the water. Because of this, and because of the predictability of the vessel's path, the Williamson turn is preferable to a round turn or other maneuver for putting a ship on a reciprocal heading.

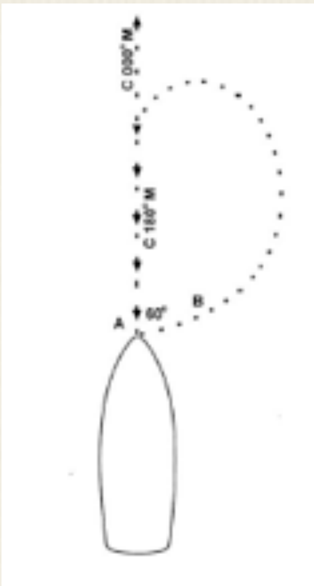
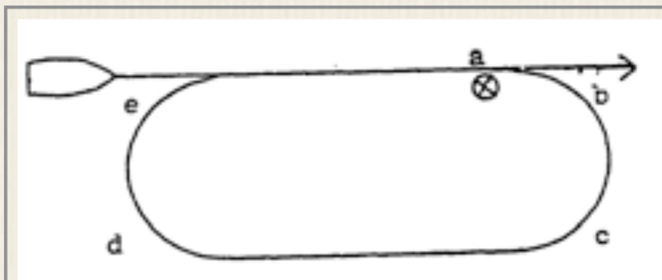


Figure 16-5
Williamson Turn

Describe Steps To Complete:
Put the rudder hard over toward the side on which the person has gone overboard and keep it there until the ship is approximately 60° from the initial heading. The precise point for a particular vessel is to be predetermined by trial. Shift the helm hard over in the opposite direction. Keep the rudder in this position while the ship swings all the way around toward the reciprocal of the ship's heading at the time Williamson turn began. When the ship's heading is approximately 20° short of the reciprocal of her initial course, at a point predetermined by trial, put the rudder amidships so that the vessel will steady up on the desired reciprocal heading. Bring the vessel upwind of the person, stop the vessel in the water with the person alongside, well forward of the propellers

Purpose:
The Race Track or Two Turn maneuver is used in good visibility when a straight final approach leg is desired. A Race Track turn is a variation of the one turn or round turn method, which facilitates a more calculable approach. This maneuver will return the ship to the man even if he is lost from sight. While the Race Track turn is relatively fast, it is also effective when the wind was from abeam on the original course.

Describe The Steps To Complete:
As shown in the diagram above the Race Track turn makes desirable straight final approach to the MOB
A. The rudder is put hard over to side man fell over on.
B. When clear of the man, put engines full ahead, continue using full rudder and steady on reciprocal heading of original course.
C. Steady for a distance which gives you the desired run for final approach.
D. Use hard rudder to put you on original course towards the MOB.
E. Use the engines and rudder to attain final position, with the vessel upwind of the man and dead in the water, with the man alongside well forward of the propellers.



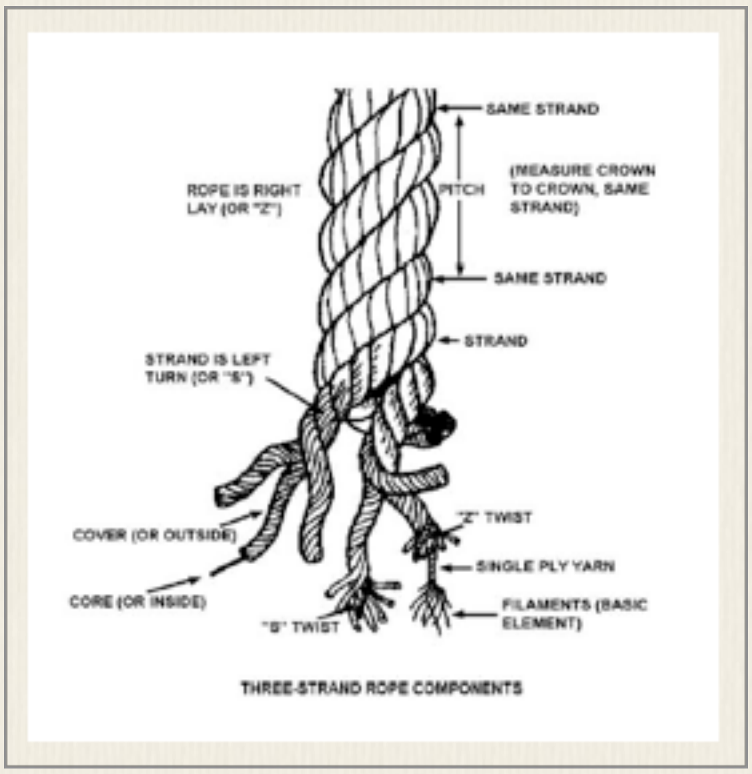
Marlinespike Seamanship

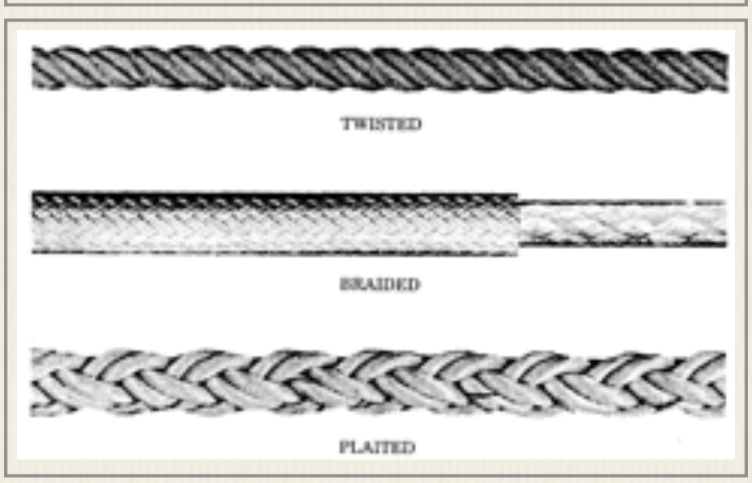
arlinespike Seamanship

Introduction

Marlinespike Seamanship is the art of handling and working with all kinds of rope. It includes knotting, splicing, and fancy decorative work. Every seaman needs to have a well founded understanding of all the fundamentals of rope work, together with the experience that comes with practice. Rope, once put aboard ship is called line.

This chapter contains information about the types, characteristics, use and care of line.





Types of Rope

Rope currently constructed may be three strand, twisted, braided or plaited. In three strand, fibers are twisted into yarns, the yarns are twisted into strands, and the strands are twisted into ropes. The direction the strands are twisted determines the lay of the rope. With the rope held vertically in front of you, if the strands go from the lower left to the upper right it is right lay. Conversely, if they go from the lower right to the upper left, it is left lay.

Braided rope is made in several ways. It has advantages, and disadvantages, depending on its use, and is somewhat more complicated to splice. There are several types of braid, such as hollow braided, solid braided, and double braided.

Hollow braided rope consists of an even number of parallel groups of small yarns braided into a hollow, tube like cord. Double braided rope is, actually two ropes, one inside the other. The core is made of large single yarns in a slack braid. The cover is made of yarns, but in a tight braid that compresses and holds the core.

Plaited rope is made of eight strands, four right twisted and four left twisted. These strands are paired and worked like a four strand braid. Thus, there are two pairs of right laid strands and two pairs of left laid strands formed into a rope that is more of less square.

Rope Construction
Rope can either be constructed of natural or synthetic fibers. Manila, sisal, hemp, cotton, and flax are all natural fibers. This type of rope takes its name from the plant from whose fiber it is made.

Manila comes from the bark of the abaca plant. It is by far the most used natural fiber rope in the marine environment, and although mostly having been replaced by synthetics, it still finds uses onboard today. It has better durability than most other natural fiber rope, which account for its continued popularity. Manila shrinks when it gets wet.

Synthetic fibers currently in use for making rope are nylon, polyester, polypropylene, kevlar and polyethylene. Although synthetics have been around since the 1940's, they gained widespread popularity in the 1960's. A variety of synthetic blends are available today, many of which have very desirable characteristics for specialty work.

Nylon is probably the most popular synthetic. It will stretch about 40 percent of its length and still return to its original length after tension is removed. It is susceptible to ultraviolet light damage.

Polyester resists deterioration from the sun and unlike nylon it attracts moisture. It is expensive, although about 20 percent stronger than nylon and has very little stretch.

Polypropylene is light and wiry. In addition it tends to be slippery, does not hold knots well, although it floats. It is stronger than manila, and has a low resistance to abrasion.

Measurement
Larger sizes of natural and synthetic fiber lines are measured by their circumference. Rope with a circumference of less than 1 3/4" is known as small stuff.

Line Characteristics
Each type of line available for use onboard ship has advantages and

Line Characteristics Chart

Characteristics	Manila	Nylon	Polyester	Polypropylene
Shock Loading Absorption Ability	Poor	Excellent	Very Good	Very Good
Able to Float	No	No	No	Yes
Resistance to Rot & Mildew	Poor	Excellent	Excellent	Excellent
Resistance to UV light	Good	Good	Excellent	Fair
Abrasion Resistance (External)	Good	Very Good	Very Good	Fair
Abrasion Resistance (Internal)	Good	Very Good	Excellent	Good
Melting Temp.	-------------	490-500° F	490-500°	330°

disadvantages. No single type of line is appropriated for all jobs.
Determination of the appropriate line should be based on both the line's construction and its material.

Strength
Line strength is obviously of critical importance to the mariner. Consulting the manufactures specifications is the best way to find out the strength capabilities of the line in question.

The mariner must remember that line that is not new, stored properly or otherwise abused is less strong than it was when it was first manufactured. Consequently, the table above will be of only marginal use.

The Safe Working Load or SWL of a line is 20% of its breaking strength. To ensure longest working life, a line must be used within its safe working load.

Abrasion resistance, stretch, and resistance to sunlight are all characteristics that vary with the type of line and the material used in construction.

Knots and splices reduce the strength of line. Knots take away more strength than splices, so whenever possible lines should be joined together by splicing. See the following chart.

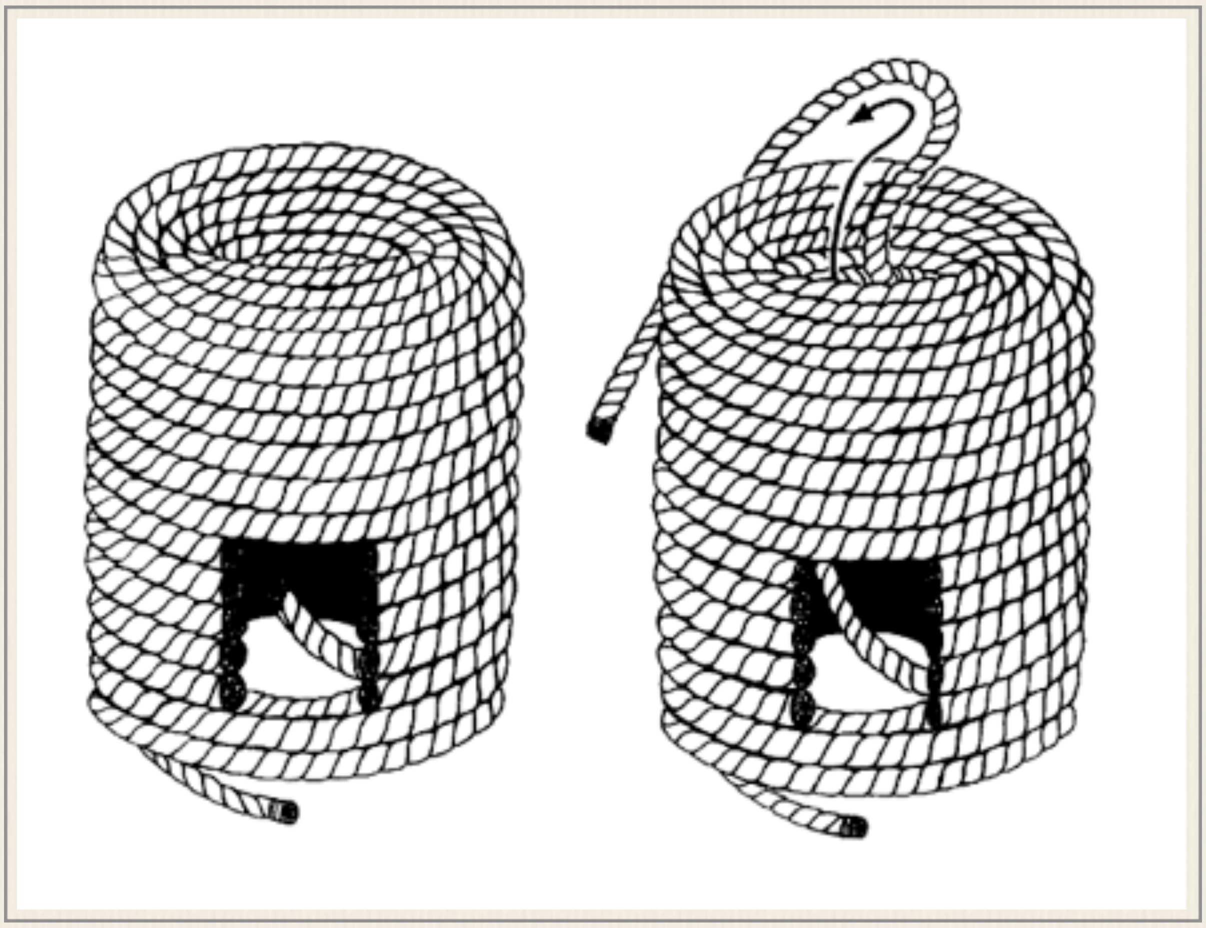
Breaking Strength
Knots are used for pulling, holding, lifting, and lowering. When using line for these purposes it is often necessary to join two or more lines together. Knots and bends are used for temporary joining, and splices provide a permanent joining. In either case, the BS of the joined line is normally less than the BS of the separate lines.

The weakest point in a line is the knot, or splice. It can reduce the BS of a line as much as 50-60 percent. A splice, however, is stronger than a knot.

Calculating SWL of Lines
Breaking strength is the tension measured in pounds, a line can absorb before it breaks. To be on the safe side you do not want to stress a line anywhere near its breaking point. The safe working load (SWL) of the line is considerably less than its breaking strength, or about 20%

As a line wears, stretches or is spliced, its breaking strength decreases. Quite naturally, this also causes a decrease in the safe working load of the line. by making a quick inspection of a piece of line and determining whether it is in good, average or poor condition you can calculate an estimate of the safe working load of a line

Rope Care and Handling
The proper way to open a new coil of natural fiber rope is to loosen the burlap cover, lay the coil on the flat side with the inside near the deck and then reach down through the eye and draw the tagged end up and out of the coil. Uncoiling from the outside will result in kinks.



Synthetics will probably come aboard on a reel. The reel should be mounted so that it runs freely, and then the rope should be unreeled.

Natural fiber is subject to deterioration from heat, sunlight and mildew rot. They may also be damaged by acids and chemicals, and should never be stowed wet.

While some ropes are more resistant to ultraviolet light than others, no rope should be stored in direct sunlight.

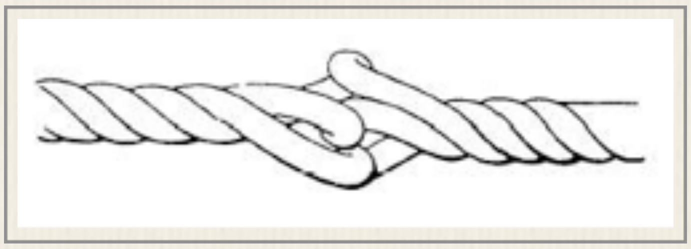
Polypropylene and polyethylene may be severely weakened by prolonged exposure to ultraviolet rays. Ultraviolet degradation is indicated by discoloration and the presence of splinters or slivers on the surface of the rope.

Natural fiber and synthetic ropes should be kept clear of rusting iron. A loss of 40 % of the breaking strength of a nylon rope can result after just a few weeks of exposure.

How a rope is treated will prolong or shorten the useful life of the rope. End for ending rope will distribute the wear more evenly and prolong the useful working life of most rope. Protecting against chafe using proper chafing gear should be normal practice for the mariner.

Even proper care will not make a rope last forever. Once natural fiber rope nears 5 years in age, it is probably not safe for heavy use. Rope and lines need regular inspection to ensure safety.

Kinks, Distortion & Twists
A line with a kink in it, should never be heaved hard while that condition exists. A strong strain on a kinked or twisted line will put a permanent distortion in the line. The illustration below show what frequently happens when a line with a kink in it is heaved on. The kink that could have been worked out is now permanent, and the line is ruined.



Whenever possible a right laid line should be put on a winch drum or capstan right handed, or with clockwise turns. Heaving on a right laid line with left hand turns will eventually kink the line.

Marlinespike Tools
A variety of tools may be used when working with rope, much depending on what is to be accomplished. The primary tool however is the “fid”. This may be a tapered wooden tool, or be fashioned from metal, and is used to split the strands of the rope.

Use of a fid to split the strands of a line to be spliced.

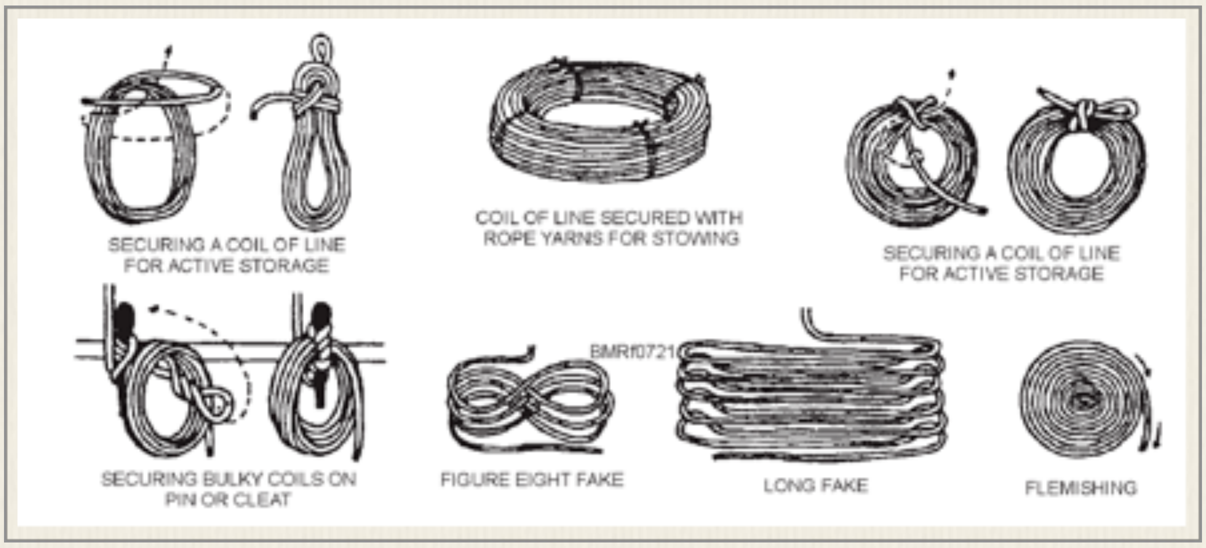
Faking, Flemishing, or Coiling
When line is to be laid out on deck, there are different methods the mariner can use to accomplish this.

Faking, or faking down, is to lay a line on deck in a series of figure-eighties, so that the line will run free without tangling.

Flaking, often confused with “faking” consists of laying out on deck in parallel rows.

Flemish is to make a flemish coil. The end of the line is laid in a tight spiral flat on the deck, with the free end in the center.

Coiling is when the line is laid in small bights, one on top of the other.



Line Safety
When handling lines, a deckhand must be aware of their surroundings at all times. A parting line will snap back at the speed of sound, and will be impossible to avoid. Try to position yourself 90 degrees from the direction of the tension force.

Many synthetic fiber ropes will stretch. Nylon can stretch up to 40% of its original length when wet without parting. It is also more slippery to hold. When attempting to ease a nylon line under tension, it has bee know to bind on the bitts. Heat buildup from the friction of lines moving through cleats or bitts, can reach a point where a synthetic line will melt. This reduces the strength of the line, increasing the chance it will part.

Make sure hand and fingers are kept clear. Never step in the bight of a line. When walking on deck, carry a line outboard. And when attempting to hold a line on a bitt or cleat, take enough turns.

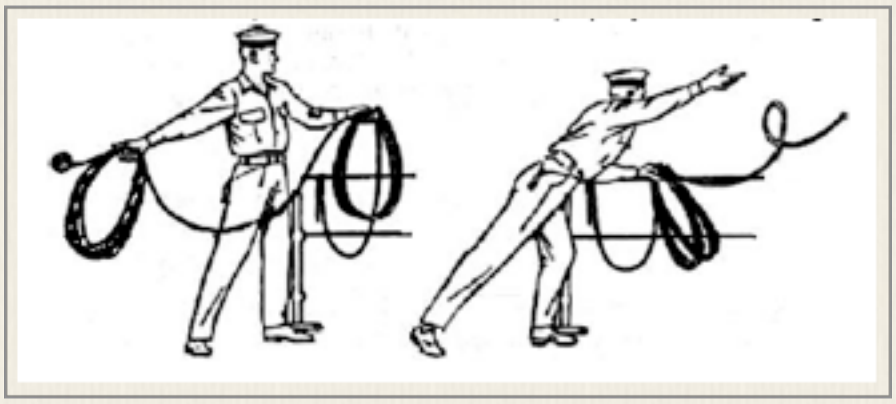
Knots, Bends and Hitches
The safety of a vessel and its crew frequently depends on the knots and splices used in joining lines together. All seamen must master the methods of quickly and properly tying those knots and making those splices that are most commonly used.

Different parts of the rope, are referred to using the following terms.

The end is known as the bitter end.
The bight is a loop or half loop formed by turning the rope back on itself.
The standing part is the long unused portion of the rope.

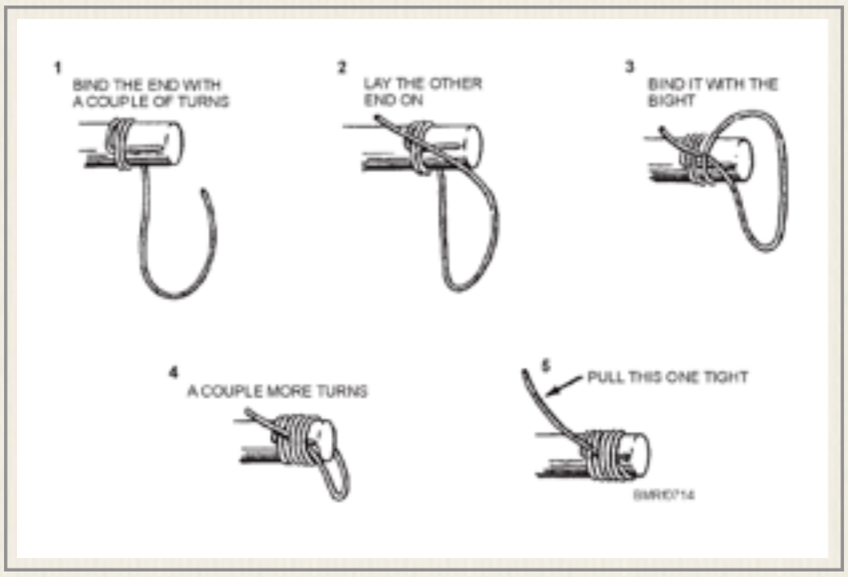
Heaving Lines
You may be required to pass a line from your boat to a pier or another boat over a long distance. A traditional heaving line is a long light line with a weighted piece of rope work at the end, known as a monkey fist. The line is thrown across, and the other crew or dock worker hauls in the heaving line and the heavier line tied to it

<u>Tossing the heaving line</u>
Secure the bitter end of the heaving line to the line you wish to transfer to the dock. Coil the line clockwise, making sure the monkey fist hangs lower than the bights of line.



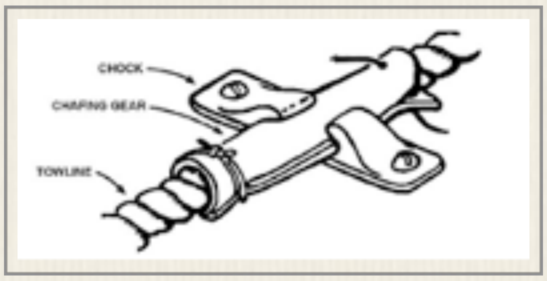
Split the coil in two. Toss the coil with a sweeping motion. Aim upwind of your target and let the line pay off the other coil as it feeds out.

Whipping
Whipping prevents the end of a line from unraveling. The following diagram is one of the ways a bitter end is whipped.



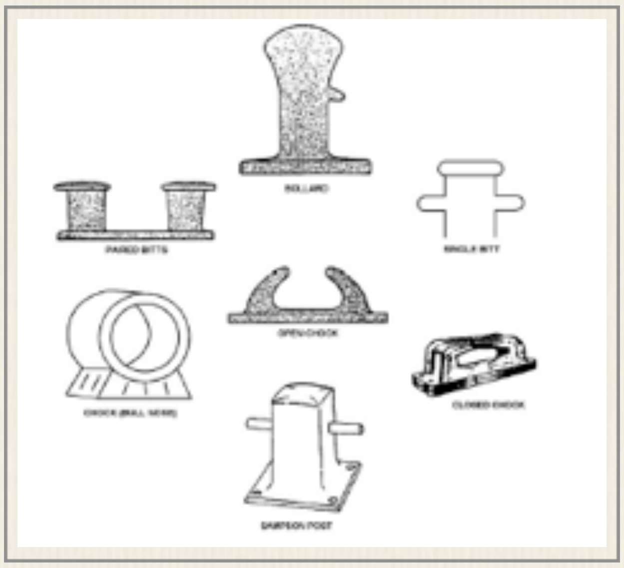
Worming, Parceling, & Serving
You must protect a line that will be exposed to the weather over long periods or is subjected to exceptionally hard wear by worming, parceling, and serving. Worming follows the lay of the line between strands using "small stuff." This helps prevent moisture from penetrating to the interior of the line and, at the same time, fills out the roundness of the line and gives it a smooth surface for the parceling and serving. Parceling consists of wrapping the line spirally with long narrow strips of canvas, again following the lay of the line. Each turn of the parceling overlaps the preceding turn, as shown in the diagram. Serving consists of wrapping small stuff tightly over the parceling, with each turn being hove as taut as possible so that the whole job forms a stiff protected covering for the line.

Chafing Gear
Chafing gear is made of old hoses, leather, or heavy canvas. It is used to protect line where it runs over chocks, or other surfaces that may damage the line due to the movement of the vessel.

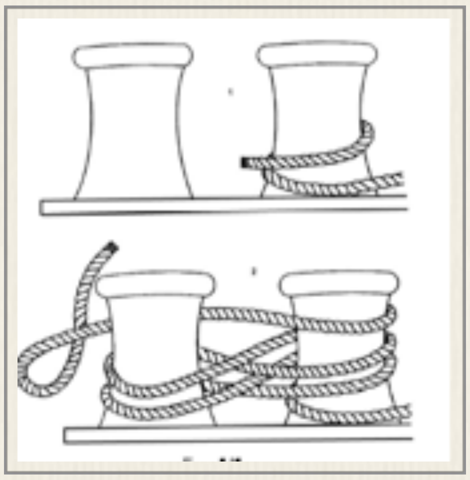


End for Ending
Inevitably one end of a line sees more use than the other. This is especially true of lines that are on drums where only a portion may be reeled out and used. Rather than replace the whole line when one end begins to show wear the ends of the line can be switched or end for ended to spread the wear and use along the entire line.

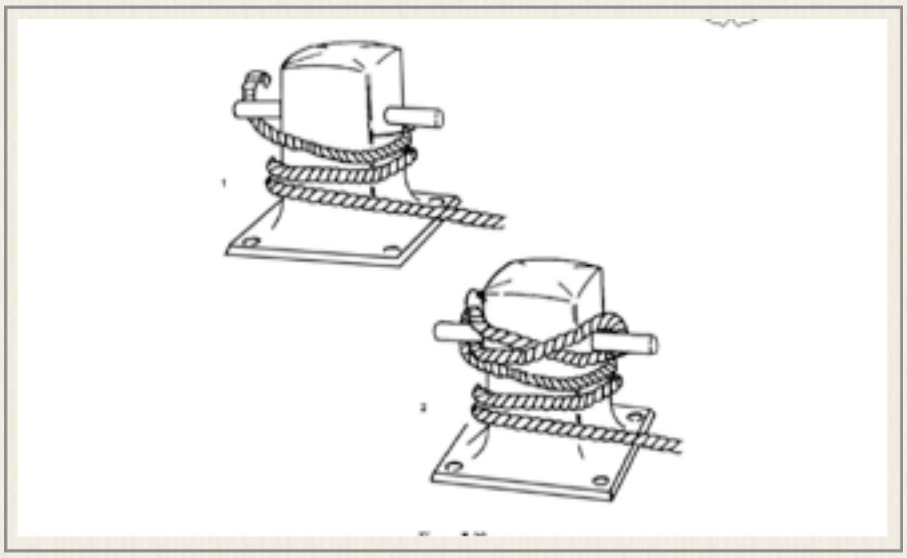
Deck Fittings
Deck fittings are attachment or securing points for lines. They permit easy handling and reduce wear and friction on lines. There are several types of deck fittings, but most often the seaman will find some type of bitt, cleat, or chock onboard the vessel they are working. Below are some commonly used deck fitting that may be encountered.



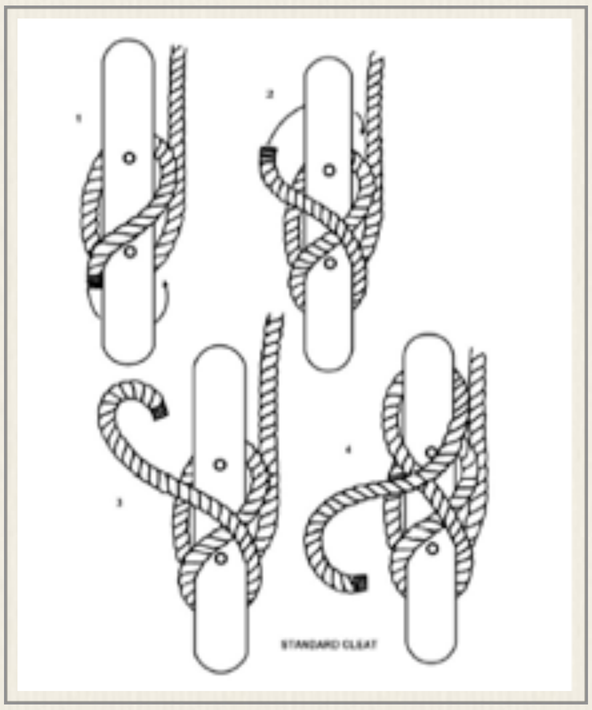
Ways of Securing a Line to a Deck Fitting



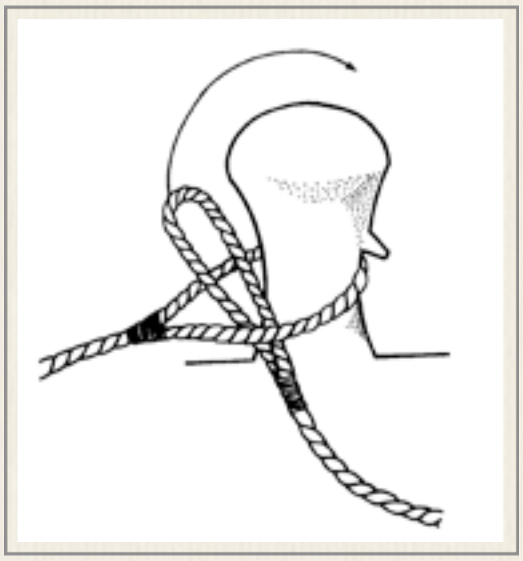
Securing a line to a double bitt



Securing a line to a Sampson post



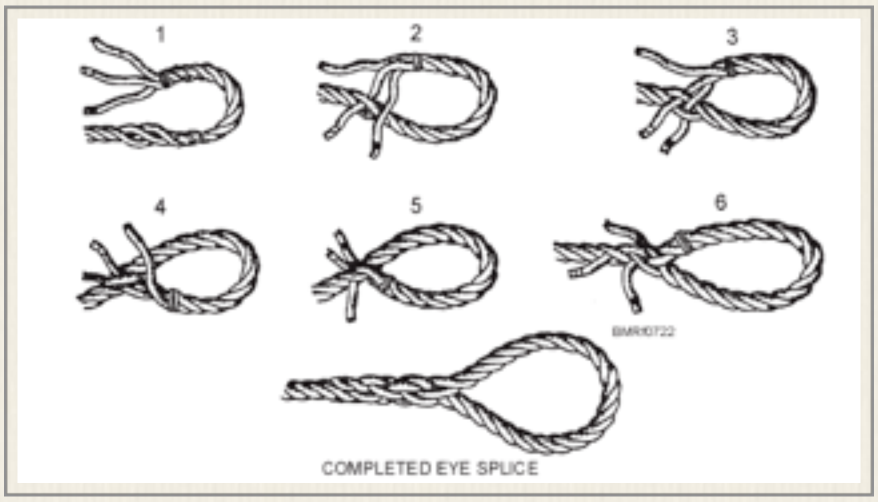
Securing a line to a cleat



Dipping the Eye

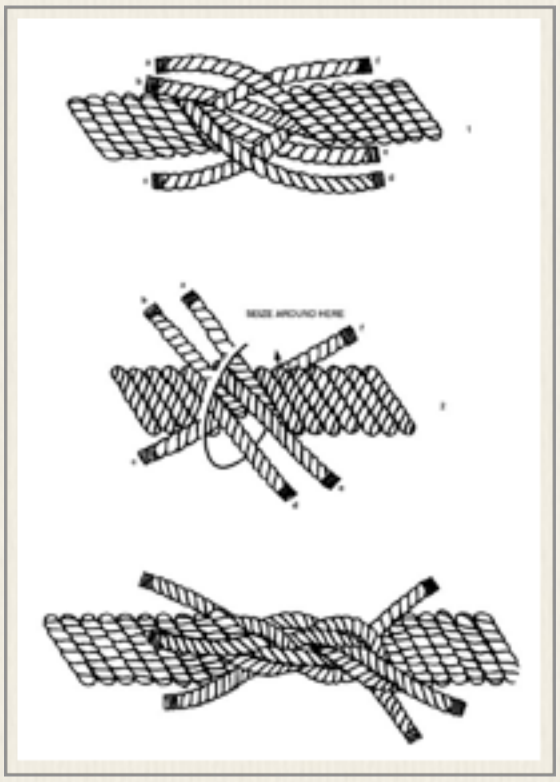
Splices

Eyesplice. An eyesplice is a loop or eye made at line's end by splicing the unlaid strands into the standing part of the line. An eyesplice, when made over a thimble, only slightly reduces the strength of the line. It is more efficient than a bowline, as well as being lighter and easier to handle.



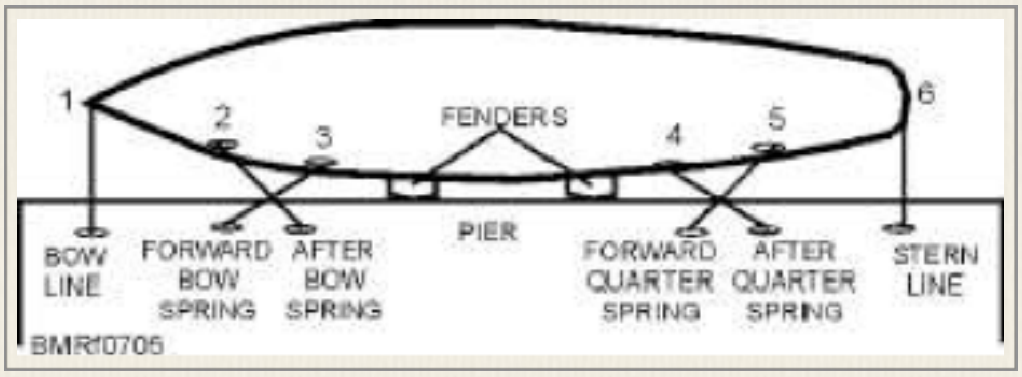
Short Splice. In this strong but bulky splice, unlay the strands of two lines for about the same distance. Then marry the two lines and tuck the strands "over one and under one" until three or four tucks are completed. Synthetics usually require an extra tuck. A short splice usually joins two lines of the same diameter and generally allows a line to retain up to 85% of its efficiency.

Long Splice. This splice takes its name from the relatively lengthy space it occupies. The diameter of the united line is not much greater than the diameter of the larger of the two lines that are joined. This fact allows the completed splice to pass through a block and to give a neat appearance. The long splice maintains an efficiency of approximately 65%-85%.

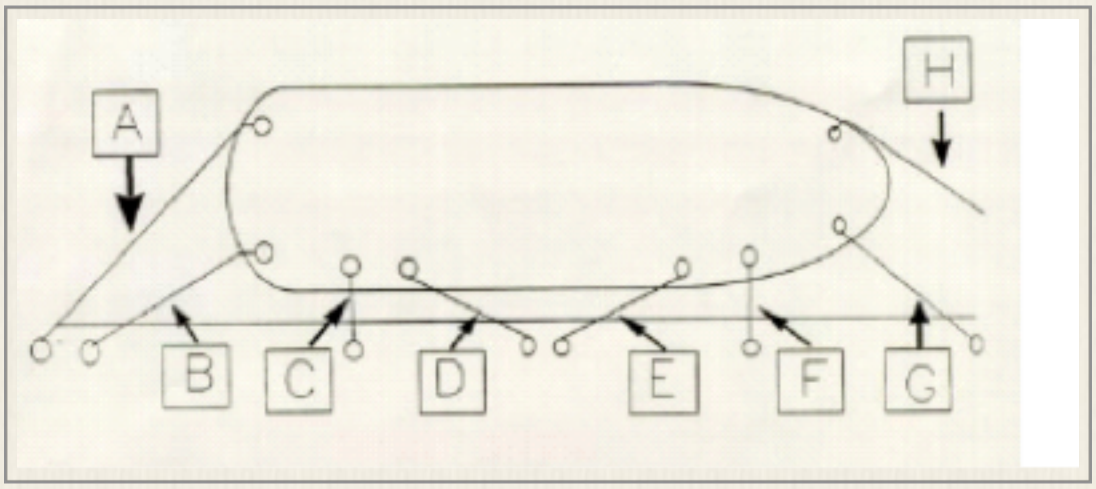


Docking Lines

The following diagram illustrates the docking lines typically used to secure a vessel to the dock.



A. Outboard or offshore stern
B. Inboard stern
C. Breast line
D. Forward quarter spring
E. After bow spring
F. Breast line
G. Inboard bow
H. Outboard or offshore bow



Another method of securing a vessel to a dock

Line Commands

Every seaman needs to have a working understanding of line commands while working on board. The following orders would be typical of those that might be herd when leaving or arriving at the dock.

<u>Orders to Line Handlers</u>

1. Stand by Your Lines: Man the lines and stand ready to cast off.

2. Pass One: Pass line one to the pier, pass the eye over the appropriate bollard, but take no strain.

3. Take a Strain on One: Put tension on line one.

4. Slack One: Take all tension off line one and let it hang slack, but not in the water.

5. Ease One: Let line one out until the strain is lessened, but it is not slack.

6. Take Two on the Capstan: Lead the end of number two to the capstan, take the strain out, but take NO strain.

7. Heave Around on Two: Apply tension to number two by heaving around with the capstan.

8. Avast Heaving: Stop heaving on the line.

9. Hold What You've Got: Hold the line as it is. If the line is on a bollard or bitts, two or three turns are taken.

10. Hold Five: Do not allow more line to go out on #5, even though the risk of parting the line may exist.

11. Check Five: Put a heavy tension on line five, but not to the breaking point, tending the line so it will not part.

12. Surge Five: Hold moderate tension on line five, but allow it to slip enough to permit the movement of the ship. (used when moving alongside the pier to adjust position.)

13. Double Up: Pass an additional bight on all mooring lines, or line indicated, so that there are two parts of each line to the pier.

14. Single Up: Take in all bights and extra lines so there is only a single part of each of the normal mooring lines on the pier.

15. Take in All Lines: Have the ends cast off from the pier, and taken aboard.

16.Take in One: Retrieve line one and bring it on board. It is proceeded by commands "Slack One" and "Cast Off One."

17. Cast Off All Lines: When secured with your own lines, it is a command to those tending lines ashore or another ship to disengage or throw off the lines from bitts or bollards. When secured with another vessel's lines in a nest, it means to cast off her lines to let her go and allow her to retrieve her lines.

Purchases

In seamanship, a "purchase" refers to any power or advantage gained by using a mechanical appliance to raise or move a heavy object.

Blocks: A block consists of one or more pulleys or "sheaves" fitted in a wood or metal frame. A block is designated by the number of sheaves it contains, such as single, double, or triple.

Single whip: A single whip consists of one single-sheave block fixed to a support with a rope passing over the sheave

Runner: This too consists of a single block, but the block is free to move, and one end of the rope is secured to the support with the weight attached to the block.

Gun Tackle: This tackle is made up of two single blocks, as shown and takes its name from the use made of it in hauling muzzle loading guns back into battery after the guns are fired and reloaded.

Luff Tackle (Jigger): A double and a single block make up this tackle

Twofold Purchase: This is made up of two double blocks.

Double Luff Tackle: A double luff tackle consists of a treble and double block.

Three-fold purchase: A three-fold purchase and the right angle method of revving the line through blocks is illustrated below.

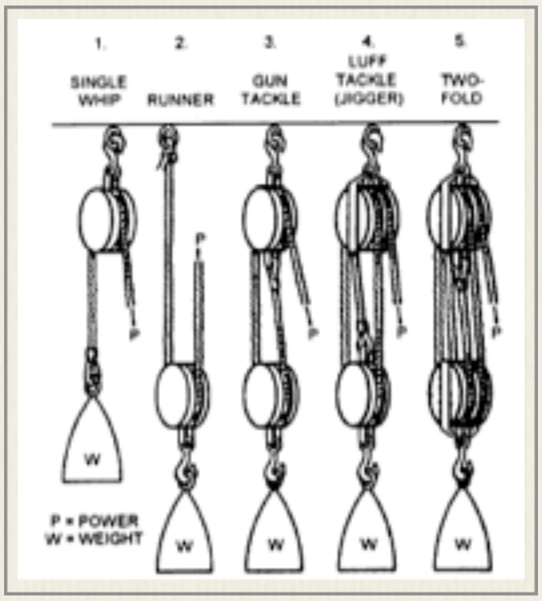
Mechanical Advantage
The mechanical advantage of a tackle is the term applied to the relationship between the load you are lifting and the power require to lift it. In other words, if a load of 10 lbs. requires 10 lbs. of power to lift it, the mechanical advantage is 1. If a load of 50 lbs. requires only 10 lbs. to lift it, then there is a mechanical advantage of 5 to 1. (five units of weight lifted for each unit of power applied)

You can estimate the mechanical advantage of a simple tackle by counting the number of parts of the falls at the movable block. For example, a gun tackle has a mechanical advantage of 2 because there are two parts of the falls at the movable block.

To find out how much power you must exert to lift a given load using a tackle, determine the weight of the load you are lifting and divide it by the mechanical advantage. For example, if you must lift a 600 lb. load by a single luff tackle, first determine the mechanical advantage gained by using this type of tackle. By counting the parts of the falls at the movable block, you have a mechanical advantage of 3. Therefore, by dividing the weight you are lifting (600lbs.) by the mechanical advantage in this type of tackle, (3), you find that you must exert 200lbs. of power to lift a weight of 600 lbs.

Friction: A certain amount of the power applied to a tackle is lost through friction. You must add this loss in efficiency in the block and tackle to the weight you are lifting to determine the power you need to lift any given load. Roughly 10% of the load must be added to the load for every sheave in the tackle. You must add this loss in efficiency of the block and tackle to the weight you are lifting to determine how much power you need to lift any given load.
For example: When lifting a load of 500 lbs. with a two-fold purchase, you must first identify that there are a total of four sheaves in both blocks. Then calculate that 10% of 500 lbs. is 50 lbs. loss at each sheave for a total of 200 lbs., which must be added to the load. consequently, the total load is no longer 500 lbs., but rather, 700 lbs. The 700 lbs. load divided by the mechanical advantage of 4 requires you to exert a force of 175 lbs. to move this load.

Maintenance Fiber-rope blocks should be disassembled periodically, inspected and lubricated.



CHAPTER 12

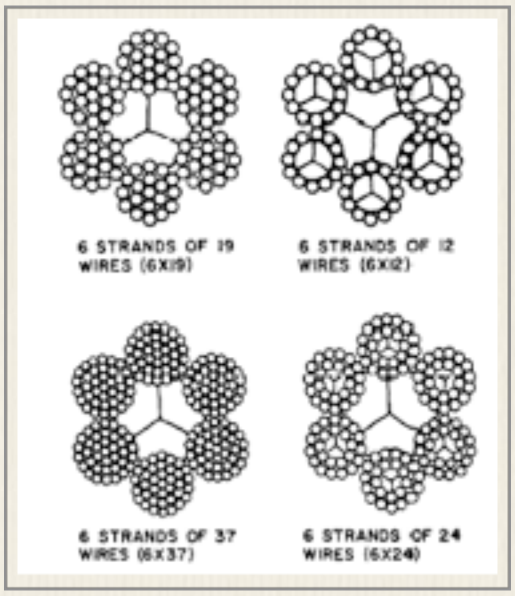
Wire Rope

Introduction

Wire rope may be used for cargo handling, towing, fishing and other specialized uses aboard smaller vessels as well as for anchoring. The use of wire rope is more prevalent on large merchant ships and at shore side loading facilities than it is on vessels under 1600 GT.

Although it possesses great strength, wire rope does not have the stretch or give of manila or the elasticity of nylon. Sudden repeated stresses may cause it to suddenly fail.

Wire rope is constructed of a number of small wires that extend continuously throughout its entire length; these wires are twisted into strands, and the strands themselves are laid up to form the rope. In general, wire rope used on merchant vessel consists of six strands; however, you may find special types of wire rope, consisting of seven, eight, or more strands in unusual places, for example elevator ropes.



Grades of Wire Rope

Wire rope is offered in the following grades to meet the demand for strength, toughness, its ability to withstand abrasion and to resist bending fatigue in varying degrees.

improved plow steel wire rope is the strongest, toughest and most wear-resistant of all standard grades

mild plow steel is used in installations where strength and resistance to abrasion are not so important

galvanized ropes have individual wires protected by a uniform coating of pure zinc. They are used where the ropes are exposed to weather, moisture or other corroding agencies

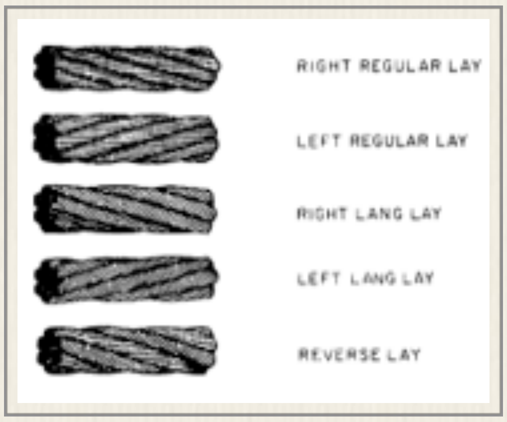
corrosion-resisting steel ropes are constructed of wires made up of alloy steel containing chromium and nickel

Construction

For most efficient and economical service, each wire rope is designed for specific operating conditions. The more strands a wire rope has the greater its flexibility. Strands with a small number of large wires are more resistant to abrasion. Special flexible strands have from twenty-seven wires up to forty-six, but thirty seven wires is the most common construction.

Pre-formed wire rope is made by a process that preshapes wires and strands into the exact helical positions they will assume in the finished rope. The process removes the excessive tension and torsion that are normally present in high carbon steel wire.

The advantages of preformed wire rope are as follows:
longer useful life under severe fatiguing service
easier to install, will not kink
easier to coil, and splice



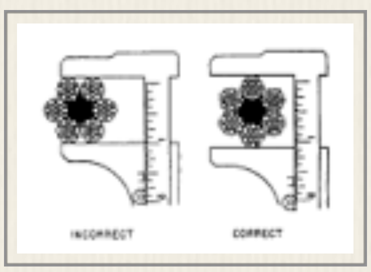
As shown above, wire rope is laid up in various ways:

Right Regular Lay: Wires in the strands are twisted to the left; strands in the rope are twisted to the right

Left Regular Lay: Wires in the strands are twisted to the right; strands are twisted to the left.

Right Lang Lay: Both wires in the strands and strands in the rope are twisted to the right

Left Lang Lay: Both wires in the strands and strands in the rope are twisted to the lef



Measuring Wire Rope
Wire rope is measured by its widest diameter, that is by the diameter of the circle that will just enclose all of the strands.

Care of Wire Rope
If possible a break in period before wire rope allows the rope an opportunity to adjust itself to the conditions under which the rope is to operate.

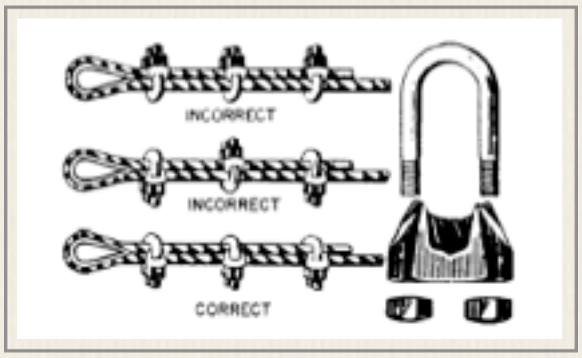
While wire rope is lubricated during manufacturing, it is not sufficient to last for the entire useful life of the rope. Periodic application of a good grade of grease should be made to prolong the life of the rope. In addition to the lubricating qualities, an application of grease also helps minimize corrosion.

Wire Rope Sockets
End attachments on wire rope vary in strength from 80%-100% of the strength of the rope. Sockets correctly attached with pure molten zinc are the only type of terminal connection that will consistently enable you to maintain the full strength of a rope. This type of attachment is usually done ashore by a rigging loft.

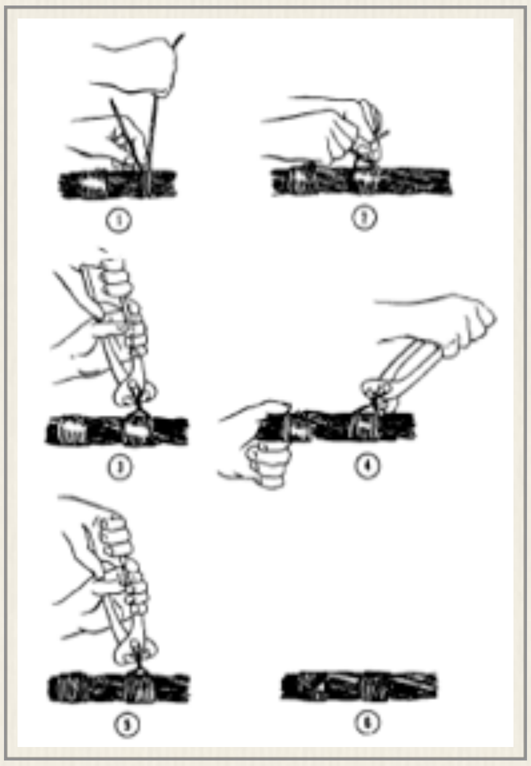
Wire Rope Clips
Wire rope clip efficiency depends upon the manner in which the clips are put on the rope, the degree of tightening of the nuts on the clips, and the number of clips use.

Clips require little skill to install, and are easily inspected. The distance between clips should be not less than six times the diameter of the wire rope. The saddle or base should be in contact with the standing part or load holding end of the rope and the u-bolt in contact with the bitter end.

The number of clips you must use increases with the size of the wire. Wire rope clips are sometimes used to make a temporary eye in a wire rope.



Seizing Wire Rope
When a wire rope is to be cut, it should be thoroughly seized so that there may be no misplacement of relative movement of the strands. It should be done with small galvanized wire seizing strand or low carbon annealed steel wire.



Inspection
Under normal conditions of use you should inspect wire rope every three months during the first half of its life and monthly thereafter. You should examine a rope used for heavy work or subject to abuse or ill treatment more frequently.

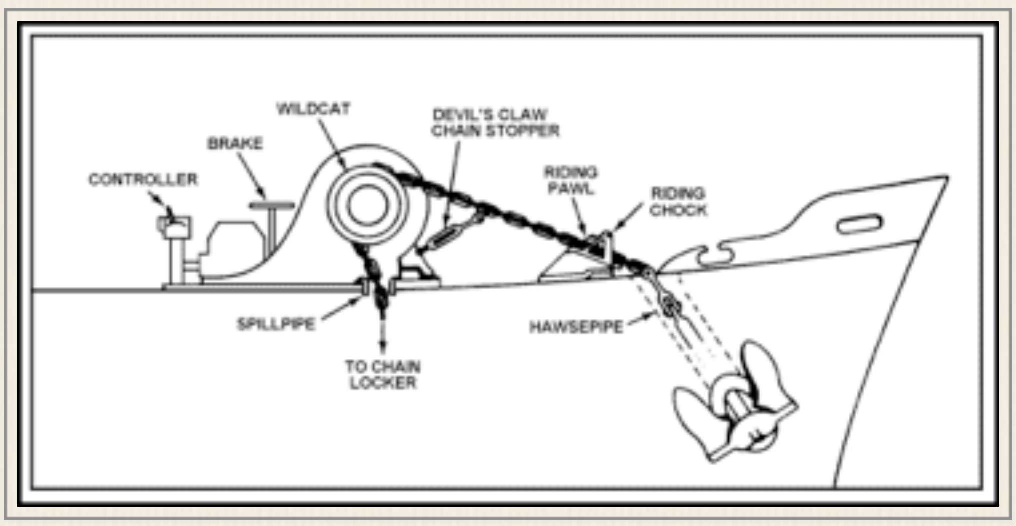
When inspecting a wire rope look for these signs:
distortion of the strands as a result of kinking, crushing or bad nips
flattening of some of the outer wires by abrasion
broken wires as a result of fatigue and wear
corrosion

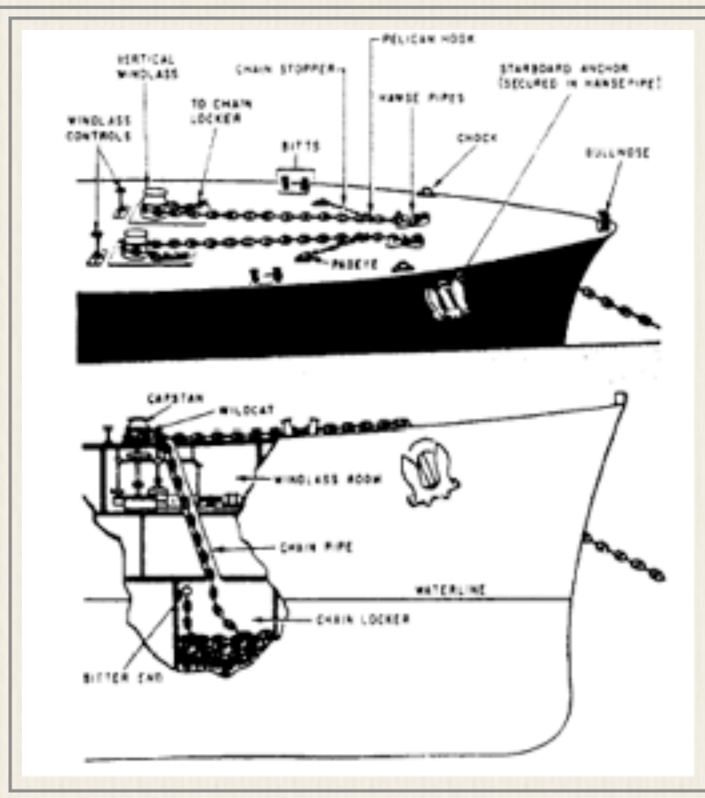
CHAPTER 13

Anchoring

Introduction

Ground tackle is the term that includes all the equipment used in anchoring and mooring with anchors. This includes anchors, anchor chain, wire rope, synthetic rope or combination of these materials when used with anchors. Additional equipment includes such items as connecting shackles detachable links, mooring swivels, & chain stoppers.

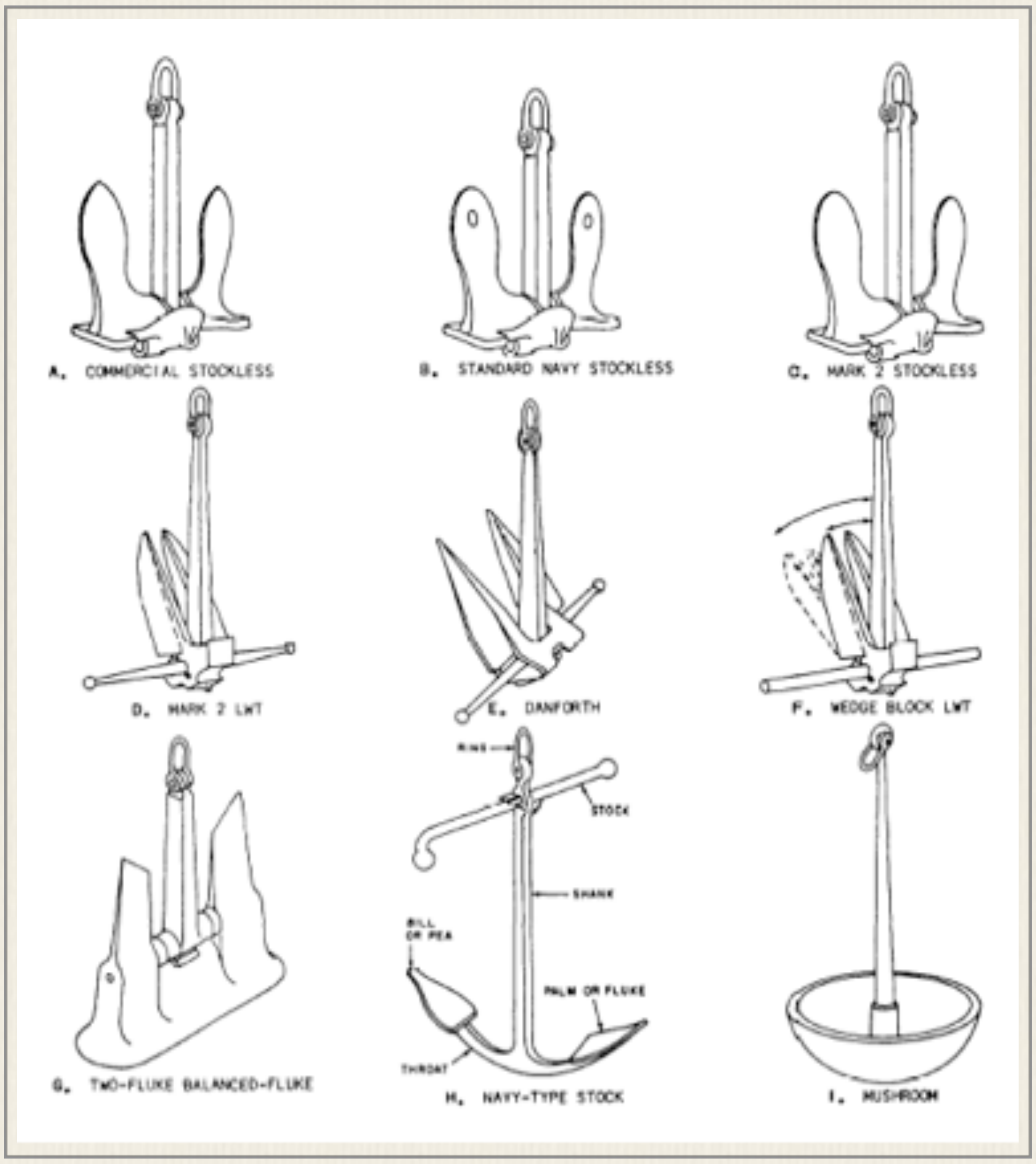




Two different anchor arrangements

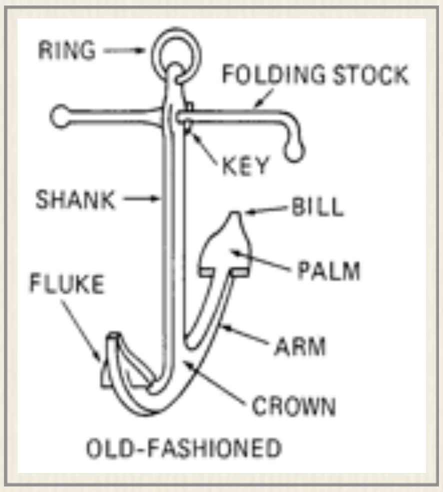
Anchors

There are a variety of types of anchors used on boats and ships, depending on the size of the vessel, and conditions under which it will be used.

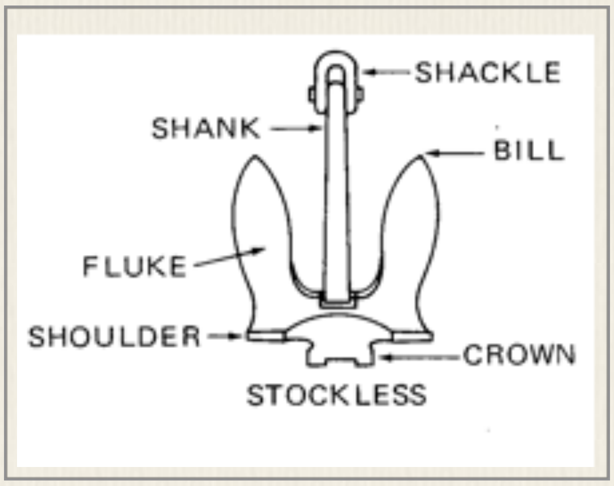


Differing Styles of Anchors

The old fashioned Navy anchor has very good holding properties and cannot tip over because of its stocks. Its design makes it difficult to stow and it is no longer in common use having been largely replaced by the stockless.

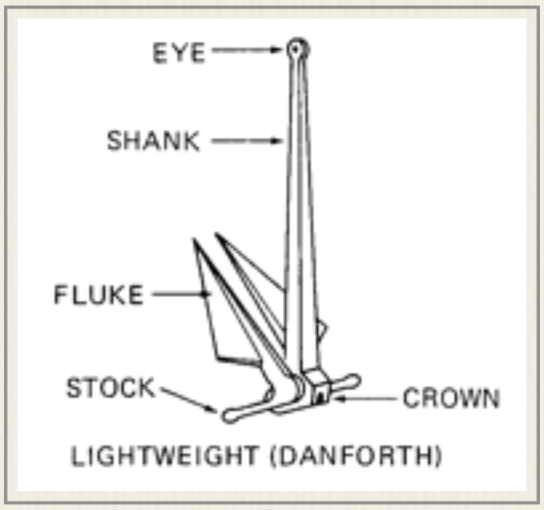


The standard Commercial Stockless anchor and its parts are illustrated below.



Stockless anchors are easy to stow and for this reason were adopted despite the fact that they do not have the holding power of other anchors. It is the most common anchor found on large commercial vessels.

Smaller vessels very often will use a Danforth type anchor. It has greater holding power than anchors of similar weight.



An anchor’s weight is calculated as 1 to 1.5 pounds per long ton of the vessel’s maximum salt water displacement.

A grapnel anchor isn’t designed to anchor to the ocean bottom, rather to grab onto structure of some sort, wreckage, rocks, etc.

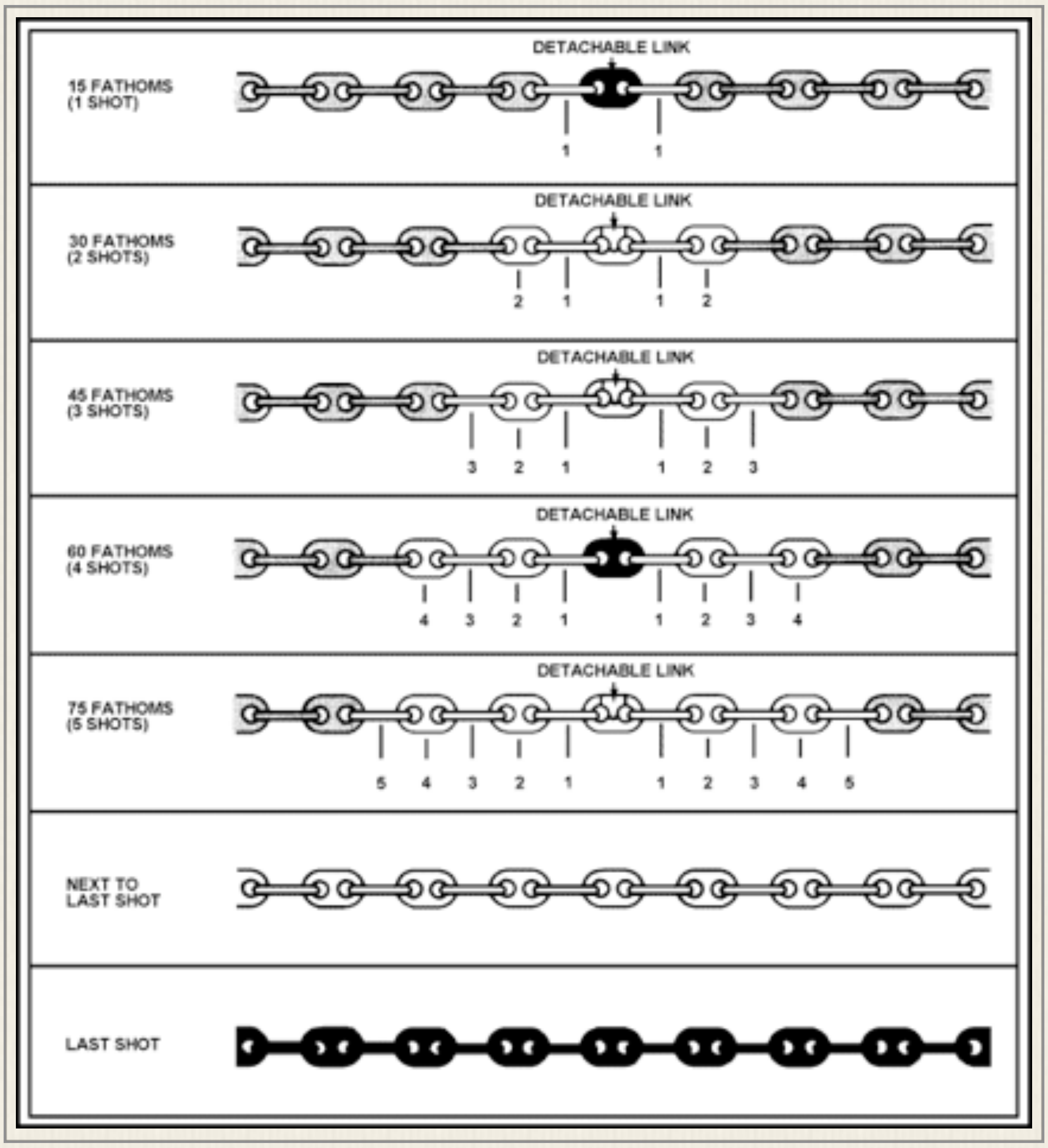
Bower anchor-carried on the bow. Each vessel has two (2). Often a vessel will carry a spare.

Stream anchor-carried on the stern. Its purpose is to maintain a vessels orientation within a narrow channel. It is usually a stockless anchor although somewhat smaller than a bower anchor.

The fluke of the anchor is the part that actually digs into the bottom. It is the ability of the anchor to bury itself that provides holding power. Rode is all of the anchor gear between a boat and her anchor.

Anchor Chain Markings

Anchor chain comes from the foundry in 90 foot segments called "shots". These shots must be connected together by the crew using detachable links. After the chain is connected to the anchor, the end of the first shot or 90 foot length of chain is marked as follows.



>#1 shot-one link on each side of the detachable link is painted white, the detachable link is painted red.
>#2 shot-paint two links on each side of the detachable link white and the detachable link painted red.

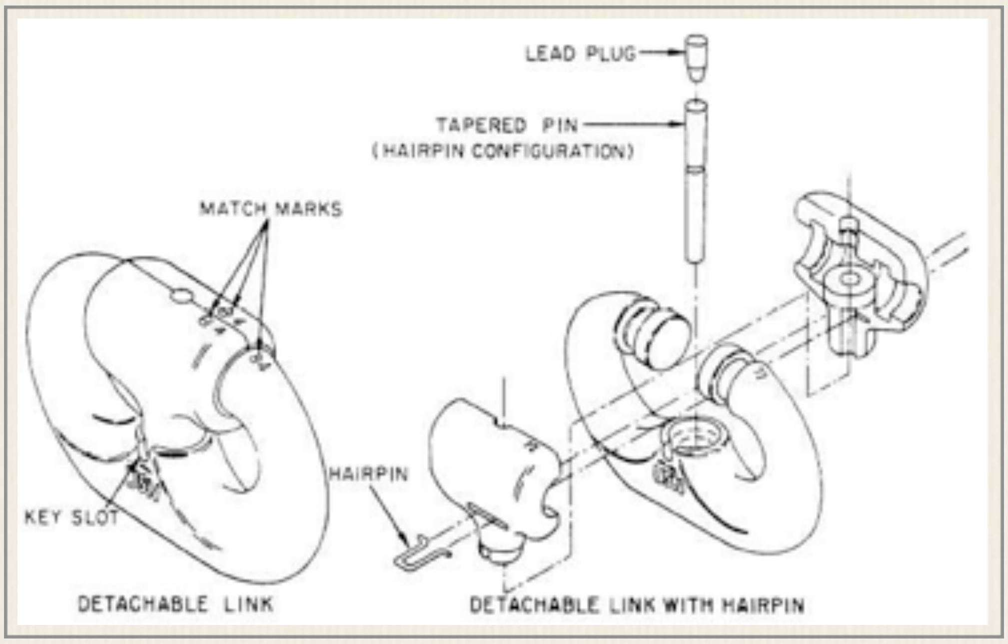
>#3 shot-paint three links on each side of the detachable link white and paint the detachable link red.

>#4 shot-paint four links on each side of the detachable link white, and paint the detachable link red.

The last two shots of chain are painted in their entirety. The second to last shot is painted yellow, and the last shot is painted red.

Detachable Links

Shots of anchor chain are joined by the detachable link. A standard detachable link is illustrated in the following diagram.

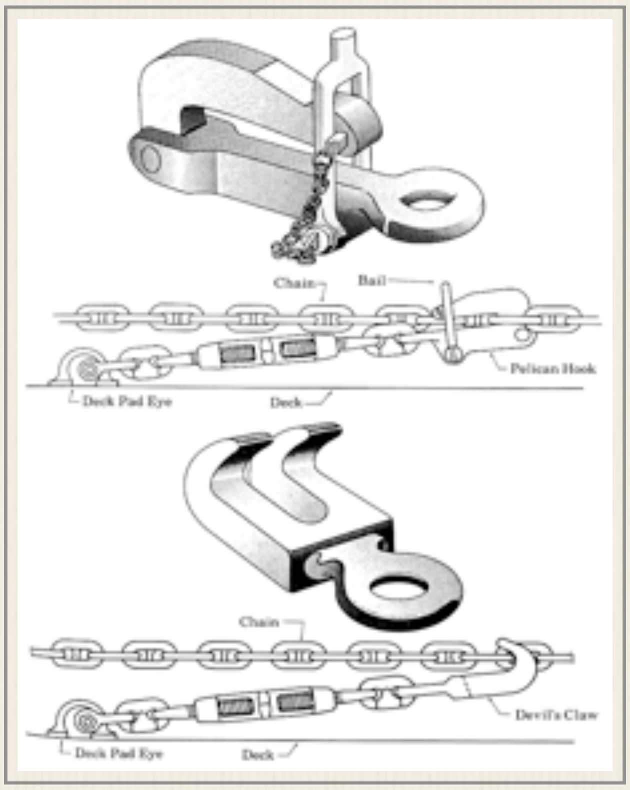


Outboard Swivel Shots

Standard outboard swivel shots also termed “bending shots” consist of detachable links, regular chain links, a swivel, an end link and a bending shackle. They are fitted on most vessels to attach the anchor chain to the anchor.

Devils Claws and Chain Stoppers

A turnbuckle attached to a deck pad eye and use of a devils claw or pelican hook at the other end secures the anchor to the vessel when it is in the stowed position. See the following illustration.



Scope of Chain
Under normal conditions, a ship usually anchors to a scope of chain between 5 and 7 times as long as the water is deep. If a ship at anchor is subjected to heavy weather, a strain much stronger an normal is placed on the chain. More and more of its length lifts off the bottom as the strain increases. If the scope is not too long, the chain lifts all the way to the shank, and the anchor breaks out and drags before the chain parts. With too long a scope, however, the breaking strain of the chain is reached and the chain parts before its entire length lifts off the bottom.

Anchor Windlass
A modern windlass is a type of winch that is specially designed to raise and lower anchors. The principal components of a work boat windlass are as follows:

>motor-a waterproof, three-phase alternating current electric motor of between 7 and 50 horsepower installed in an exposed pr partially exposed location. Hydraulic motors are also used for this purpose.

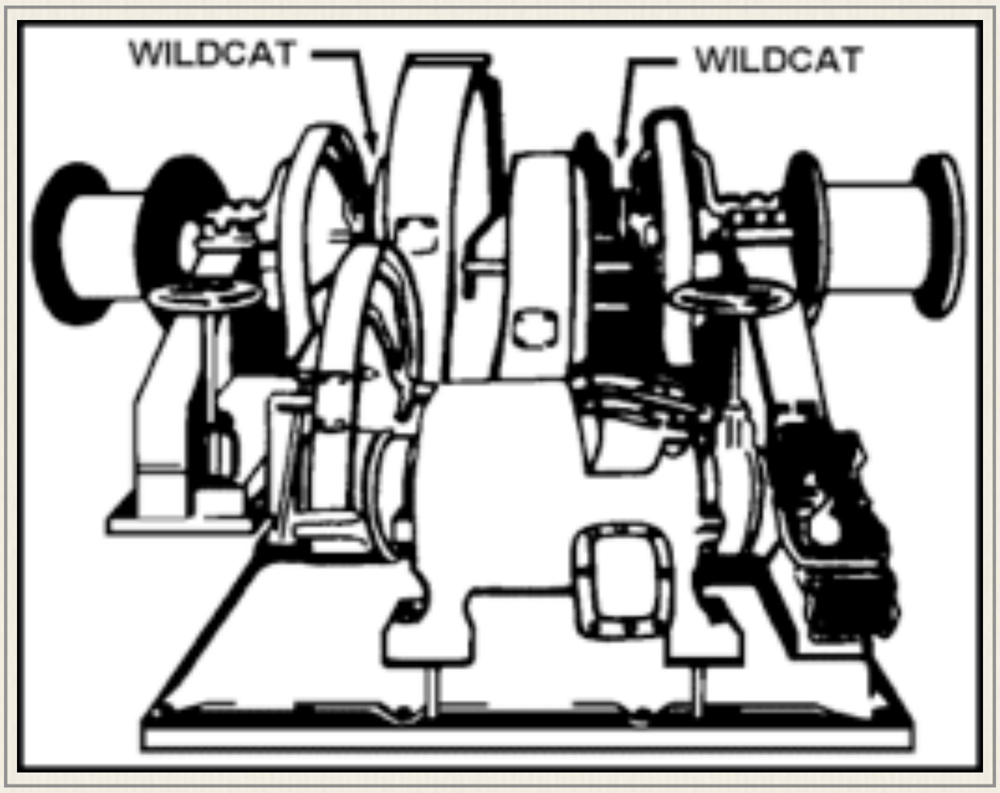
>wildcat-a specially constructed grooved wheel with recesses called whelps, which are used to grip the anchor chain.

>controls-to start, stop, and reverse the electric motor.

>mechanically operated controls, usually wheels and levers to connect or disconnect the wildcats from the main drive shaft

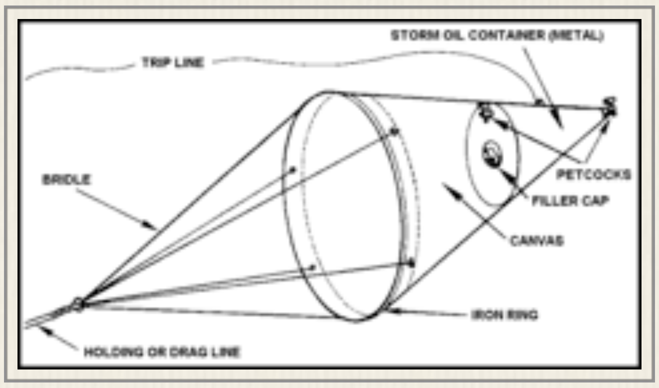
>a friction type brake usually consisting of an adjustable lined brake band that grips a brake drum

The opening in the deck underneath the windless leading to the chain locker is known as the spill pipe.



Sea Anchors
Rigging a sea anchor is usually a step taken under emergency conditions to slow you vessel's drift and to keep her bow into the seas. A sea anchor is usually used at sea or, at least in open, exposed bodies of water and its purpose is different from that accomplished by a vessel's regular anchors.

The purpose of a sea anchor is to create drag through the water and hold either the bow or stern into the sea so that the vessel can ride comfortably in heavy weather. A traditional sea anchor used on small boats and yachts is a conical shaped canvas bag that is dropped over either the bow or stern depending upon the nature of the situation and is secured with heavy line. Storm oil to calm the seas and prevent seas from breaking may be used in conjunction with the sea anchor.



The parts of a sea anchor.

A sea anchor can be used for emergency steering. It will help if you are broken down and rolling in heavy seas and it will reduce the possibility of capsizing.

The best way to haul in a sea anchor is with a tripline.

Care of Anchors and Ground Tackle
Anchors chain and appendages are to be kept in good condition by the ship's force. The chain is overhauled whenever necessary and precautions taken to see that the various shots are properly marked and in good order. As the chain comes in, when getting underway, each link is examined for cracks, and other defects. Two competent observers should examine the chain.

Anchoring and Mooring
Letting go a single anchor is perhaps the simplest way of securing a ship to the bottom, and if the holding ground is good, the ship should ride easily in bad weather, provided ample scope of chain is used. The disadvantages are that in a strong current or in a gale the ship may sheer considerably. Also when a ship is anchored, it swings to the combined efforts of the wind and current. Therefore, it is necessary to have an unobstructed area equal to the length of the ship plus the scope of the chain used. If for some reason, the anchorage does not afford such an area, the ship must be moored.

Mooring to a buoy is another way of securing a ship. The buoys are usually anchored with a three-point moor. This requires the ship to use only its anchor chain forward or, if it is mooring bow and stern between the two buoys, to use a mooring rope aft. The radius of swing is limited to the ship's length.

Anchoring
Letting go an anchor may vary slightly from vessel to vessel, but every operation starts with an overall inspection of the area and equipment to make sure the situation is safe.

The anchor detail will be informed by the bridge as to the depth of the water, amount of chain to be put out and any other necessary conditions that need to be accounted for.

The first step in the process starts with the removal of the buckler plates and release of the devils claw. The anchor is walked out of the hawspipe to the waters edge and the break is applied. The wildcat is then unlocked.

Word is passed to the bridge that the anchor is ready to be released and when the command to “Let go” is given, the break is released and the anchor will fall.

The chain is stopped completely by applying the brake to prevent the chain from piling on top of the anchor. The brake is taken off gradually and the chain is laid out on the bottom as the ship moves ahead or back until sufficient chain is out to ensure that the pull on the anchor is horizontal. The brake is now applied and the anchor is set. Once the anchor is set and is holding, the brake is taken off and the chain is veered to the desired scope.

When the desired scope of chain is out, the order is given to “Pass the stoppers.” The brake is set and the stoppers are applied and evened up. All gear is then stowed and the area secured.

Heaving In

When heaving in, once again, the first step in the process is to survey the situation to make sure it is safe. The stoppers are removed, and the wildcat is engaged. As power is applied to the windlass, the chain is pulled onboard, and deposited in the chain locker.

It is not uncommon to hose the rode off while it is being hauled in to minimize the mud and sand taken onboard. When the shank of the anchor is secured in the hawspipe, the break is applied, stoppers are passed and the windlass is unlocked from the wildcat. Then final step is the installation of the buckler plates and securing of any gear utilized during the evolution.

CHAPTER 14

Cargo Handling

Cargo handling and stowage require many skills and many items of equipment. In this chapter you will study the basic technique of cargo handling and learn of some of the commonly used equipment. You also will study the safety precautions that you must observe.

Cargo Handling Equipment

Equipment used for handling cargo is varied to meet the situation. Here we will discuss some of the equipment, its description, and its use in cargo-handling evolutions.

General Equipment

Pallets are small platforms on which cargo is so placed that both platforms and cargo may be moved as a unit.

Much cargo is stacked on pallets in uniform loads and securely strapped to the pallets by steel or fiber bands. Usually this cargo remains banded until it reaches its destination, thus eliminating the need for handling each item several times.

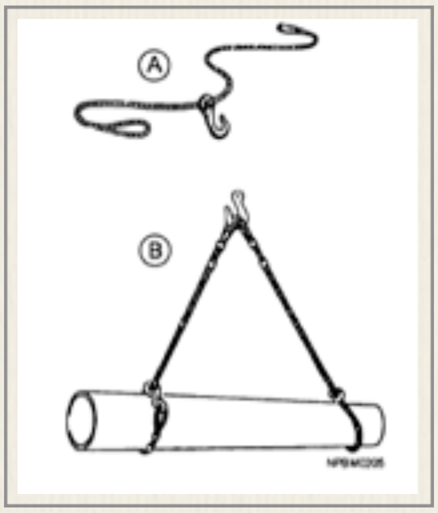
Cargo nets are used to advantage when handling non-uniform packages. The nets may be made of manila or wire rope, or nylon bands. In replenishment-at-sea operations, palletized cargo may be transferred in cargo nets, although the net load is limited to one pallet per draft.

In this case, nylon band nets are particularly advantageous. Pallet trucks may run over the net, pick up the pallet, and quickly move it from the landing area.

At times, the beckets of cargo nets are too short for large, bulky loads. It is difficult to get the beckets over the hook and chances of crushing something are increased. For these reasons, many ships keep cargo net shorteners at hand. Spreader bars may be used to prevent damage to the upper part of the load.

Large crates and odd-shaped cargo usually are hoisted by means of slings. A sling is a length of rope, either fiber or wire, with the two ends spliced together. It is looped around the item to be hoisted, and one end is passed through the other and over the hook.

Barrel slings are for hoisting steel drums and barrels of standard size by hooks placed over each end.
These slings may be used singly or in conjunction with a spreader bar or frame to hoist as many as six or eight drums at a time. Barrel slings are not recommended for wooden barrels.



A strap is a length of rope with an eye spliced at each end. The strap usually is looped around the article to be lifted, and one eye is passed through the other and over the hook.
Frequently, however, two straps of equal length are used to hoist a heavy or bulky load. Then the straps ordinarily are placed under the ends of the load, and both eyes of each strap are put in the hook.

Considerable attention must be paid to the condition of slings and straps. They are subject to stress and abuse and should be inspected frequently for wear and distortion.

A hand hook has a hardwood handle fastened at a right angle to a highly tempered steel shaft. The shaft is curved at the end to form a hook which is tapered to a sharp point. The primary purpose of the hand hook is to move or turn crates and bales.

Never use the hand hook on metal unless there are holes in which the point of the hook can be inserted. Do not tip over barrels or drums, nor remove hatch boards with a hand hook.

Crowbars and pinch bars should be kept handy when working cargo. They are useful for tearing out dunnage, breaking out cases, and in many other situations where a lever is necessary.

Various shapes of crowbars

Rollers are ideal for moving cases that are too heavy to lift, rollers may be lengths of pipe, or they may be fashioned from hardwood. They must be long enough to pass completely under the load to be moved. Several are placed under the case and several more in front. As the case is rolled forward, the rollers passed over are picked up and positioned ahead of the load. The case can be turned by placing the rollers at an angle or angling those already under the load by striking one end of them with a sledge hammer or maul.

Cargo Stowage

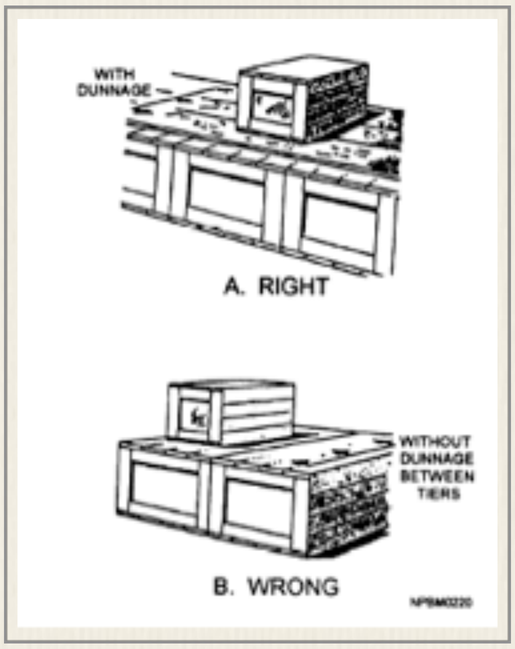
In the stowage of cargo, you strive to protect ship and cargo from damage, protect the crew from injury, maintain maximum stability of the ship, attain speed in loading and unloading, and make maximum possible use of the space, considering the type of cargo.

The articles of equipment which will be needed first will be loaded last. Articles and supplies that will not be needed until later will go in the bottom of the hold.

When you are loading cargo, follow the loading plan and keep alert to make sure that nothing is stowed in violation of these basic principles and rules. Before discussing the methods of stowing cargo, however, it is essential that you understand the use of dunnage.

Dunnage

Dunnage is any material used to protect both the ship and the cargo. The most common materials are rough finished boards and other pieces of wood.



Other material used are bamboo, battens, cardboard, heavy paper, burlap, etc. The main function of dunnage is to ensure that the cargo is delivered in good condition and does not damage the ship.

Use dunnage to:

prevent movement and chafing by blocking off and securing containers and filling spaces that cannot be filled with cargo

separate cargo so that only the proper amount will be discharged at each port; burlap or heavy paper ordinarily is used for this purpose

allow for drainage and ventilation by laying dunnage athwart ships or fore and aft, permitting air to circulate and preventing the accumulation of moisture by allowing condensation and leakage to flow in the drainage system

Whether the dunnage is laid athwart ships or fore and aft depends on where the scuppers in the hold are located. If they are at the sides of the hold, dunnage is laid athwart ships. If the scuppers are at the forward or after ends of the hold, dunnage is laid fore and aft. The idea of course, is to expedite drainage of water to the scuppers.

Contaminated dunnage or green lumber can do considerable damage to cargo. Wet, dirty greasy, oil-soaked, or chemically fouled dunnage should never be reused without thorough cleaning.

It is impossible to lay down hard and fast rules governing the use of dunnage, but the following pointers must be remembered:

dunnage must be sufficient and of proper type to protect the cargo not under ordinary conditions but under extreme operating conditions

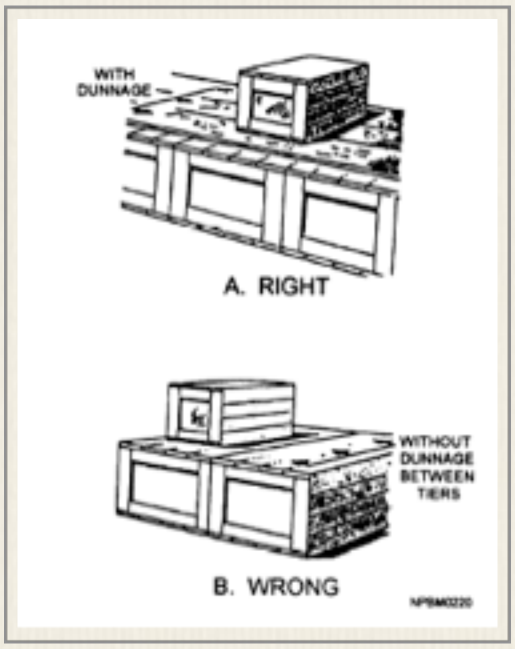
dunnage must be done in such a way as to allow for air circulation and drainage or moisture.

dunnage must be clean and reasonably free of knots and cracks

Cases and Cartons

Much of the cargo in cases and cartons which you will load will be palletized, but general cargo usually is made up of an assortment of wooden and fiberboard boxes and cases constructed in various sized and shapes. Stowing all these mixed sizes and shapes requires careful planning and skillful placement and dunnaging. Generally, the largest and heaviest cases are stowed in the lower hold, and smaller boxes are packed between and around them.

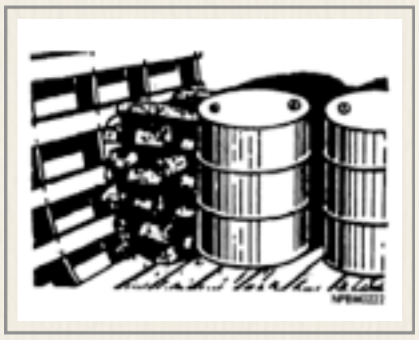
When stowing, either start at the centerline and work outboard in both directions, or start at one side and work toward the other. Keep each tier perfectly level. In ships where the deck of the lower hold rises a little in the wings as the deck approaches the turn of the bilge, do not stow boxes on this rise because succeeding tiers above will put extra pressure on the tilted edge of the wing boxes and crush them.



Never place a box so that it lies inside the edges of the box beneath it. Lay dunnage between the tiers as shown in view A, or the weight of succeeding layers will probably crush the box on the bottom.

Like cartons, cases (tight wooden boxes) may be stowed brick fashion; but being stronger, they do not need the dunnage floors between tiers.

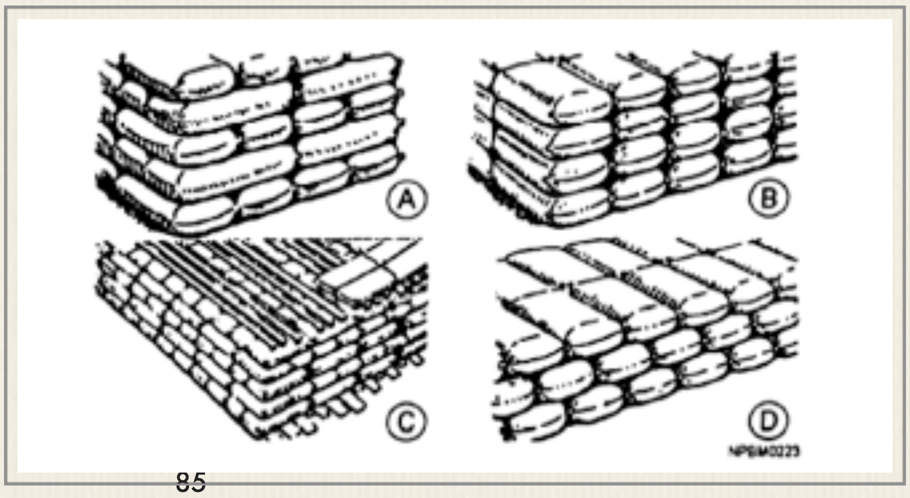
Crates
Crates are framework containers, sometimes with open sides and ends
and sometimes with sides and ends enclosed by cardboard or thin plywood.
Crates for ocean shipment should be strengthened with diagonal braces, and those not so strengthened must receive special care in stowage. The best place to stow crates is in 'tween-deck spaces or in the top tiers of the lower hold. Only light cargo should be stowed on top of crates.



Drums
Drums may be deck loaded or placed in the hold. If stuck below, a single layer of dunnage should be laid down to provide drainage and friction against rolling.
Drums are stowed on end, with bungs up and packed together as closely as possible. If a row of drums does not completely fill the athwart ship space, the drums should be spread evenly, and those in the second row set in the intervals between. This eliminates the need for additional bracing or dunnaging to fill the extra space at the end of the row and may make room for more rows in the hold.

However, dunnage must be stacked between the outboard drums and the flare of the sides as shown.

Bags
Before bags can be loaded, a dunnage floor of two or more layers must be spread to keep the bags off the steel deck and to provide drainage. If ventilation is not a problem, the top layer may be solid. In any event, the spacing of the top layer should not be more than 1 inch, otherwise the weight of the top tiers will cause the bags in the bottom tier to split. Vertical dunnage must be used to keep the bags from the sweat



battens and from steel stanchions, bulkhead, ladders and so on. Normally, no other dunnage will be needed.

Bags may be stowed in any of the ways shown. Alternating them, as in view A, or using strips of dunnage, as in view C, makes a secure stack, but piling the bags, as in view D, makes better use of the space. The method of stacking shown in view B provides fair ventilation but some commodities, such as rice and onions, require circulation of air throughout the cargo. The circulation can be obtained by using venetian vents.

Reels

Many reels containing sheathed cable have special handling instructions stenciled on their sides. These instructions must be complied with, least careless handling ruin the cable. Generally, large, heavy reels should be stowed in the lower hold with their axes athwart ships. They should be chocked with 8 x 8 timbers cleated together by 2 x 6s and lashed and stored as securely as possible. Preferably, the reels should be blocked in by other cargo, such as rags, lumber, or other items that can stand a little chafing. Otherwise, dunnage bulkheads should be constructed about 6 inches from the reels to protect adjacent cargo from them.

Small reels may be tipped on their sides and, depending on their contents, braced and dunnaged if necessary.

Vehicles

Vehicles pose peculiar stowage problems because of their size and mobility. It is not difficult to picture the havoc an unsecured heavy tank could wreak during a heavy sea. Therefore, it is extremely important that you give close attention to the job your crew is doing when stowing vehicles. Great care must be taken to avoid blocking off bitts, chocks, sounding tubes, valves, and other equipment which must be accessible. Spaces to be left clear should be outlined in chalk.

Whenever possible, a wheeled vehicle should be rolled into place with someone doing the steering. If this is not feasible, a rolling car jack may be used to cut either end around; or winch power can be used to pull it into place, the wheels being placed on a dolly. Vehicles should be stowed in a fore and aft position with 4-6 inches between them to prevent their rubbing against each other. Wheels should be chocked on all four sides to prevent movement in any direction. Individual chocks should then be braced. At times it may be necessary to lash each vehicle with wire rope and put blocks under the frame to prevent sideways movement.

Deck Cargo

Deck cargo consists of miscellaneous gear for which there is no room below, or which, because of its nature or size, cannot be stored below deck.

Because of the varying sizes and shapes of commodities stowed on deck, few specific rules for their stowage can be given. This section, however presents such material as is generally applicable to the stowage of all deck cargo.

When stowing a large quantity of cargo on deck, care must be taken to avoid blocking access to deck machinery and equipment. Marking important areas off with chalk can be a helpful reminder, of the spaces to be kept clear.

Cargo Characteristics

In the process of stowing and delivering cargo, consideration must be given to the characteristics of the cargo to ensure its safe delivery. If cargo is stored improperly various types of damage may result. Improper storage results when a cargo's inherent characteristics are not considered. Inherent characteristics refer to the properties unique to each type of cargo such as flammability. For example, a cargo which gives off gas may damage other cargoes stored in the same area. Thus, in order to prevent damage, the inherent characteristics of the cargo should be considered and if necessary the cargo should be segregated. The following is a list of the most common types of cargo and the precautions that should be observed when stowing these cargos.

<u>1. Wet Cargo</u>

Wet Cargo can be defined as liquids stored in a tank or container. In warm weather, wet goods suffer from evaporation. The moisture released from evaporation condenses on cool surfaces, which causes sweating. Water vapor or moisture condenses on cargo once the air becomes saturated. This point of saturation is known as the dew point. The dew point is determined by the relative humidity or percentage of water vapor the air is capable of holding at a given temperature. Sudden changes in temperature affect the relative humidity of the air. In order to minimize sweat damage, ventilation of holds should be controlled so as to allow the outside and inside air to gradually equalize.

2. Refrigerated Cargo

Refrigerated Cargo is divided into three classes: frozen, chilled, and air cooled.

Frozen Cargo

Includes meat, fish, egg products, butter or such goods which must be carried at temperature of 10° to 15° F.

Chilled Cargo

Is usually the term applied to meat carried at about 29 degrees F. Because of the uniformity and constancy of temperature required, this class of cargo requires the most careful attention. The carcasses or quarters of meat are suspended from rails fitted in a fore-and-aft directions on the deck heads.

Air-Cooled Cargo

Usually consists of fruits and vegetables, but certain kinds of canned goods, bacon, cheese, eggs, beer and wines are often included.

The air-cooled system consists of the delivery of cool and extraction of warmed air from the cargo holds by means of fans. Again, the air cooling process utilizes the forcing of air over coils through which brine at the required temperature is circulated.

3. Bulk/Homogenous Cargo

Bulk cargo is broadly defined as two types: bulk solids and bulk liquids. Most limited tonnage offshore supply and freight vessels are designed to carry both types of bulk cargo. For example, liquid mud is a bulk liquid. On the other hand, drill pipe, generator sets, machinery, and other cargoes of this type are general deck cargo.

Homogenous cargo is simply a name for a load cargo that generally has the same properties or characteristics. Thus, homogenous cargo could be a load of liquid mud, bayrite, or a load of general deck cargo such as anchors, chains, or drill pipe.

The primary consideration in the stowage of all bulk cargo is preventing weight shifts. Liquid bulk cargo in tanks can develop free surface if not pressed completely up. General deck cargo that breaks free from its tie downs, is also dangerous if allowed to cause a shift in weight.

Aside from weight shifts, there are other sources of damage that must be considered which related specifically to dry bulk/solid cargo. Cargo such as grain is subject to damage through what is know as inherent vice. Inherent vice refers to damage caused by overheating of cargo. Dry cargo may also be damaged by stowage with other cargo that gives off fumes, vapor, or gas. Cargo which give off fumes, vapor or gas is known as odorous cargo. Dry cargo that has the ability to absorb these fumes, vapor or moisture in the form of a gas is known as hygroscopic cargo. This process by which dry cargo becomes damaged by fumes, vapors or gas is knows as tainting. Additionally, cargo may also be damaged by dust which is referred to as contamination.

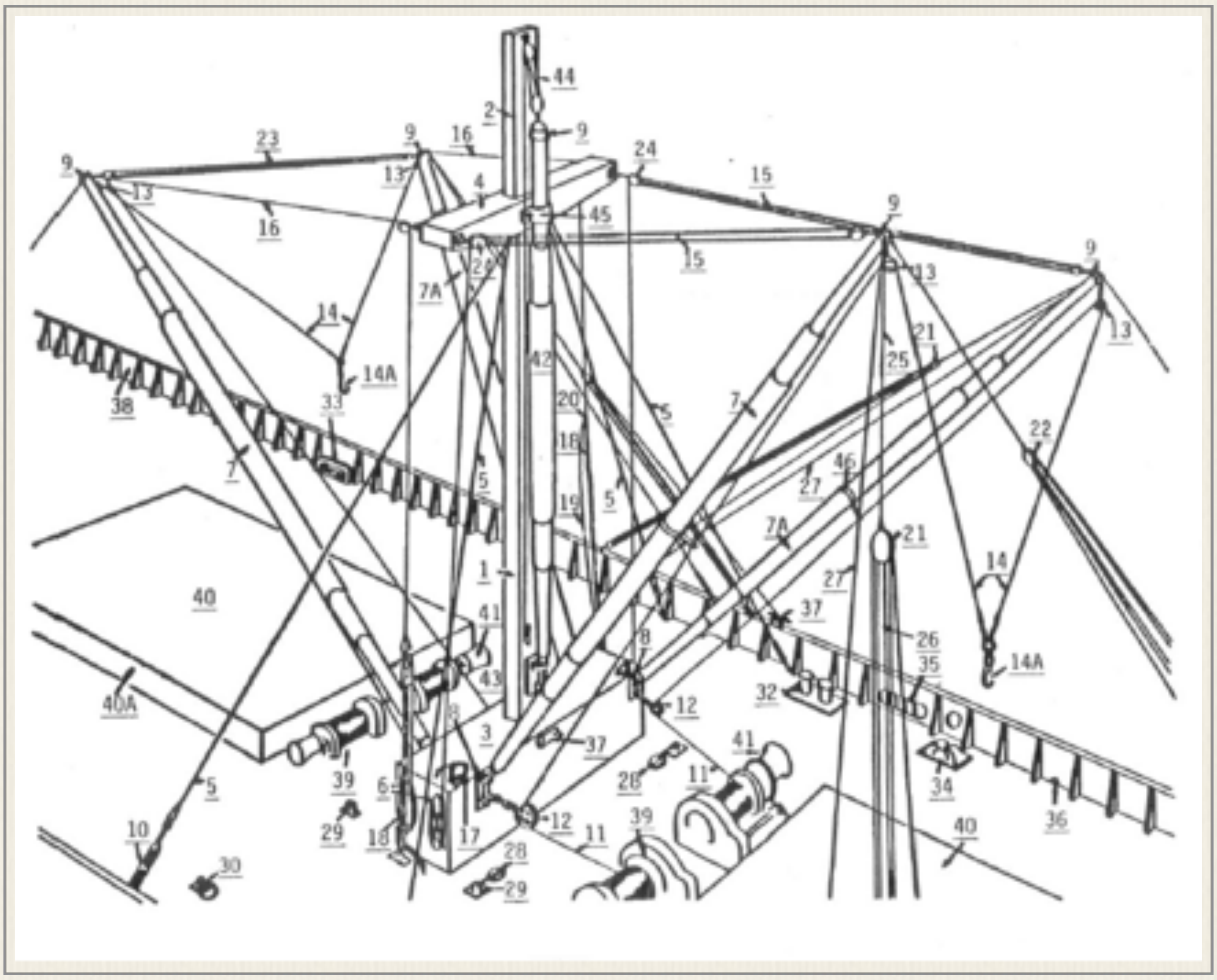
Dangerous/Hazardous Cargoes

Various types of bulk liquid and solid cargoes are dangerous or hazardous to the ship's crew, passengers, other cargoes and to the ship itself. Special consideration must be given to these types of cargoes in transportation. Dangerous cargo can be defined as cargo that has the potential to cause an immediate threat or danger to the personnel handling it or to the vessel. For example, such cargoes as explosives and flammable or combustible materials would be considered dangerous cargo. Hazardous cargo can be defined as a substance that due to its chemical or physical properties, can cause unreasonable risk to the health and/or safety of individuals, property, or the environment. A cargo can be both dangerous and hazardous, such that the distinction between the two classifications is very fine. For example, benzene, a known carcinogen, whose chemical properties can cause serious health risks would be classified as hazardous cargo, yet it is also extremely flammable liquid which makes it a dangerous cargo.

There are rules and regulation governing the shipment of dangerous or hazardous cargoes of which the vessel operator must be aware. The rules and regulations governing the shipment of dangerous cargo are outlined in 46 CFR Subchapter N. In addition the transportation of hazardous materials is covered in 49 CFR Subchapter C, part 176.

Regulatory Requirements
IMDG Code-- The International Maritime Dangerous Goods Code was first published in 1965 by the International Maritime Organization (IMO). The IMO is responsible for periodic updating of the IMDC which govern the vast majority of shipments of hazardous materials by water. The IMDG code is intended to provide for the safe transportation of hazardous materials by vessel and to prevent marine pollution.

Cargo Rigs



Components of a Yard and Stay Cargo Rig

1. Mast

2. Topmast

3. Mast Table

4. Crosstree

5. Shroud

6. Topping lift cleat

7. Hatch boom

7a Yard boom

8. Gooseneck

9. Spider band

10. Turnbuckle

11.Cargo Whip

12. Heel block

13. Head block

14. Cargo whips

14a. Cargo hook

15. Topping lift (multiple)

16. Topping lift (single)

17. Stopper chain

18. Bull Chain

19. Bull line

20. Flounder

21. Outboard guy

22. Inboard guy

23. Midship guy

24. Topping lift block37. Cleat

25. Guy pendant

26. Guy tackle

27. Preventer

28. Snatch block

29. Pad eye

30. Pad eye ringbolt t

31. Shackle

32. Bitts

33. Closed chock

34. Open chock

35. Freeing port

36. Scupper

38. Bullwark

39. Hatch winch

40. Cargo winch

41. Hatch coming

42. Yard winch

43. Jumbo boom

44. Gooseneck and step

45. Breasting up tackle

46. Boom gate collar

47. Slack wire fairlead

Yard and Stay Cargo Rig

The yard and stay method of cargo handling, as illustrated, is just one of a number of different cargo handling rigs and is common to both the merchant marine and the Navy. This method of cargo handling, uses two booms. One boom, called the hatch boom, “plumbs” (placed directly above) the hatch. The other boom, called the yard boom is rigged out to one side so that the head of the boom is over the dock or pier.

The two cargo whips coming from different winches are rove through their respective heel and head blocks and are shackled to the same cargo hook. The hook is usually a triple swivel hook.

The winches are located so that their operators have an unrestricted view of the hatch area. On some ships, one man can operate both winches.

The load is hoisted out of the hold by the hatch boom, then transferred to the yard boom and lowered safely to the pier. The two booms are held in fixed positions once the operation begins and while the load is transferred from one boom to the other.

Before the cargo can be worked, the ship’s booms must be topped, (raised) spotted, (set in the correct position) and secured in that position.

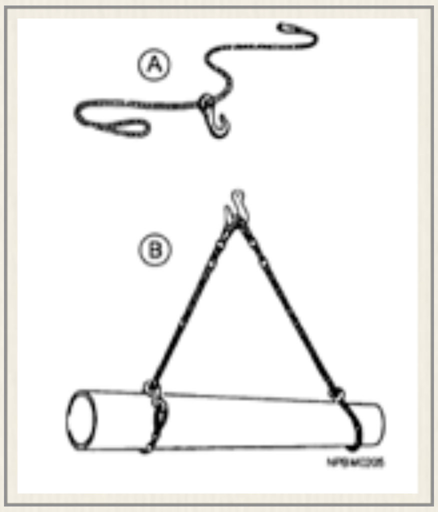
The band attached to the end of a boom, to which the guy wires are attached is called the spider band.

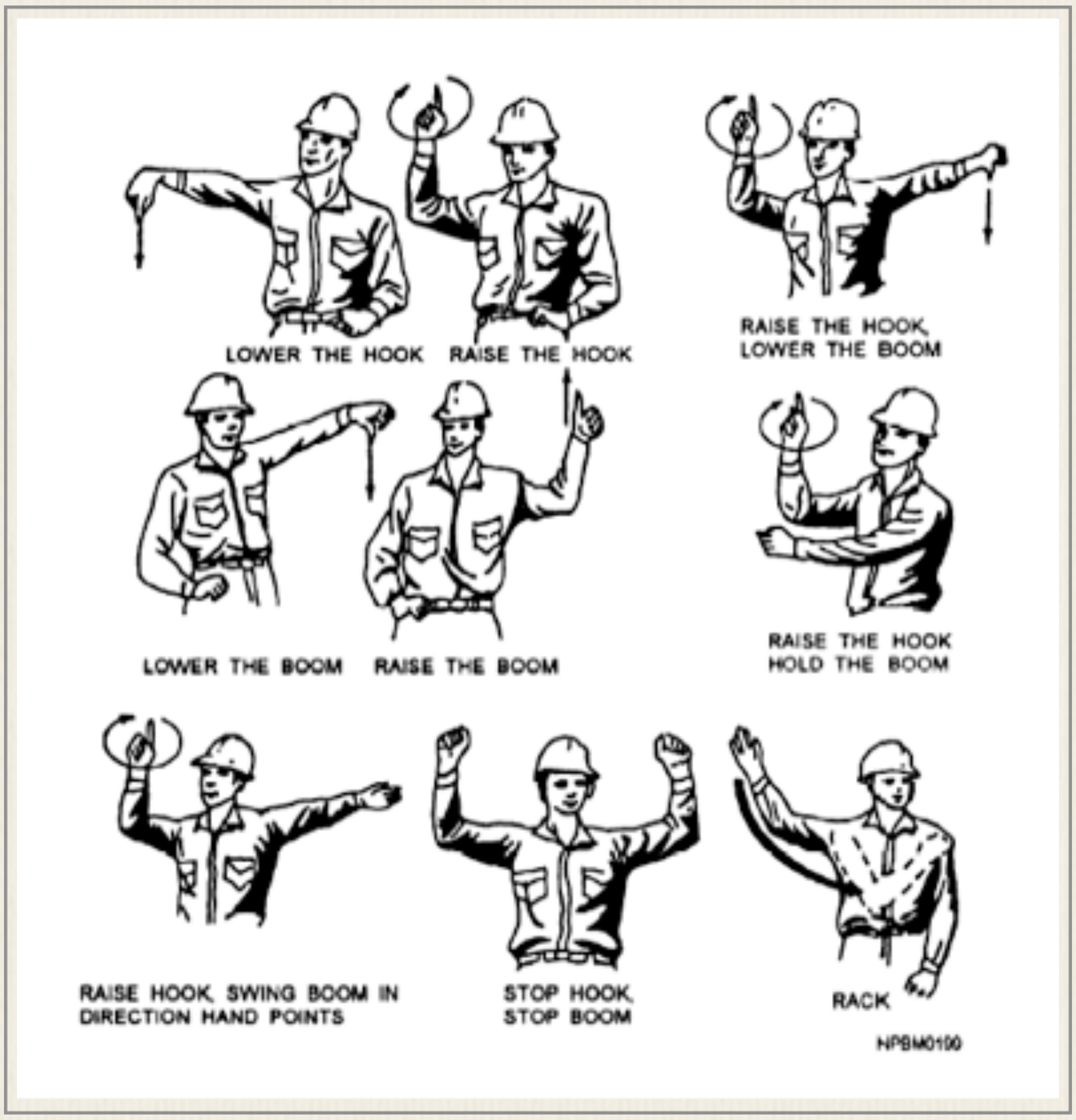
The center of the boom is the thickest, and it tapers off towards the ends.

The boom angle is that angle of the boom compared with the horizontal.

Standing rigging is stays and shrouds.

The goose neck allows the boom to move vertically and horizontally.




LOWER THE HOOK
RAISE THE HOOK
RAISE THE HOOK,
LOWER THE BOOM
LOWER THE BOOM
RAISE THE BOOM
RAISE THE HOOK
HOLD THE BOOM
RAISE HOOK, SWING BOOM IN
DIRECTION HAND POINTS
STOP HOOK,
STOP BOOM
RACK
NPBM0100

CHAPTER 15

Pollution

Federal Water Pollution Control Act (FWPCA) Clean Water Act
During the late sixties, in response to a number of pollution incidents, and a growing public awareness and concern for controlling water pollution led to the enactment of the Federal Water Pollution Control Act of 1972.

As amended in 1977, this law became commonly known as the Clean Water Act.
The Act established the basic structure for regulating discharges of pollutants into the waters of the United States.

It gave EPA the authority to implement pollution control programs such as setting wastewater standards for industry.

The Act made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions.

OIL POLLUTION ACT OF 1990 (OPA 90)
The Oil Pollution Act of 1990 (OPA 90) was signed into law on August 18, 1990, largely in response to growing concern, stemming from the Exxon Valdez incident, about the nation's oil spill response capability. OPA 90 contains provisions amending the Federal Water Pollution
Control Act (FWPCA) and other statutes, and provisions that create new statutory structures without amending an existing law.

The Oil Pollution Act of 1990 (33 U.S.C. 2701-2761) amended the Clean Water Act and addressed the wide range of problems associated with preventing, responding to, and paying for oil pollution incidents in navigable waters of the United States. It created a comprehensive prevention, response, liability, and compensation regime to deal with vessel and facility-caused oil pollution to U.S. navigable waters. OPA greatly increased federal oversight of maritime oil transportation, while providing greater environmental safeguards by:

>Setting new requirements for vessel construction and crew licensing and manning,
>Mandating contingency planning,
>Enhancing federal response capability,
>Broadening enforcement authority,
>Increasing penalties,
>Creating new research and development programs,
>Increasing potential liabilities, and
>Significantly broadening financial responsibility requirements.

Criminal Penalties:
The Federal Government can impose a criminal penalty of up to $250,000 for an individual.
The Federal Government can impose a criminal penalty of up to $500,000 for a corporation.
Under 46 U.S.C. sec. 7703 a licensed Merchant Mariner can be subject to suspension or revocation proceedings.

Financial Responsibility:

Under the act vessels are required to carry a **Certificate of Financial Responsibility** as evidence of financial responsibility sufficient to meet the maximum amount of liability to which the responsible party could be subjected under section 1004(a) or (d) of this Act, in a case where the responsible party would be entitled to limit liability under that section. If the responsible party owns or operates more than one vessel, evidence of financial responsibility need be established only to meet the amount of the maximum liability applicable to the vessel having the greatest maximum liability.

INTERNATIONAL/NATIONAL LEGISLATION:

MARPOL (33 CFR 151)

The MARPOL Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively and updated by amendments through the years.

The MARPOL Convention came into force in response to the Torrey Canyon Incident in 1967.

> In 1967, the tanker Torrey Canyon ran aground while entering the English Channel and spilled her entire cargo of 120,000 tons of crude oil into the sea.
> This resulted in the biggest oil pollution incident ever recorded up to that time. The incident raised questions about measures then in place to prevent oil pollution from ships and also exposed deficiencies in the existing system for providing compensation following accidents at sea.

The International Convention for the Prevention of Pollution from Ships (MARPOL) was adopted on 2 November 1973 at IMO and covered pollution by oil, chemicals, harmful substances in packaged form, sewage and garbage.
Garbage placard

The Convention includes regulations aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations - and currently includes six technical Annexes:
States Parties must accept Annexes I and II, but the other Annexes are voluntary. A U.S. vessel in ocean service is always subject to MARPOL.

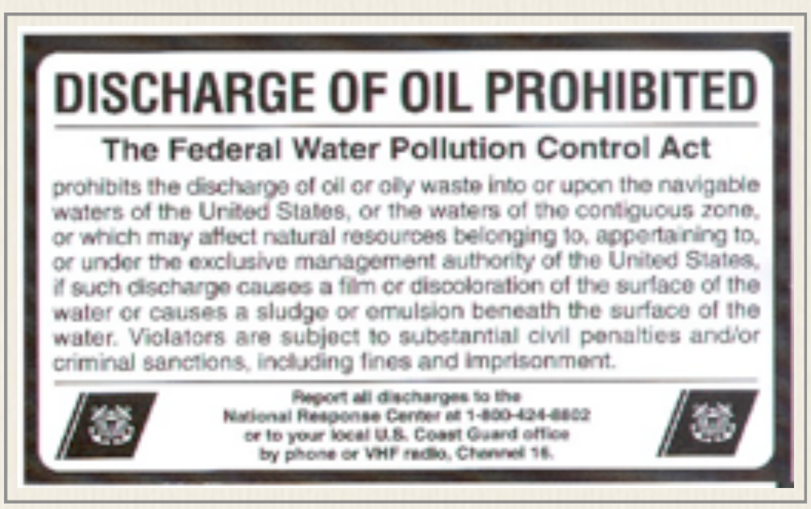
Annex I — Regulations for the Prevention of Pollution by Oil;
Annex II — Regulations for the Prevention of Pollution by Noxious Liquid Substances (NLS);
Annex III — Regulations for the Prevention of Pollution by Harmful Substances in Packaged Forms;
Annex IV — Regulations for the Prevention of Pollution by Sewage (not in force on the date this manual was published); and
Annex V — Regulations for the Prevention of Pollution by Garbage

> Stipulates special area that restrict the disposal of any garbage at sea such as the Red Sea.

Discharge
As taken from the Code of Federal Regulations (CFR)

> **``discharge''** means any emission (other than natural seepage), intentional or unintentional, and includes, but is not limited to, spilling, leaking, pumping, pouring, emitting, emptying, or dumping;

Discharge of Oil Placard.



Causes of spills:
The causes of oil spills can be divided into two groups: accidents and operations.

There is often a large oil loss in accidents, up to 20% have an oil loss of over 700 tons.
During the time frame of 1974 to 1999 the following accidents occurred:

Type of Accident	Number of Incidents
Collisions	475
Hull failures these	671
Fires and explosions	154 (most uncommon)
Groundings	518 (the greatest # of oil losses over 700 tons.)

Oil Spills
The Federal Water Pollution Control Act, The Outer Continental Shelf Lands Act Amendments of 1978, The Deepwater Ports Act of 1974, require that the responsible party notify the National Response Center as soon as knowledgeable of an oil spill from a vessel or facility operating:

In or along U.S. navigable waters;
On the Outer Continental Shelf;
In a deepwater port; or
From a vessel transporting oil from the Outer Continental Shelf.

The NRC (1-800-424-8802) requires the following information when reporting a spill:
Who you are:
Your name, address and phone number.
The name, address and phone number of the responsible party, if known.
Anonymous calls are accepted.

What happened:
What material was released?
How much was released?

Where it happened:
City, County, State
Location, nearest street corner or landmark

When it happened:
When did it happen?
When did you discover it?

Why it happened:
How did it happen?
What caused the discharge?

Marine Sanitation Devices.
There are two varieties of marine sanitation equipment. One variety treats the waste and then discharges it into the water (Type I or Type II). The second retains the waste onboard or treats it in a manner which does not result in any discharge into the water (Type III). This includes holding tanks, re-circulators and incinerators.

Requirements
Type I- Flow-through device (maceration and disinfection)
Equal to or less than 65 feet in length

The effluent produced must not have a fecal coliform bacteria count greater than 1000 per 100 milliliters and have no visible floating solids.

Type II- Flow-through device (maceration and disinfection)
Greater than 65 feet in length

The effluent produced must not have a fecal coliform bacteria count greater than 200 per 100 milliliters and suspended solids not greater than 150 milligrams per liter.

Type III- Holding tank
any length
This MSD is designed to prevent the overboard discharge of treated or untreated sewage.

No Discharge Area (NDZ)
"No Discharge Area" is a designated body of water that prohibits the discharge of treated and untreated boat sewage. Federal Law prohibits the discharge of untreated sewage from vessels within all navigable waters of the U. S., which include territorial seas within three miles of shore.

An NDZ is an area of a body of water or an entire body of water into which the discharge of sewage (whether treated or untreated) from all vessels is completely prohibited; they are designed to give States an additional tool to address water quality issues associated with sewage contamination.

Pollution Control
Pollution control is a term used in environmental management. It means the control of emissions and effluents into air, water or soil. Without pollution controls the undesirable waste products from human consumption, industrial production, agricultural activities, mining, transportation and other human endeavors will accumulate or disperse and degrade the natural environment. In the hierarchy of controls, pollution prevention and waste minimization is more desirable than pollution control.

Use of drip pans:
Drip pans are small portable containers used to catch liquids. Unless there is a permanent means for the retention of a slight leak drip pans should be used at connections of hose and piping used for the transfer of possible pollutants.

Retention of used oil:
Since it is illegal to discharge oil into the water ships must have a suitable containment area to hold the oil until it can be discharged. Used oil is normally only generated by the ships equipment but can also come from spills. Most ships hold oil and water waste mixture in a holding take before separating the water out of the oil and transferring the waste oil to a slop tank.

MARPOL Placard:
Vessels are required to display MARPOL placards showing dumping restrictions. All vessels over 40 feet must also have written waste management plans, which must include the name of the person in charge of the vessel, procedures used for collecting, processing, storing and discharging the vessel's garbage in accordance with the requirements.
The Captain or person in charge should advise passengers of the location of trash receptacles and mention the refuse discharge regulations.

Chemical dispersants agents-no longer used:
These are chemicals which enhance the natural dispersion of oil. This is the most common method used for oil slicks, especially when mechanical recovery is impossible. They are used to reduce the extent of damage caused by

the floating oil. Chemical dispersants have little effect on oil with a high viscosity as the chemicals run off the oil before the solvent can work. Oils that the dispersants have an initial effect on become resistant after a while because the viscosity increases as the more volatile oils evaporate. Chemical dispersants are no longer supposed to be used for cleaning oil spills.

Oil discharge containment pail:
A spill kit is a collection of items, to be used in case of a spill, leak or other discharge of oil. Spill kits are developed so that a prompt response and clean-up may be performed.

It might also be helpful to have a whisk broom, a dust pan, and a heavy duty plastic bag to line your collection container. By keeping it clean you may be able to re-use it. All of this should easily fit inside a 5-gallon, covered, plastic pail. The pail should be labeled so anyone can clearly identify it as a spill kit. The cover should be placed loosely on top to keep the contents dry and clean, but the pail should be easy to open.

Cause/prevention of small spills:
Accidental spills from tankers contribute and estimated 400,000 tonnes annually. Analysis of tanker spills occurring throughout the world shows the majority (some 75%) occur in port during routine ship operations such as loading, discharging and bunkering. Most of these spills are, however, relatively small: over 92% are less than 7 tonnes and probably, in total contribute less than 20,000 tonnes annually.

Most incidents are the result of a combination of actions and circumstances, all of which contribute in varying degrees to the final outcome. The primary cause of spills is human error. Human error can also be a component of equipment failure which is the second largest cause of spills. Education and training are the best way to prevent oil spills. The Army Corps of Engineers will not clean up a spill.

Booms:
In the event of an oil spill it is important to keep the spill contained. Oil absorbent booms are a good way to do this. Booms provide reliable absorption on water and in special industrial applications. Oil-Only Absorbent Booms absorb oil and petroleum products from the water while Bilge/Sump Booms work well in boat bilges, sumps and oil-water separators. In the work environment, use booms to quickly surround a spill and keep it from spreading. Block running liquids from sensitive areas such as walkways and drains. Mold booms around barrels or equipment to catch leaks and spills.

Bulk Cargo Operations
Bulk liquid cargo operations means a transfer of liquid or liquefied gas listed in and carried as a liquid cargo or liquid-cargo residue in integral, fixed, or portable tanks, except a liquid cargo carried in a portable tank actually loaded and discharged from a vessel with the contents intact. Special endorsements are required to be in charge of bulk liquid cargo operations and appropriate checklists must be completed prior to starting cargo operations.

Tankerman PIC:
Each licensed person acting as the PIC (person in charge) of a transfer of liquid cargo in bulk shall hold a Tankerman-PIC or restricted Tankerman-PIC endorsement.

Actions in event of a spill:
Although containment and cleanup is the goal, the primary consideration is human safety.
Emergency responders must understand the fundamental differences between safety considerations for petroleum product responses and those for other hazardous material incidents.

U.S. flag vessels weighing more than 400 gross tons and U.S. flag oil tankers weighing more than 150 gross tons must carry approved oil spill response plans.

The steps to take in the event of a spill are:

STEP I: INITIATE THE UNIFIED PLAN AND THE APPROPRIATE SUBAREA CONTINGENCY PLAN
STEP II: SECURE THE SCENE
STEP III: EVACUATE IF NECESSARY

STEP IV: MAKE INITIAL ASSESSMENT OF THE SITUATION
STEP V: MANAGEMENT
STEP VI: CONTAINMENT AND CLEANUP

Critical time during bunkering:
The start of pumping, changing tanks, and topping off are the most critical times during bunkering and cargo transfer operations. During start up it is the first time that the system has cargo in the lines under pressure and ruptures or blow outs are most likely to occur at this time. Topping of is when the last 10 percent of the tank is being filled. When changing tanks and topping off the rate of flow must be adjusted and sounding taken more often to prevent overflowing tanks. Many tanks narrow towards the top so even with a reduced rate of flow the tank level will rise more rapidly.

Declaration of inspection form:
Before starting bulk cargo transfers it is a requirement to complete a declaration of inspection.

Ballast water management plan:
An increasing number of port states world wide require that vessels arriving in their waters should submit reports regarding their water ballast practice. The background for this is problems experienced with harmful aquatic organisms spreading from one area to another through a ships ballast water system.

CHAPTER 16

Lifesaving

This chapter deals with survival at sea. We will examine different types of lifesaving equipment, survival crafts, and survival procedures that can make the difference between being rescued or becoming another victim of the accident.

In a disaster, the primary responsibility of the captain is to the passengers. He must render assistance to another vessel, if he can do so without serious danger to his vessel.

The abandon ship signal is more than 6 short blasts and a long blast of the ship's whistle. If you abandon ship, everyone must stay together. This creates a larger, more visible target for rescue operations

<u>Preparation</u>

Emergency preparation starts with the vessels Station Bill. Posted in numerous locations throughout the ship it details crewmember responsibilities for various shipboard emergencies. It also includes whistle signals, along with basic emergency instructions.

Your obligation is to become familiar with your various responsibilities, know where you should report during emergencies and what you will do during these times.

You may also have in your berthing compartment a small card called the supplementary station card. It is usually posted near your rack, or it may be given to you when you sign on. It lists your emergency duties.

The individual in charge of a lifeboat station will probably also have a muster list. This gives the rating and abandon ship duties of each member of that boat crew.

Any prudent mariner will need to be prepared for any possible emergency. The best way to accomplish this is through drills. Research has proven that you react the way you have been trained, and there is no substitute for realistic weekly drills.

Further, individual preparation can't be overlooked. Knowing how to don an immersion suit, having adequate clothing in severe weather, and necessary personal items such as needed medicine, extra eye glasses etc, can make the difference between life and death.

<u>Emergency Signals</u>

Every mariner must know the emergency alarm signals and lifeboat drill signals. They are listed on the station bill and should be periodically reviewed.

>Fire and Emergency-continuous sounding of general alarm bells and whistle for at least 10 seconds

>Abandon Ship-more than six short blasts and one long blast on the whistle and general alarm.

>Man Overboard-hail and pass the words "Man Overboard" to the bridge.

Lifeboat Drill Signals

Lower boats-one short blast on the whistle
Stop lowering boats-two short blasts on the whistle
Dismissal from boat stations-three short blasts on the whistle.

Personal Floatation Device

PFD's must be replaced when severely damaged. They are designed to turn an unconscious person's face clear of the water. Storage should be in convenient, protected, topside locations and be readily accessible. They may not be stored in the shipping plastic.

Kapok PFD's must have the kapok pads covered in plastic.

One PFD must be carried for each person on board. On inspected vessels, 10% of the PFD's must be child size.

If you must jump from a vessel, the correct posture includes holding down the PFD against the chest with one arm crossing the other and covering the mouth and nose.

Work vests may not be substituted for PFD's, and must be stored separately from PFD's.

Immersion Suits

Immersion suits reduce the rate of cooling. These are specialized, full body suits designed primarily for commercial use, and fit over normal clothing. There are several different types available, but in general increase survival time anywhere from 3 to 10 times that of an unprotected person.

Immersion Suit

They provide limited body movement, and should be donned out on open decks. They provide sufficient flotation so that you do not need to wear a life preserver. The suit should be stowed in the storage bag in which it was received and be readily accessible.

Lifefloats/Buoyant Apparatus

These are large orange rectangular rigid lifesaving device designed for survivors to hold on to while in the water.

They may not be stowed in tiers more than 4 feet high. The vessel's name and number of persons allowed must be conspicuously marked in 1 ½" letters.

A lifefloat must have 2 paddles, a water light and a painter.

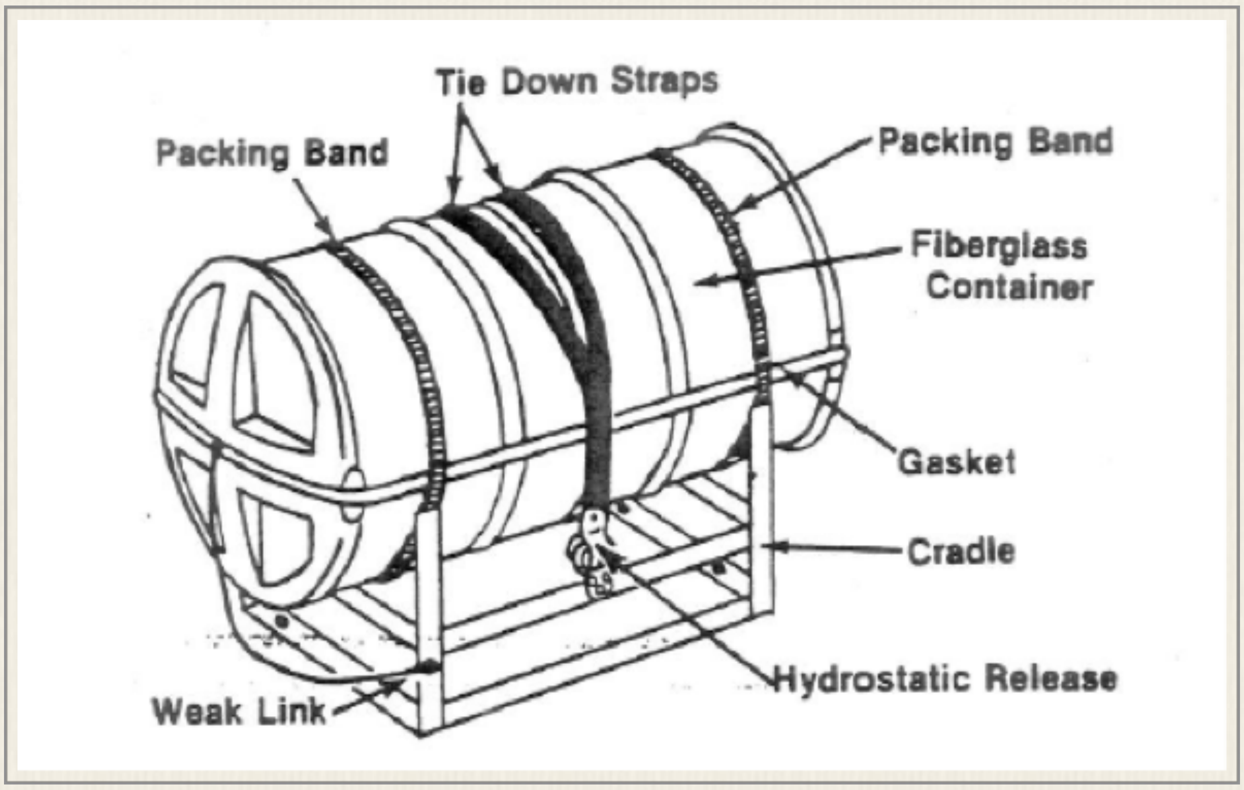
The painter on a lifefloat must be at least 30 meters.

Liferafts
Inflatable liferafts may be round, oval, or octagonal, or boat shaped. Design varies among manufacturers. They must be Coast Guard approved and range in capacity, depending on the route of the vessel of between 4 and 25 people.

On inspected vessels they are required to be inspected once a year by a USCG approved service facility. The casings are sealed and the raft is not easily inspected, so conducting drills usually includes descriptions of the raft and its' contents.

Buoyancy tubes form the outer edge of the raft. They are made from thick nylon reinforced rubber. Buoyancy tubes make the raft float, and are divided into at least two compartments.

Rafts are stowed in a cradle on the open deck. The hydrostatic release allows the raft to float free in the event the ship sinks before the raft can be launched manually. A weak link in the painter keeps the raft from being pulled under by a sinking vessel.



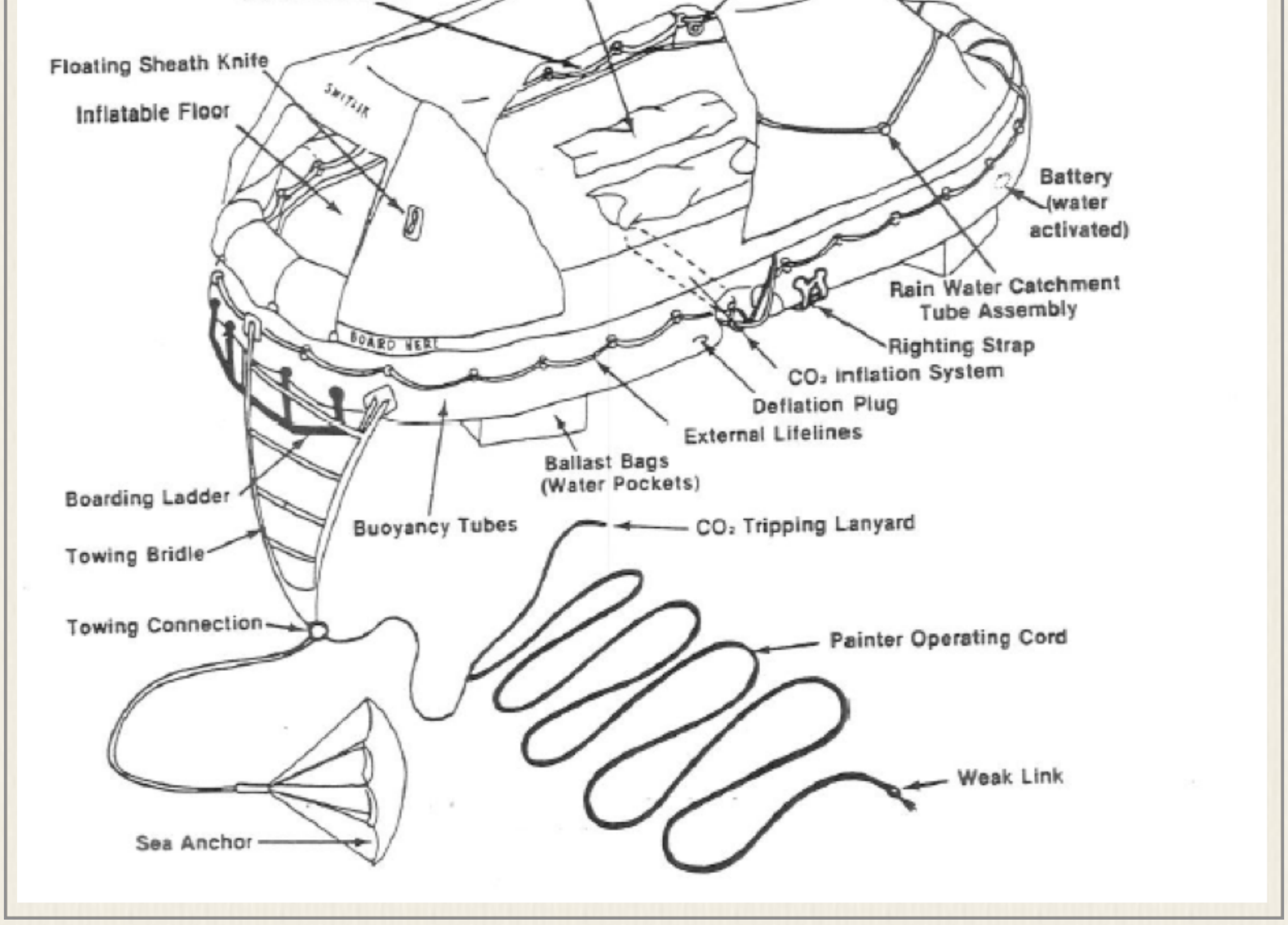
Liferaft & Cradle

The container is a strong, weather-tight, and tamper proof. Holes are drilled in the bottom to allow for drainage of condensation, and allow air circulation. Most containers are made of fiberglass, and are held together with packing bands which break when the raft is inflated.

When a raft is manually launched, the painter must be secured to the vessel before the raft is thrown over the side.

Carbon dioxide (CO_2) is generally used to inflate the raft. The cylinder is located on the bottom of the raft. A sharp tug on the sea painter trips the cylinder head on the CO_2 bottle allowing release of the gas to inflate the raft.

The buoyancy tubes are fitted with pressure relief valves. This is done to allow the escape of excess gas from the buoyancy tubes. It is normal for the gas to escape when the raft is first inflated. A hissing sound will indicate this gas is escaping. After initial inflation, the valves should be capped to stop the loss of gas as the sea works on the raft.



Standard features on an ocean life raft.

The canopy provides protection from the elements and will pop up automatically as the raft's arch tubes inflate.

Lights are installed on the canopy of the raft. They automatically activate when the raft inflates. They are powered by dry cells or water-activated batteries and must operate for a minimum of 12 hours. During daylight hours, remove the cells from the water and shake them dry. This will prolong their life.

The canopy has two layers to insulate the inside from extreme temperatures. It is also fitted with tubes to collect rainwater.

The canopy is colored international orange or some other bright color, which provides for increased visibility from the air against the dark background of the sea.

The raft's floor is inflatable. When in cold climates, inflate the floor with the inflating pump to insulate the crew from the effects of cold sea water.

Leave the floor deflated in warm climates to allow the cooler sea water to cool the interior of the raft.

A boarding ladder and towing bridle are located at opposite ends of the raft. The raft must contain a painter system providing a connection between the vessel and the raft. Lifelines are located on the exterior of the raft. There may also be lines inside of the raft to provide survivors with handholds to steady themselves in rough weather. Righting straps will be located on the bottom of the raft to right it should the raft turn over during inflation or boarding.

Water pockets or ballast bags are provided on the bottom of the raft. They have holes allowing seawater to fill them when the raft is launched. This slows the raft's drift and makes it more stable.

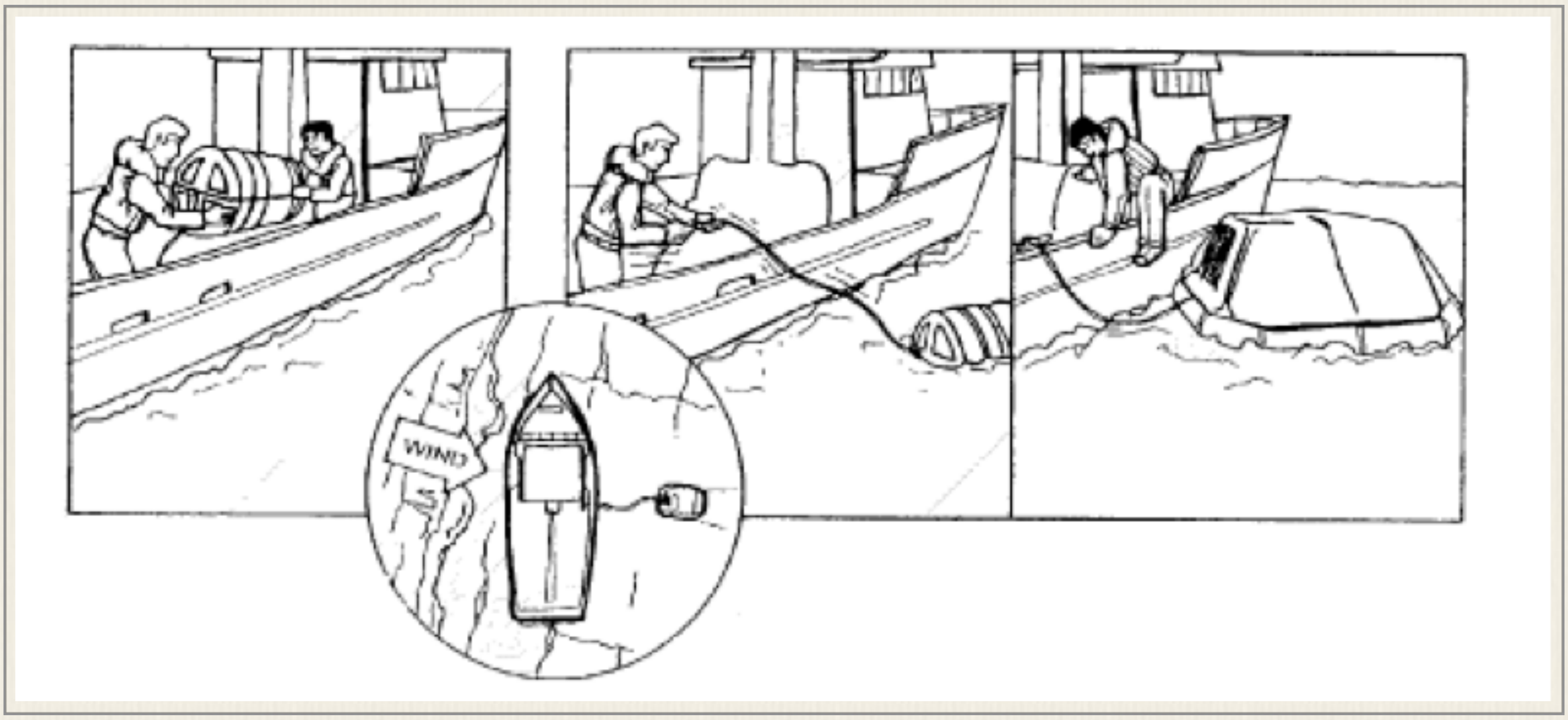
No liferaft shall be approved for ocean service which has a carrying capacity of less than 6 persons.

The number of persons the liferaft will hold is marked on the container and the raft itself. The manufacturer's name is also shown on the container.

The raft is designed to carry its rated number of persons even if half the compartments in the buoyancy chambers are deflated.

Launching

The preferred manner to launch an inflatable life raft is manually. The raft is removed from its cradle after disconnecting the hydrostatic release. This releases the tie down straps. The operating cord is secured to the vessel and the entire container is thrown overboard. The cord is pulled out its full length (100 feet), which then activates the CO2 bottle.



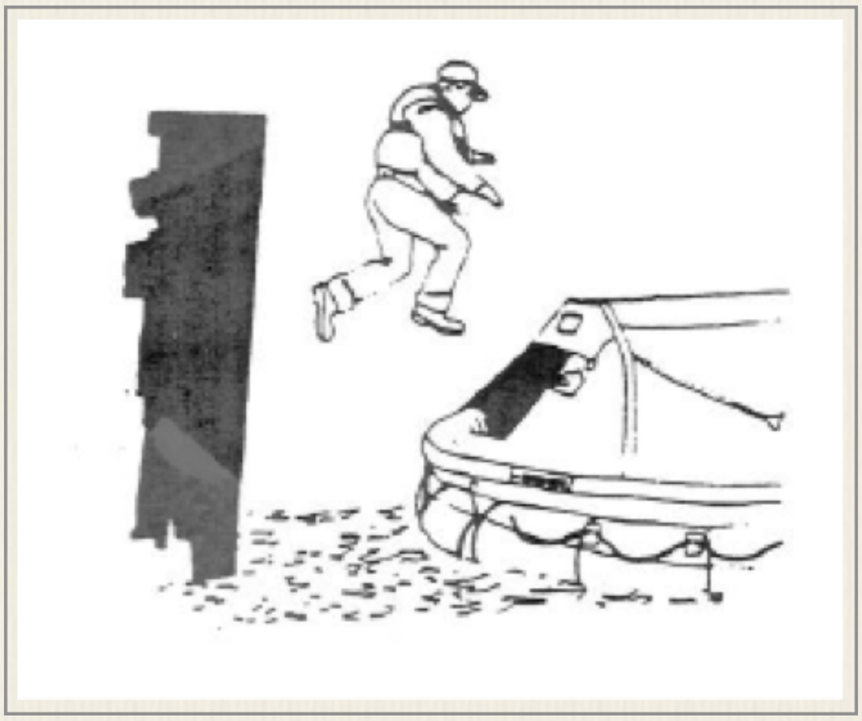
Manually launching a liferaft.

The operating cord then acts as the painter to hold the raft alongside the ship until it can be boarded. Boarding is permitted on a partially inflated raft.

Some inflatable liferafts are davit launched from the ship's deck. The passengers and crew can board form the deck and be lowered to the water. This makes it possible for the passengers to board the raft dry. Davit launched rafts are sturdier than ordinary rafts, so they will hold the raft's full load while suspended from a davit.

Liferafts can also be launched automatically. Should a vessel sink before the raft can be launched manually, the hydrostatic release will trip and the raft will float free of its cradle. The ship must sink to between ten and fifteen feet before the hydrostatic release will be triggered. A weak link will keep the operating cord connected to the vessel. If the vessel sinks in water deeper than the length of its operating cord, the weak link will break allowing the raft to float free.

If necessary a crewmember can board a raft by jumping directly into it. However this should be done from heights of no more than 2 meters.



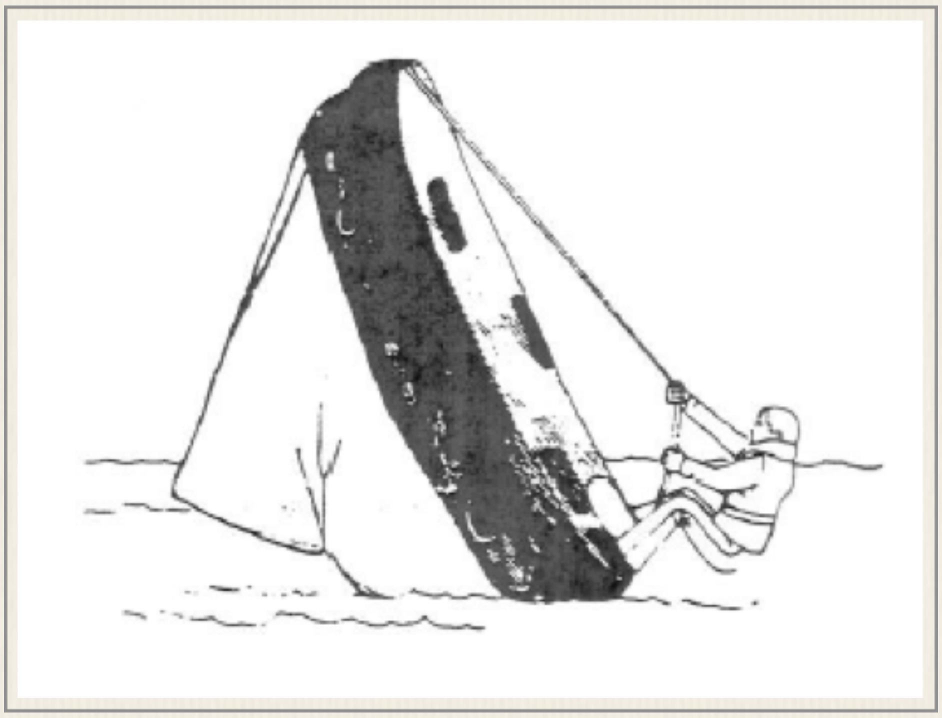
Entering a liferaft directly from a vessel.

Righting an overturned liferaft.

Should a raft inflate upside down or capsize, a righting strap is fitted to the bottom of the raft. Usually the outside of the raft is marked "right here". Reach up and grab the strap and start pulling yourself up onto the bottom. Position yourself on the edge of the raft where the CO_2 cylinder is located. While holding the strap, lean back using your weight to re-right the raft.

If the raft lands on top of you, often a pocket will form underneath where your head pushes up the floor of the raft. Pull yourself out from under the raft, or swim out depending on which is more comfortable for you.

Should the canopy of an overturned raft fill with water, it may be considerably more difficult to re-right the raft. It may require several persons to re-right a flooded raft.

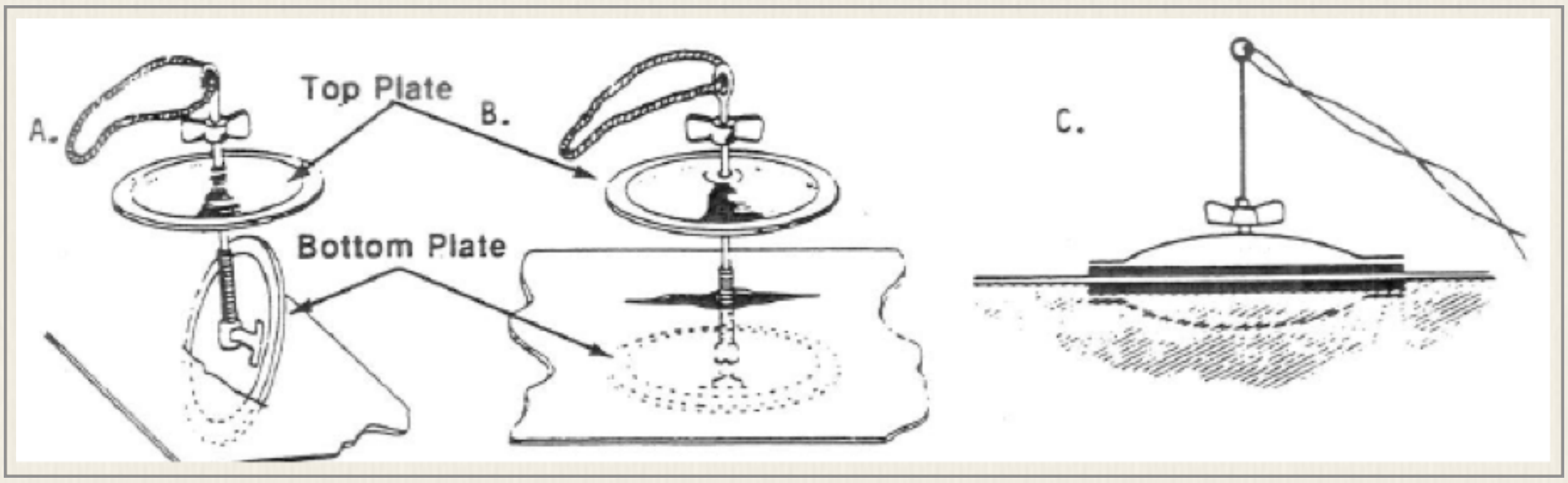


Righting an overturned liferaft**.**

Liferaft Equipment
Inflatable liferafts are provided with the equipment necessary for handling the liferaft alerting rescuers and surviving at sea. The following list are items that would be found in an ocean going liferaft. Liferafts for vessels that travel coastal, or on inland waters would have less equipment.

1. Heaving line
2. Instruction book-survival manual
3. Jackknife
4. Paddles
5. Inflation pump
6. Sea anchors
7. Bailers
8. First aid kit
9. Flashlight
10. Signal mirror and whistle
11. Pyrotechnics
12. Provisions
13. Can Opener
14. Drinking Cup
15. Fishing Kit
16. Anti Sea Sickness tablets
17. Repair kit

<u>Repair Kit</u>
It may be necessary to repair the buoyancy tubes in the liferaft. There are patches, cement and other tools necessary to make repairs in the kit provide. Also included are sealing clamps for plugging larger holes and holes which cannot be kept dry enough to use cement.

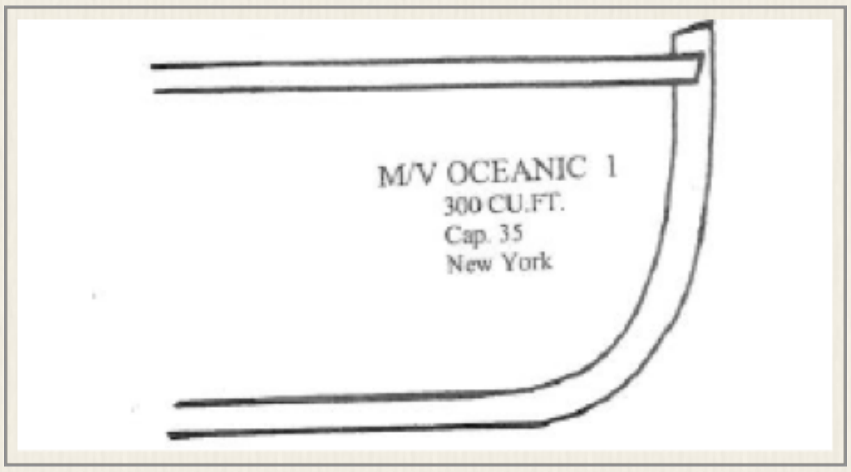


Use of sealing clamps to repair a liferaft**.**

Lifeboats

There are several types of lifeboats found on board merchant vessels today. While there may be variations between manufacturers, most are built with common features. A thorough understanding of construction, equipment and launching procedures is essential to all mariners. The following section will provide the student with a comprehensive understanding of features common to all lifeboats.

Lifeboats may be constructed of galvanized steel, aluminum, plastic or wood. They are usually pointed on both ends, known as double ended, as this design has been found most seaworthy. Care must be taken with metal lifeboats to ensure no electrolytic corrosion occurs as the result of contact with dissimilar metals (such as metal tools) left in or near them.



Lifeboat Markings

Lifeboats are marked on each side of the bow, in letters at least 3” high with the vessel’s name and the lifeboat number.

In letters that are at least 1 1/2 “ high, the capacity in cubic feet, the number of persons permitted and the vessel’s port of registry.

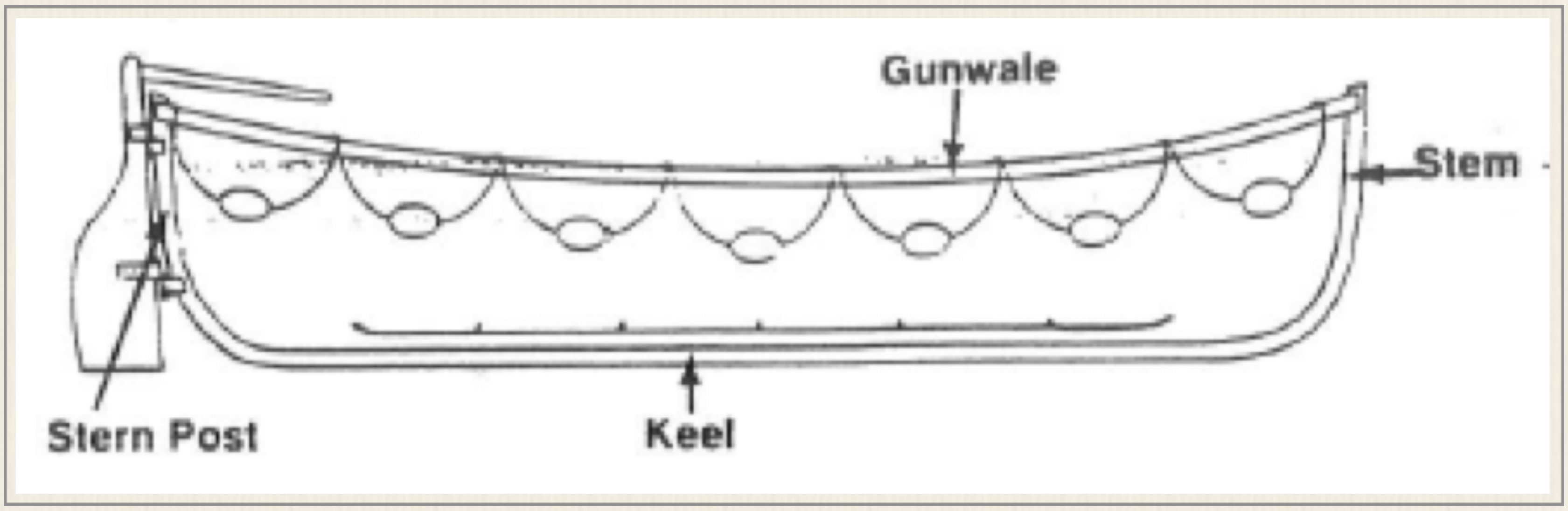
Additional markings such as the vessels name is required on the oars, and each life preserver. There is no size requirement for these markings. The number of persons permitted in the vessel shall be marked on at least two thwarts, in letters 3” high.

The tops of the thwarts, the side benches, and the footings of open lifeboats are painted International orange. The canopy exteriors of enclosed lifeboats are also painted international orange. On open lifeboats, there is a twelve-inch wide white stripe from the keel to the side bench as background for the red Rottmer releasing lever in the middle.

Lifeboats are numbered beginning forward, and odd numbered boats are on the starboard side, and even numbered boats on the port side.

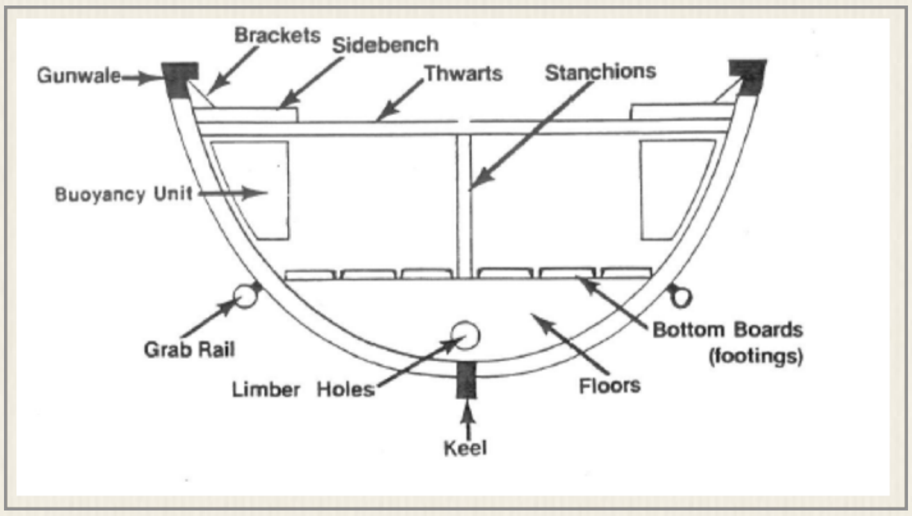
Lifeboat construction

Lifeboats are considered to be the primary lifesaving equipment aboard ships. A typical metal lifeboat is constructed the way most any vessel is, beginning with the keel. To this, the stem and stern post is attached and together with the gunwales, give the boat lengthwise strength.



The plating is usually in rows beginning at the keel, and starts with the garboard strake.
Where the bottom turns up and begins the sides of the vessel it is known as the bilge strake and the upper most row along the gunwale is called the sheer strake.

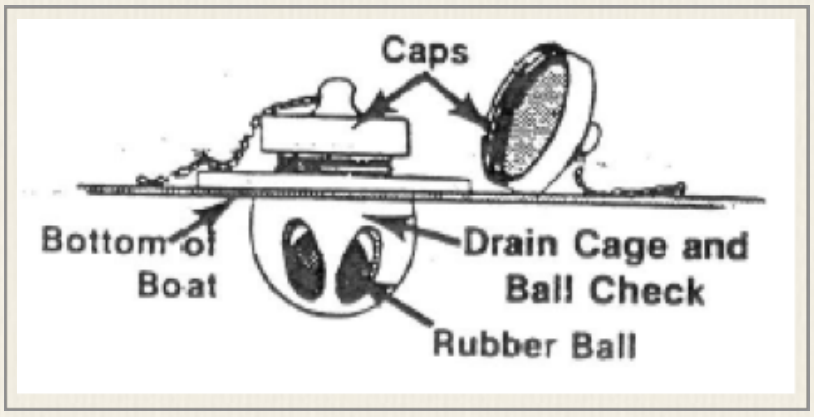
The thwarts extend from side to side in a typical lifeboat, and in addition to providing a place to sit, add strength. Stretchers are provided for individuals rowing to brace their feet against while rowing.



Cross section of an open ended lifeboat.

The bow and stern sheets and side benches provide additional seating for passengers.
Footings are the inside bottom of the lifeboat and rest upon the floors. The footings are the part of the vessel a person would stand on, and add overall strength to the vessel.

One or more drains are provided in each boat to allow water to run out when the boat is stored. The cap should be secured in place before the boat is lowered.



Boat drain.

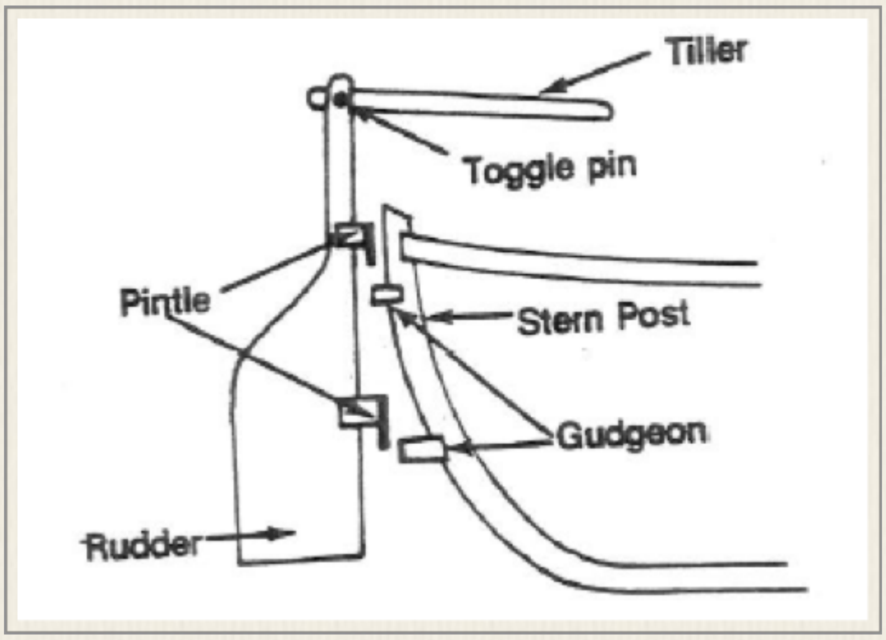
A small metal cage forms part of the drain extending below the shell of the boat. A rubber ball floats within the cage to act as an automatic closing valve. The cap for the drain is secured with a small length of chain, so the drain can be closed off before the boat is launched. Drains should be checked to ensure they are clean, and that the cap screws on easily.

Overhead view of a lifeboat.

On boats that are equipped with diesel engines, there are openings in the hull plating to allow cooling water to enter. These engines usually have a transmission which allows operation in forward or reverse. The propeller shaft passes through the hull at the stuffing box, and a stern gland prevents water from entering the boat. Engines must be operated each time abandon ship drills are conducted although if the boat is not dropped completely to the water, care should be used to see the engine does not overheat.

Hand propelling gear is installed on some boats. This type of propulsion has a propeller, stern tube, stern gland and gears, but rather than use an engine for propulsion, power is supplied by pushing and pulling lever handles fore and aft. The bottom ends of the lever handles fit into sockets connected to a bar on each side of the boat. These bars in turn move cranks on each side of the gear box. The bars, cranks, and levers for hand propelled boats must be kept clear when stowing gear.

A rudder is provided each boat for steering. The rudder is turned by means of a tiller, which fits on the upper part of the rudder called the rudder stock.

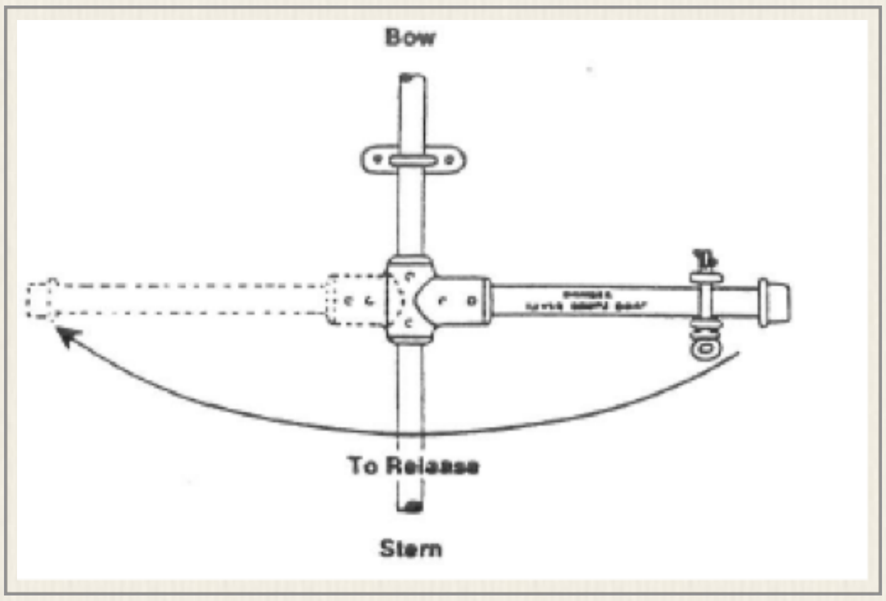


Rudder assembly.

The rudder has pintles, metal pieces which fit into the gudgeons on the stern post. Rudders for most boats are made of wood, however, if they are made of metal, are usually hollow and watertight in order that it will float. A test nipple allows testing of watertightness. In addition, most lifeboats will have a sweep oar, or steering in addition to the rudder.

Releasing Gear

A releasing gear is installed on lifeboats to let go the falls. The most widely used gear, the Rottmer gear releases the falls at both ends of the boat at the same time. The individual in charge of the boat turns a lever, which rotates a shaft connecting to hook locks at each end. When the hook locks are opened, the hooks releases the falls even though there may be a strain on them.



Rottmer Releasing Gear.

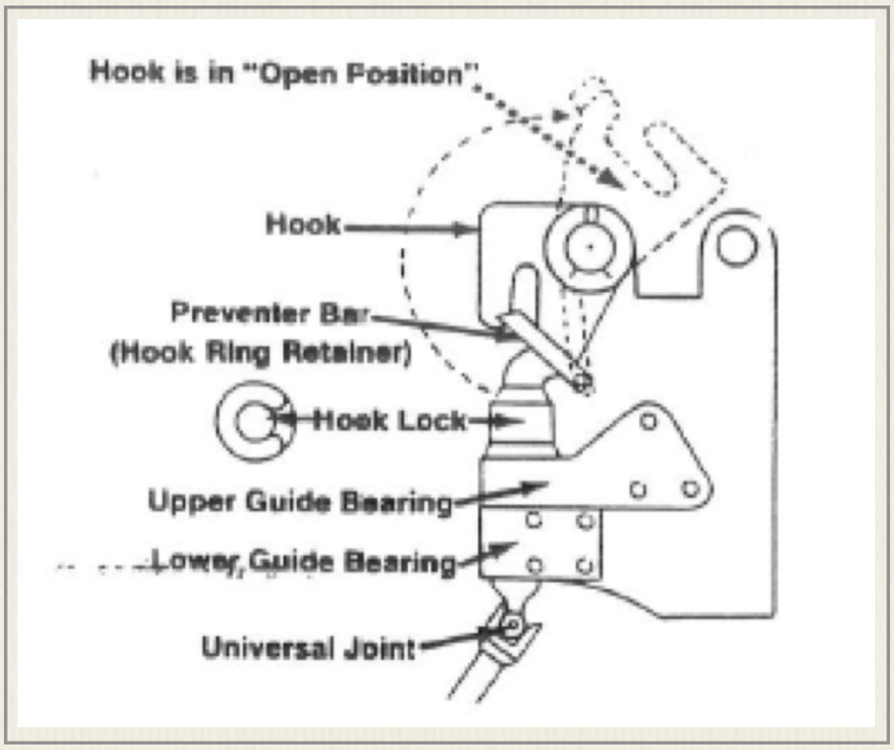
Simultaneously releasing the falls is essential in a seaway, however, unintentional release can cause serious injury. Regulations require that the lever be painted red and marked, DANGER, LEVER DROPS BOAT.

While the thwarts, side benches and footing of lifeboats shall be painted international orange, the area in way of the red mechanical disengaging gear control lever shall be painted white to provide a contrasting background for the lever. This band of white should be approximately 12 inches wide depending on the internal arrangement of the lifeboat.
Preventer bars are fitted to the releasing hooks to prevent the falls from becoming disengaged when there is no strain on them.

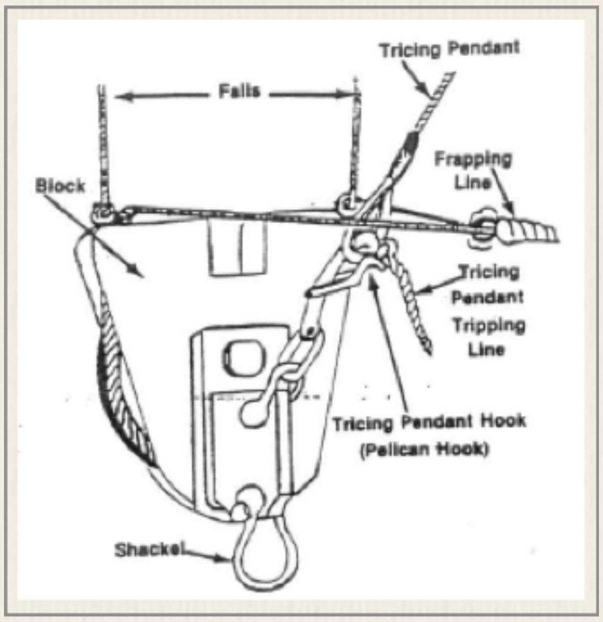
Releasing Gear

The falls blocks are attached at each end of the lifeboat to the Rottmer releasing hooks with hook rings. The hooks are part of the boat's Rottmer releasing system. The hook rings are permanently fastened to the falls blocks.

The Rottmer releasing system is to ensure both ends of the lifeboat are released from the falls at the same instant.



Each Rottmer releasing hook has a set of preventer bar, also known as hook ring retainers, to prevent the hook rings from accidentally falling out of the hooks-before the releasing lever is released.



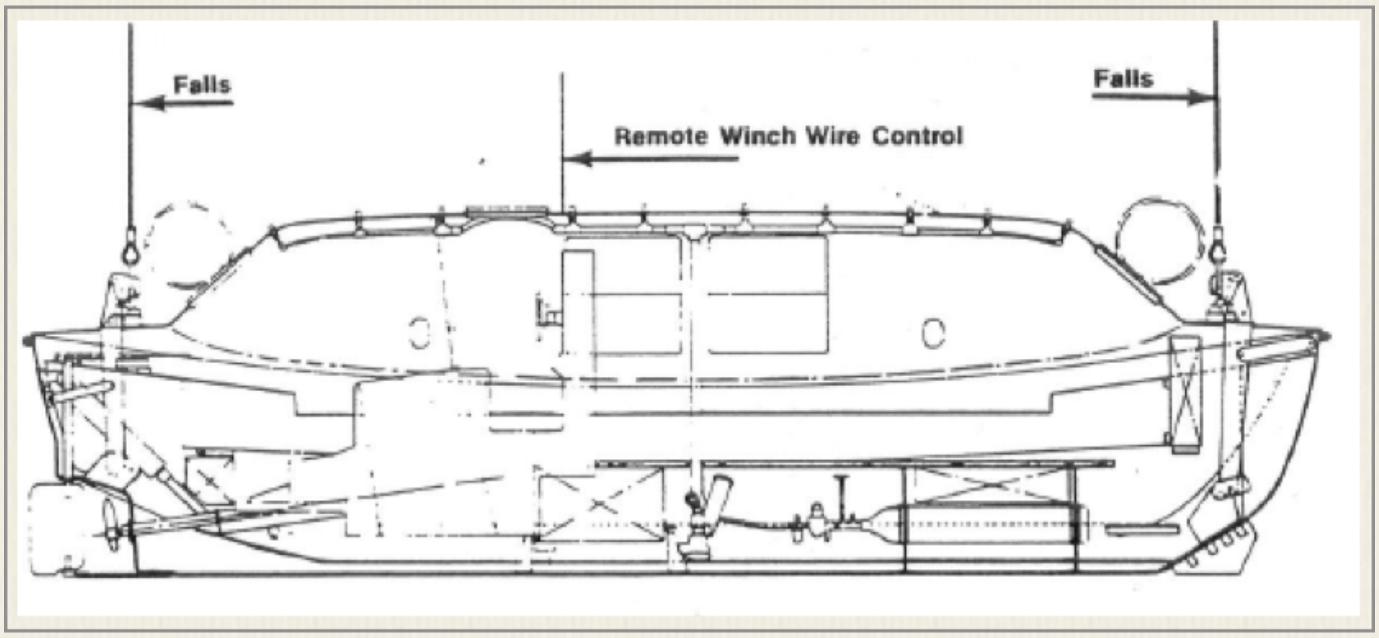
A typical falls block.

Additional Features

In addition to everything mentioned, lifeboats are equipped with grab rails. In the event the vessels turns over, survivors will have something to hang on to. Lifelines, usually in bights of three feet or less will hang from the gunwales, and provide other handholds for individuals in the water.

Enclosed Lifeboats

Most open lifeboats are being replaced by totally enclosed lifboats. These vessels have certain advantages, the most obvious being better shelter for the survivors. In addition most will right themselves if they capsize. Enclosed lifeboats also have watertight access doors, diesel engines and inside steering making them easier to maneuver in rough conditions. Some have external fire protection that sprays water over the craft, to allow it to escape through areas where there may be fire. These vessels are also equipped with a tank of compressed air for the survivors and engine, and will last for ten minutes.



An enclosed lifeboat.

Equipment

Lifeboats are provided with equipment to assure that necessary items for survival and alerting rescuers are available. Equipment will vary depending on the type of vessel, the route the vessel is certified for and any particulars about the specific service. The following is a list of items that may be found in a lifeboat.

Bailer- a scooping device used for removing water from the boat.
Bilge Pump-a manually operated pump designed to remove water from the boat.
Boathooks-a wooden pole with a metal ball-point and hook. Used for fending off, hooking falls, etc.
Buckets-usually galvanized steel and equipped with a lanyard.
Compass-a small magnetic compass is provided in each boat.
Ditty bag-a canvas bag containing a sailmaker's palm, needles, sail twine marline and marline spike.
Drinking cups-these should have a 3' lanyard attached.
Fire extinguisher-at each end of a motorized lifeboat.
First Aid Kit-Instructions for use of the contents of the kit are attached to the inside cover. The kit should contain bandages, eye dressing, tourniquet, scissors, safety pins, wire splint, ammonia inhalents, etc.
Flashlight-three spare cells and two spare bulbs are required. Batteries must be replaced yearly during the annual overhaul of the lifeboat. The light must be capable of being used as a blinker signaling device.
Hatchets-used for cutting falls and secured by lanyards at each end of the vessel.
Heaving line-buoyant 1-inch line 10 fathoms long.
Jackknife-one blade is a can opener for opening food and water tins.
Lantern-containing enough oil to burn for 9 hours.
Lifeboat gunwale ladder-required only on boats with a capacity of 60 or more persons, be stored mid-ships and be ready for immediate use.
Lifeline-made in bights of 3 feet or less, and must hang within 12 inches of the water. Provided for swimmers to hold on to or for survivors unable to find space in a crowded boat.
Life preservers-two are provided in each boat in addition to those provided on board ship for each crewmember
Locker-suitable stowage space for small items of equipment for protection from the elements.
Matches-a watertight can stowed in the equipment locker or under the stern thwart to hold them and keep them dry.
Mirrors, signaling-a device used to alert rescuers to the location of a lifeboat.

Oars-pulling boats are equipped with the proper number of rowing oars and a steering oar. Ships name is marked on all oars.
Oil, illuminating-in addition to the oil carried in the lantern, an additional quart is required for refilling if this becomes necessary.
Oil, storm-one gallon of vegetable, fish or animal oil must be carried in the metal container fitted at the apex of the sea anchor so that it can be easily distributed on the water to reduce the drag of the wind on the water, thus helping to prevent breaking seas.
Painter-lifeboats in deep sea service need a sea painter and boat painter, each of at least 2 ¾ inch circumference manila rope. The painter must be at least 2x as long as the distance between the boat deck and the waterline. The boat painter is made fast to the stem by a shackle through a splice dye and is used to hold the boat alongside. The sea painter has a long spliced eye which can be bent around a thwart and secured with a toggle. It is used when the ship is along side. The toggle, made of hardwood, should have a lanyard made of small stuff. The end of the lanyard is secured to the thwart, not the painter so the toggle cannot injure anyone when the sea painter is released. Other requirements may apply, consult the CFR.
Plugs-these are the closures provided for the automatic drains. They are attached to the boat with small chains in a handy position for use.
Provisions-two pounds of provisions for each person of the boat's authorized complement are carried in the lockers.
Rowlocks-each oar is provided with a rowlock which is attached to the boat by a small chain near its proper place. Two spare rowlocks are also carried in the equipment locker.
rudder and tiller-Since the rudder and tiller must be shipped before or soon after the boat is launched, they should be kept available in the stern of the boat.
Sea anchor-a device used to hold the boat into the wind or seas. The trip line permits the sea anchor to be easily brought back aboard.

Pyrotechnics
Floating orange smoke distress signals. This is a daytime signal and is capable of alerting planes and ships to the presence of the boat. It is ignited by means of a pull wire and then thrown overboard.

Red hand distress flares. Twelve hand held flares are carried. Each is ignited by removing the cap on the end and scratching the bottom on the flare against the scratch surface on the cap. Others can be ignited by twisting the lower end of the flare, aligning the arrows and then striking the bottom of the flare with the heel of the hand.

Red parachute distress flares. Twelve cartridges and a pistol or 12 hand held rocket propelled flares are carried. These flares are capable of reaching several hundred feet above the water and can be seen at night for considerable distances.

Most pyrotechnics are approved for up to 3 years, from the date of manufacture.

Other Supplies
Water. Sealed packs containing 3 quarts for each person of the lifeboat's authorized complement are carried in the lockers. They must be replaced every 5 years.

Tool kit. Required for motor propelled lifeboats, and contains the following tools:1 twelve ounce ball peen hammer, 1 screwdriver with 6 inch blade, 1 pair of 8 inch slip joint pliers, and 1 eight inch adjustable wrench.

Radio. Required only for motor propelled lifeboats with a radio cabin.

Equipment will vary depending on the approved route and service of the vessel. Life rafts carry similar but lesser amounts of equipment.

Davits, Winches, Blocks, and Falls
Davits are the preferred method of lowering and hoisting lifeboats. They are installed in pairs which can be extended over the water from the side of the ship in order to lower or hoist the lifeboat by means of fiber or wire rope falls. (falls are the ropes used to hoist or lower lifeboats)

Davits

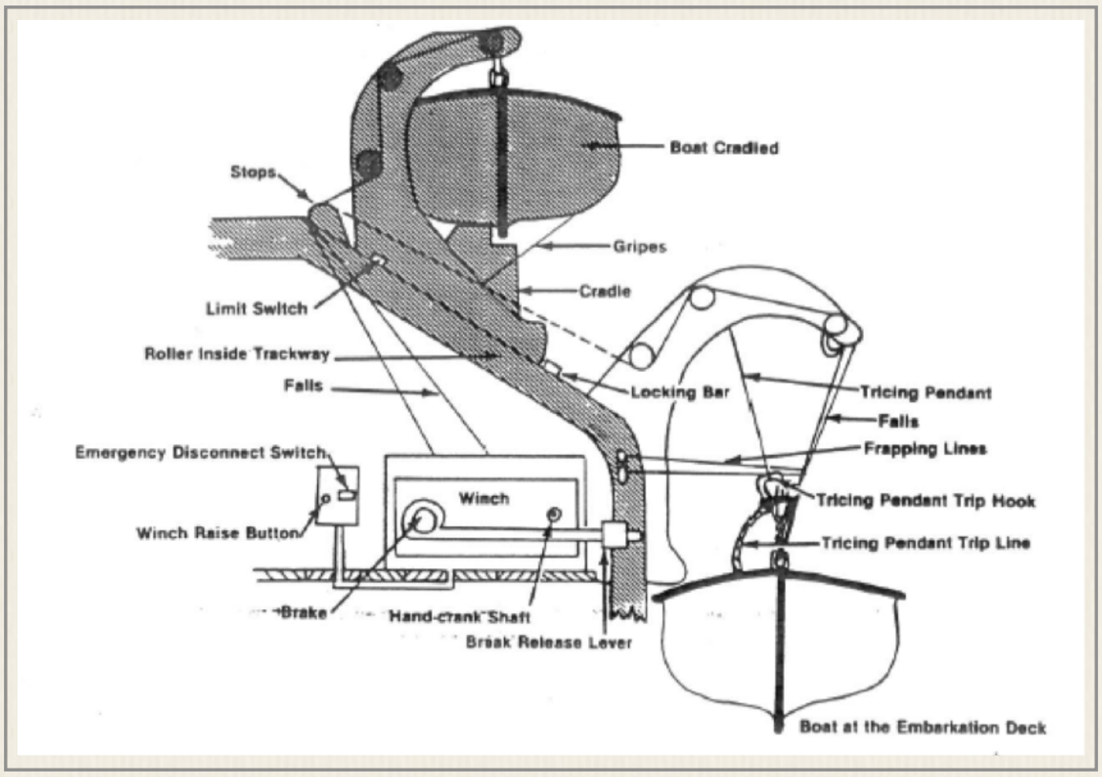
There are many types of davits available but conventional rolling chock gravity davits are the most commonly used davit aboard merchant vessels today. They are usually installed on both sides of the ship, and launch or retrieve lifeboats using wire falls and a winch.

Most often lifeboat davits use 6X19 regular lay wire rope that is pre-lubricated. The bottom end of wire rope falls are connected to the winch drum. The falls are then led through sheaves to the davit arms and through large blocks. Blocks and falls used as lifeboat gear must be designed with a minimum safety factor of six, based on the maximum working load. Wire rope falls are coated with grease to provide lubrication for the internal working of the wire as well as protection against external corrosion.

Winches

All vessels in ocean and coastwise service, provided the height of the deck on which the lifeboats are carried exceeds twenty feet, must be fitted with winches and wire rope. A hand brake for controlling the speed at which the falls are lowered is also required. There must be a governor brake capable of automatically controlling the lowering of a fully equipped and fully loaded lifeboat to a maximum speed of not more than 120 feet per minute. A motor or hand crank can be used to reel in the falls.

Winches not properly covered and lubricated are subject to damage from moisture and condensation which can gather in the electric winch motor. Winches may be either electric of pneumatic.



Rolling chock gravity davit.

The areas around lifeboats should be kept clear of freight, spilled oil or anything that may interfere with the immediate launching of the boat.

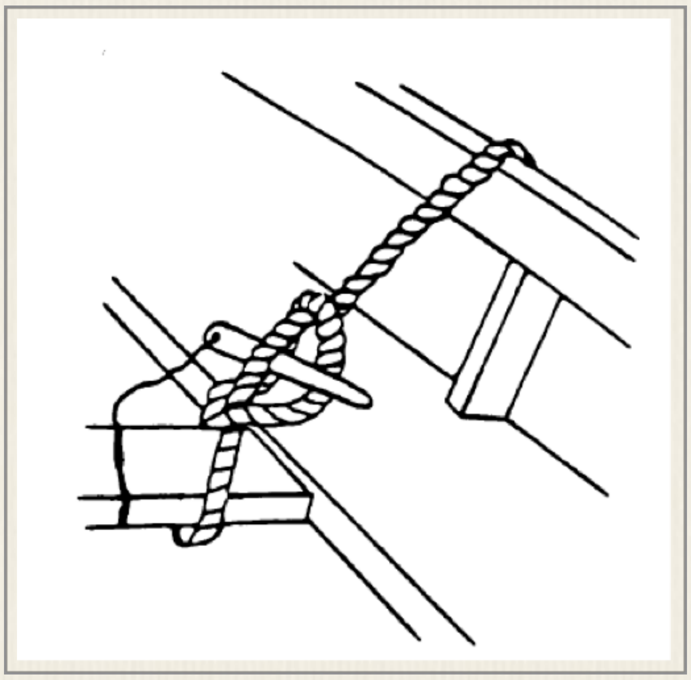
Gravity type davits are reliable, but demand periodic inspection and maintenance. There are some particular aspects that require special attention.

Limit Switches: These switches stop the lifeboat before it is in the fully stowed position. It prevents the winch from hoisting the boat so far that it “two blocks” and parts the falls. If this were to happen the lifeboat will launch itself after an uncontrolled decent. The limit switch is part of the control circuit.

Hand cranks: Winch hand cranks have couplings that should automatically disengage the crank if the electric motor starts to turn the winch. They do not always work properly and can cause injury from a rapidly rotating crank handle. Disconnect the power using the emergency disconnect switch while the crew hand cranks the boat back into its stowed position.

Painters

The sea painter is a piece of rope, either manila or synthetic that is used to launch and recover a lifeboat. It is usually about 2.75' in circumference with an eye splice in one end. It length is usually 3 times the distance between the boat deck and the light water line. The sea painter is attached to the forward inboard thwart with a toggle.



A sea painter connected with a toggle.

Survival at Sea

Abandoning Ship

It is the decision of the captain when to abandon ship. If possible you should plan ahead and prepare for any possible situation you might encounter afloat, and be prepared to follow these practical suggestions before abandoning your vessel.

>put on warm clothes and a lifejacket
>bring or don an immersion suit
>take a long drink of water en-route to the survival craft
>take other useful items with you. (blankets, etc)

If you must enter the water:
>secure the lifejacket properly
>if possible get down to a height of 15 feet or less before jumping
>remove eyeglasses, contact lens and sharp objects

Before jumping:
>cover the nose and mouth with left hand
>cross-over left hand with right hand and hold lifejacket securely
>look down to ensure nothing is in the way
>with toes over the edge, step off, looking forward, feet together
>remain in this position until bobbing to the surface
>board survival craft as soon as possible.
>get away from danger
>save your strength, do not swim or thrash around any more than necessary because it hastens the onset of fatigue and hypothermia.

Moral

Do not under-value moral. It is the state of mind which backs you with courage and confidence. The lack of it has proved fatal far more often than the lack of water. Moral is frequently the total of little things. Do not slight the trivialities which contribute to it.

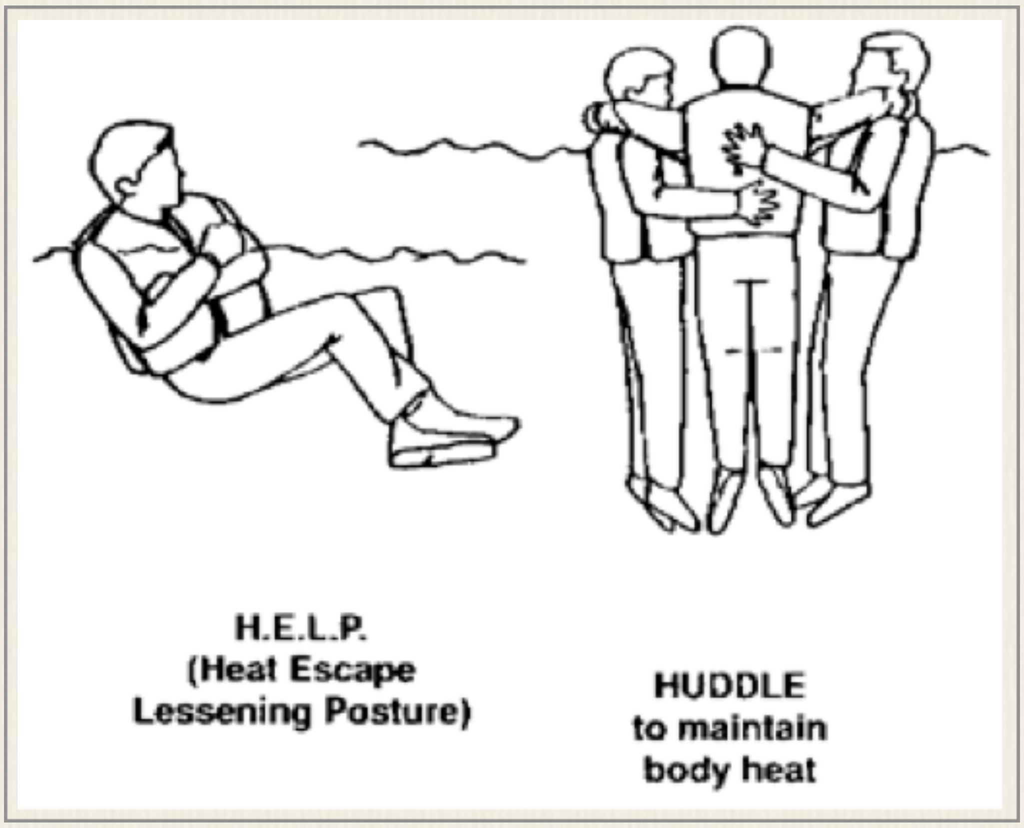
Ditch bag
Preparing a ditch bag, ahead of time will ensure that you have at least the basic items to help in your survival. While the contents of the bag should be configured to your specific situation, some items should be included in every bag.

To start with, the container you select should be waterproof. The following items included should be based on the type of voyage you are on, as well as weather conditions and the area you are traveling.

- extra clothing
- flashlight
- flares
- knife
- first aid kit
- fishing kit
- signal mirror
- survival guidebook
- personal medicine
- extra glasses if necessary.

Other items based on your particular situation can be included.

Hypothermia
Hypothermia means lowered deep body temperature. In cold water, the skin and peripheral tissues cool very rapidly. Core temperature cooling takes 10-15 minutes before affecting the heart and brain. Intense shivering occurs in a futile attempt to increase the body's heat production and counteract the large heat loss. Unconsciousness can occur when the deep body temperature falls from the normal 37°. C (98.6F), to approximately 32° C (89.6F). Heart failure is the usual cause of death when deep body temperature cools below 30°C or (86 F).



Ways to maintain body heat while immersed in water.
The areas that are especially prone to high heat loss, the head, sides of the chest, and groin region can be protected by using the HELP position while in the water. This stands for the "Heat Escape Lessening Posture". This technique involves holding the inner side of your arms tightly against the side of your chest, the thighs are pressed together and raised to close off the groin region. The use of this position can significantly help reduce heat loss and can result in a nearly 50% increase in survival time. Some life jackets offer more thermal protection than others. Float coats and similar devices can significantly decrease cooling, and increase survival times.

Hypothermia Treatment
Prompt medical attention should be given to someone suffering from hypothermia. It is too complex a subject to give extensive advice here. It is sufficient to indicate the wide range of re-warming methods that have been used in different situations.

body to body contact
hot wet towels and water bottles
electric and chemical heating pads
heated blankets
warm drinks

warm showers/baths

In general, it is best to donate heat to the core of the body leaving arms and legs alone. Do not rub the surface of the body. If the person is severely hypothermic handle the body gently to avoid jolts that may adversely affect the heart's function.

In the unfortunate event of cold water immersion, your rate of progress into hypothermia depends on water temperature, who you are, (body build) how you behave in the water and what you were wearing when you went in.

Additional Regulations
The United States Code of Federal Regulations (CFR's) and the International Safety of Life at Sea Convention of 1974 (SOLAS) mandate the lifesaving systems, equipment and appliances that are required to be carried on board vessels that are subject to the regulations and convention. In 46 CFR Subchapter W, Part 199, Lifesaving Systems for Certain Inspected Vessels, includes the requirements for all inspected vessels, plus additional requirements for passenger and cargo vessels.

Further, in 46 CFR, Part 199, Subpart B details for all inspected (with few exceptions) vessels the requirements for emergency situations. Covered are topics such as emergency communications, emergency station muster lists, manning and launching and recovery of survival craft. Also covered are the training and drill requirements, operational readiness and maintenance and inspection of lifesaving equipment.

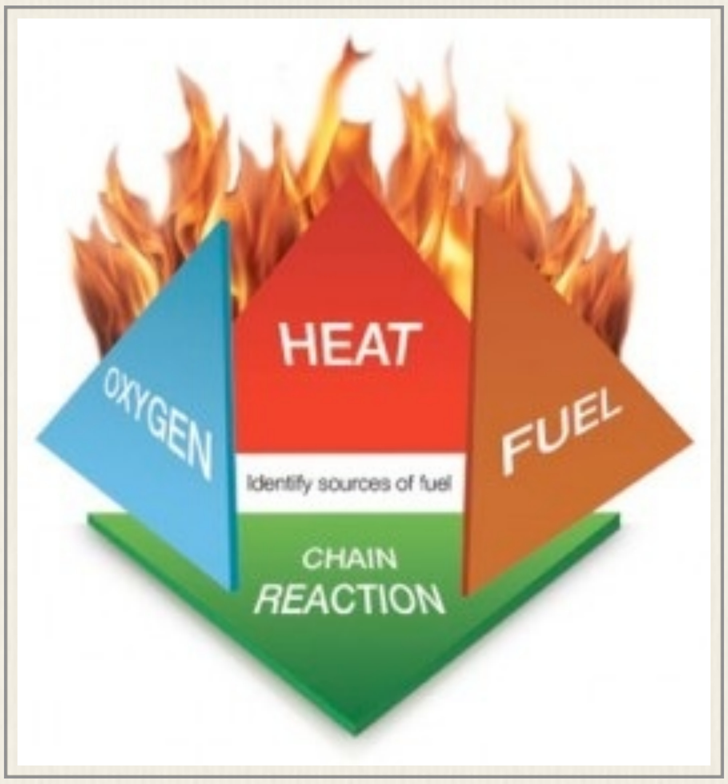
A careful review of the CFR's is necessary for anyone operating an inspected vessel. (Small passenger vessels are covered by subchapters K and T)

The Officer in Charge of Marine Inspection (OCMI) may require a vessel to carry specialized or additional life-saving equipment other than as required in the CFR's if the OCMI determines that the conditions of a voyage present uniquely hazardous circumstances that are not adequately addressed by existing requirements.

Fire Fighting

What is fire?
Fire is rapid oxidation. The byproducts are heat and light.

Fire Tetrahedron
In order for burning to occur, several components must be present.



Fuel
The fuel component of the fire tetrahedron is any solid, liquid or gas that can combine with oxygen in the oxidation chemical reaction. A fuel with sufficiently high temperatures ignites if an oxidizing agent is liberated. Combustion continues as long as enough energy or heat is present. Under most conditions, oxygen in the air is the oxidizing agent. Some materials release their own oxygen during combustion and can cause fuels to burn in an oxygen-free atmosphere.

Heat
Self sustaining combustion of solids and liquids depends on radiant heat providing energy for continued vapor production. Sufficient heat will maintain or increase this feedback, and the fire either remains constant, or grows. A positive heat balance is required to maintain combustion, and occurs when this heat produced is fed back to the fuel. If heat is dissipated faster than it is generated, a negative heat balance is created.

Oxygen
Oxygen availability is critical if combustion is to be supported. Normal air

is 21% oxygen. There are numerous situations onboard ship where oxygen content is less than this.

Oxygen deficient conditions are most commonly found in empty ballast or cargo tanks, double bottoms or void spaces. Oxygen concentrations below 21% can adversely affect both fire production and life safety. Fire intensity begins to decrease below an 18% oxygen concentration. Oxygen concentrations below 15% do not support combustion in the flaming mode.

Flaming and Smoldering:
Fire burns in two basic modes, flaming and smoldering.

The faming mode requires an uninhibited chemical chain reaction. This chain reaction is a series of reactions that occur in sequence with the results of each individual reaction being added to the rest.

Not everything is understood about this process, but it is established that heating a fuel can produce vapors that contain substances that combine with oxygen and burn. For flaming combustion to continue, enough heat energy must be produced to cause the continued development of fuel vapors.

Smoldering combustion is defined as glowing combustion on the fuel surface and may or may not be related in any way to the oxygen content in the vicinity of the smoldering process.

What is understood here is that fuel vapor production and temperatures may not be sufficient to support flaming combustion. Oxygen concentrations as low as 3% may support fire in the smoldering mode.

Main Sources of Fire
<u>Careless Smoking</u>
>Disposal of butts and matches
>Smoking in prohibited areas
>Smoking and alcohol

<u>Faulty Electrical Circuits and Equipment</u>
>Use of non-approved electrical equipment
>Wiring and fuses
>Jury-rigging
>Exposed light bulbs
>Vapor-tight fixtures
>Electric motors
>Charging storage batteries
>Machinery Spaces

<u>Galley Operations</u>
>Energy sources
>Ranges & deep fryers
>Poor housekeeping

<u>Unauthorized Construction</u>
>Poor constructions of shelves, etc. where the collapse of such would cause a spark or fracture of a line carrying hot oil

<u>Welding and Burning Operations</u>
>Unsafe burning and welding practices
>Failure to maintain competent fire watches and to observe proper procedures

<u>Shipyard Operations</u>
>Shore side workers aboard
>Careless safety precautions during repairs and maintenance

Fuel Oil Transfers and Service Operations

>Overflows on to hot surfaces
>Leaks in transfer systems
>Oil burner maintenance
>Accumulation of oil in bilges

Spontaneous Combustion

>Ships materials and or cargos subject to spontaneous combustion

Improper Handling and Stowage of Cargo and Stores

>Loading leaking drums and packages
>Spontaneous combustion
>Stowing flammable items against hot bulkheads
>Inadequate segregation
>Unsafe stowage

Loading and Discharging Operations of Dangerous Liquids

>Improper fendering
>Lack of coordination during transfers
>Cargo expansion
>Collection of vapors in pump rooms and wells
>Static electricity
>Naked flames or sparks
>Improper use of cargo hoses
>Vessel to vessel transfers
>Cargo heating systems

Collisions

>Ignition of flammable vapors through sparks caused by collisions

Fuel Characteristics

Shape and Size-surface to mass ratio: which is the surface area of the fuel to the mass of the fuel (this increases as the fuel particles become smaller and more finely divided-saw dust as opposed to logs).

Position-fire spread is more rapid with solid fuel arranged vertically than horizontally.

Physical Properties-liquids have properties that make them more difficult to extinguish and more hazardous to the crew. Liquids assume the shape of its container-if something spills on deck it flows and accumulates in low areas. Vessel movement further complicates this with flow in different directions.

Volatility-the ease with which a liquid gives off vapors

Spread of Fire

Conduction Transfer of heat through a solid body.

Radiation Transfer of heat from a source across an intervening space.

Convection Transfer of heat though the motion of heated matter such as smoke and gases.

Hazardous Products of Fire

Flames

>Avoid contact with flames
>Maintain safe distance
>Wear protective clothing

Heat

>Temperatures above 122°F are hazardous to humans
>Avoid direct exposure even if wearing protective clothing

Gases

>Hazardous gases are carbon dioxide and carbon monoxide
>Inhalation of carbon monoxide can lead to death in a few minutes
>Inhalation of carbon dioxide leads to unconsciousness
>Wear appropriate breathing apparatus

Principals of Fire Behavior

1.Fuel may be found in any of 3 states: solid, liquid or vapor.

2.Only vapors burn, liquid or solid fuels must be changed to the gaseous state.

3. Solids change to gases by a pyrolysis process-the chemical decomposition of a substance by the addition of heat.

4.Gases from liquids by vaporization. This requires less heat than pyrolysis.

Fuel Vapor to Air Mixture

For combustion to occur, the fuel gas has to mix with oxygen in the proper ratio. The flammable range of a substance is reported using the percent by volume of gas or vapor in the air for the LFL (lower flammable limit) and the UFL (upper flammable limit).

Below the LFL the fuel/air mixture is too lean to burn and above the UFL it is too rich to burn.

Variations in temperature and pressure can cause the flammable range to vary considerably.

Classes of Fire

Class	**Material**	**Extinguishing Method/Agent**
A	wood, furnishings, paper	water, fog, foam, Halon
B	combustible liquids, greases, gases	foam, CO_2, dry chemical
C	live electrical equipment	CO_2, Halon, dry chemicals
D	combustible metals	dry powders, sand

Principals of Fire Development

When the four components of the fire tetrahedron come together, ignition occurs. For a fire to grow beyond the first material ignited, heat must be transmitted beyond that first material to additional fuel groups.

Fire development in a compartment is usually controlled by the availability of fuel or oxygen and is termed either fuel controlled or ventilation controlled.

Five Stages of Fire Development

1. Ignition-the point at which flaming combustion begins. The fire is generally small and confined to the material first ignited.

2. Growth-as fire gas plume begins to form above the burning fuel, air is drawn into the flume and convection causes the heated gasses to rise. Hot gases rise, hit the deckhead and begin to spread outward. The fire spreads because radiated heat from the flames increase the temperature of surrounding fuels to their fire or flash points. At this stage the fire is fuel controlled.

3. Flashover-this is a transition point between growth and the fully developed fire. During flashover conditions in the compartment change very rapidly, temperatures increase, additional fuel groups are becoming involved. Gases at the deckhead level that accumulated during growth stage causes radiant heating of combustible materials remote from the origin of the fire. At this point a compartment is fully involved in fire.

4. Fully Developed Fire-during this period, the burning fuels are releasing the maximum about of heat possible and producing large volumes of unburned fire gases. This stage is frequently ventilation controlled.

5. Decay-as the fuel is consumed, the amount of heat energy released begins to decline-the fire again becomes fuel controlled.

Thermal Layering of Gases

This is the tendency of gasses to form layers according to temperature. Thermal balance, and heat stratification are also terms the crewmember may hear to describe this phenomenon. The hottest gasses tend to be at the top, while cooler ones at the bottom .

Thermal layering is critical to fire fighting activities. If the hottest air and gasses are allowed to rise, the lower levels will be safer for fire crews. If water is applied continuously to the upper level where the temperatures are highest, the rapid conversion to steam can cause the gases to mix. This swirling of smoke and steam disrupts normal thermal layering and causes hot gases to mix throughout the compartment. This mixing disrupts the thermal balance or creates a thermal imbalance that can burn crew members, or force them to retreat. The only way to correct this situation is to vent the compartment.

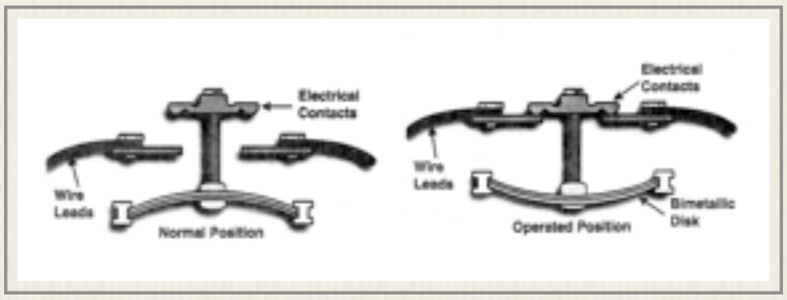
A proper attack procedure is to ventilate the compartment and allow the hot gases to escape. Onboard ship, this is not always possible. Directing a fire stream to the deckhead in short bursts will help maintain the thermal balance. A narrow cone (20-30 degrees) fog pattern may also help minimize disruption of the thermal layers.

Backdraft

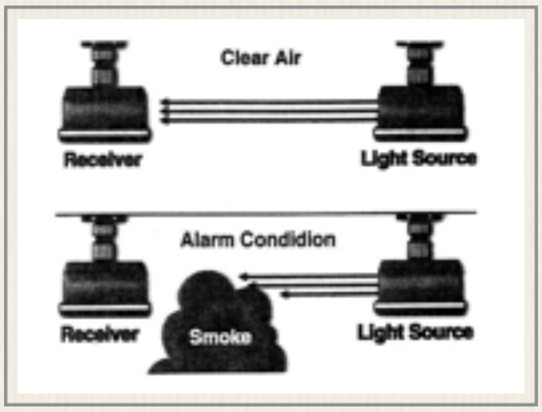
Collection of large volumes of hot unburned fire gases in unventilated spaces can be extremely dangerous. Crewmembers entering compartments or other confined spaces must exercise care when opening doors, portholes, or any ventilation openings. Since these gases are above their ignition temperatures, the addition of oxygen may cause these gases to ignite with explosive force. This is known as backdraft. The potential for backdraft is reduced with vertical ventilation, which allows these hot gases to vent off.

Fire Detection Systems
Depending on the particular class of vessel, there is almost always some sort of fire detection system protecting part of if not the entire vessel.

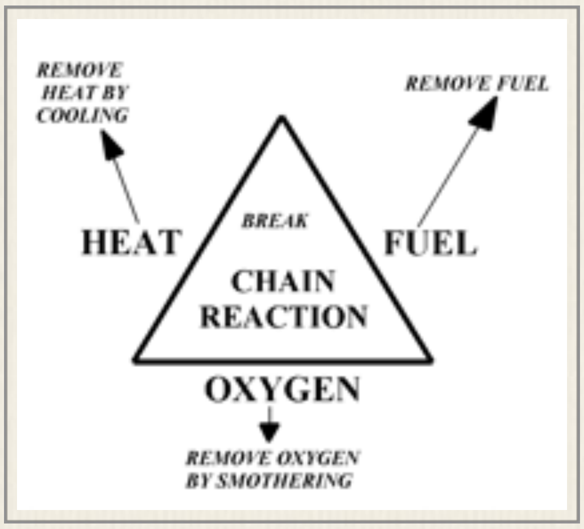
<u>Heat Detection Systems</u>
This system might use some sort of bi-metallic sensor that would close an electrical connection, as shown below. The electrical circuit, once completed triggers an alarm in the wheelhouse.



<u>Smoke Detection Systems</u>
These systems use some sort of photo-electric sensor that when interrupted, completes an electrical circuit triggering an alarm in the wheelhouse.



Methods of Extinguishing Fires
Remove any component of the fire tetrahedron, and the fire goes out. Certain components are easier to remove than others, and vary by circumstances. Remove the heat by cooling, remove the fuel, cut off the supply of oxygen or break the chain reaction, and you effectively kill the fire.



Depending on the circumstances, availability of various agents and other factors would influence your choice of agents, and method of attack.

Containment may be your only solution if one or more components of the fire tetrahedron cannot be removed.

Fire dampers should never be disabled, altered or left permanently open. Operated manually or by fusible link.

Extinguishing Agents

<u>Water</u>

>provides cooling
>when turned to steam provides smothering

<u>Foam</u>

>blankets a surface and provides a barrier (smothering)
>most effective on non flowing liquids

<u>Carbon Dioxide</u>

> is non conducting
>extinguishes by smothering
>doesn't leave residue

<u>Dry Chemical</u>

>various types
>breaks the chain reaction

<u>Halon</u>

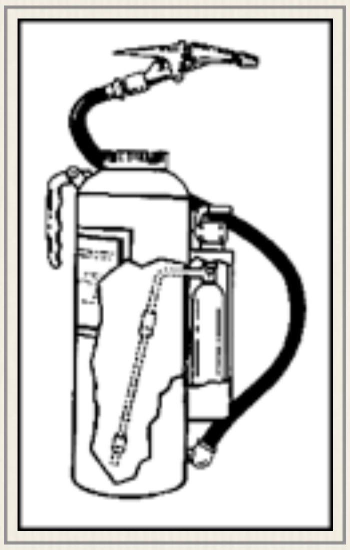
>disrupts the chain reaction
>does not damage cargo
>best on electrical fires

Fire Extinguishing Systems

<u>Fixed Systems-</u> These are systems designed and installed in a ship as part of its original construction.

<u>Semi-Portable Systems-</u>These are extinguishers that allow a hose to be run out to attack the fire. There is some ability to move and or control the system, but not move the entire unit any great distance.

<u>Portable Systems</u>-These are extinguisher that weigh less than 55 lbs. when fully charged, and can be carried to the fire for a fast attack.



Portable Extinguishers

Provide the first means of attack. Every portable extinguisher is classified in two ways, with one or more letters and with a numeral. The letters A,B, C, or D indicated the classes of fire on which the extinguisher may be used.

The USCG also uses Roman numerals to indicate the sizes of portable extinguishers. The numeral I indicates the smallest size and the number V indicates the largest. Thus a B-I extinguisher is a small portable extinguisher suitable for use on class B fires.

Portable extinguishers use a variety of extinguishing agents, but the most common found onboard ship are, carbon dioxide, dry chemical, and foam. On occasion you may find a halon portable extinguisher. Water-Soda Acid extinguishers are essentially obsolete.

<u>Carbon Dioxide (CO2)</u>

>use on Class B and C fires only
>4-35 lbs.
>reach of 3-8 feet
>discharge time of 8-30 seconds
>direct at bas of Class B fires, and then back and forth
>aim at base of Class C fire
>does not freeze

>inspect annually for damage and weight
>must be recharged after use and if weight less than 10% of label weight
>weigh on calibrated scale

Foam

>use on Class B fires only (unless rated for A fires)
>2.5 gallon size produces 18-20 gallons of foam
>reach is about 30-40 feet
>discharge time, slightly less than 1 minute
>bank off nearby surface to allow foam to flow over the surface of burning liquid
>protect contents from freezing
>read and understand directions for use

Dry Chemical

>use mainly on Class B and C fires
>2-30 lbs.
>Reach 10-30 ft.
>discharge time, 8-10 seconds
>direct charge at seat of fire, starting near the edge & sweep side to side
>unaffected by temperatures

Halon

>use on Class B and C fires (and A with appropriate chemical)
>2-12 lbs.
>reach of 9-15 feet
>discharge time of 9-15 seconds
>direct at seat of Class B fire and apply with a slow, side to side sweeping motion
>direct at source of an electrical fire

Operating a Portable Fire Extinguisher.

The PASS Procedure describes the use of portable extinguishers in four easy steps.

P - Pull the pin at the top of the extinguisher.

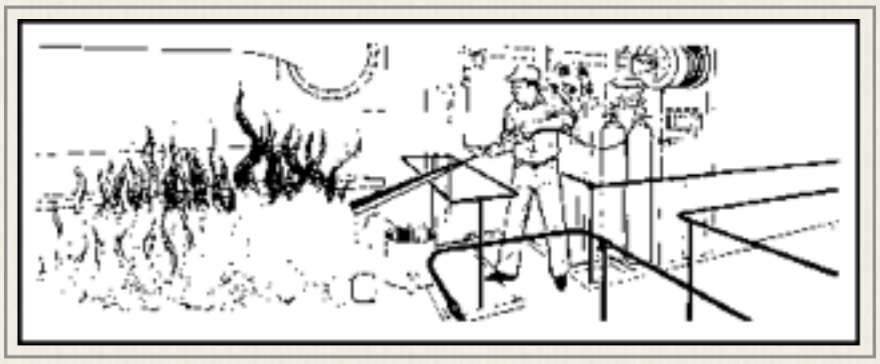
A - Aim the nozzle toward the bas of the fire.

S - Squeeze the handle to discharge the agent

S - Sweep the nozzle back and forth at the base of the flames

Semi Portable Extinguishers

These extinguishers are usually mounted on a bulkhead, and have a length of hose that allows it some flexibility. They usually have more fire fighting capability than portable extinguisher, but obviously also have a limited working range.



Use of a semi-portable system.

Fixed Systems

Carbon Dioxide

Advantages

none conductive
non-corrosive
easily stored-maintains quality for long periods
when discharged, remains at lower levels of a space until it diffuses

Disadvantages:

hazardous to humans-can lead to respiratory arrest
re-ignition is possible
cold discharge but little cooling effect
limited amount can be carried

Usually consists of banks of high pressure storage bottles (K-bottles) along with associated piping, valves, and control systems.

Warning alarm sounds for at least 20 seconds before discharge

Two types of systems

1-total flooding-used primarily in machinery spaces-expels 85% of its total capacity within 2 minutes for quick extinguishment
2-the cargo system-not activated automatically-requires space be sealed first to be effective-agent is introduced into space at a preset rate to reduce oxygen content 6o level that will not support combustion.

Requires activation by use of two pull cables. System is not dependent on any source of power other than the discharged CO_2.

Requires controls to be outside space protected.

The system can be activated from within the space, by removing the locking pins and operating the levers of the control head mounted on the two pilot cylinders and pilot port valve. This may result in bypassing the 20 second alarm prior to flooding.

Inspection and Maintenance of Carbon Dioxide Systems.

Failures of these systems is usually due to operator error, or lack of knowledge of system operation.

Inspection should be on a regular basis. Piping, controls, & nozzles should be inspected and checked for obstruction by paint, or other substances.

Halogenated Systems
Good on liquid or electrical fires--limited usefulness on class A or D.

Similar to CO2 systems in appearance. Systems are usually customized for each individual situation.

No longer available, and illegal to install, but if one is currently in place it is ok to maintain.

Uses Halogen 1301.

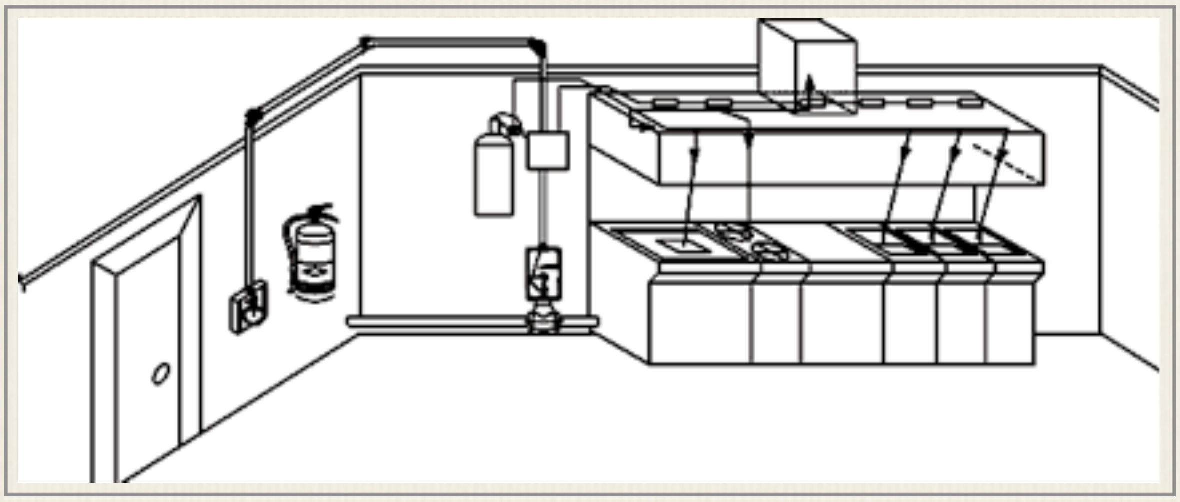
Galley Systems
May be wet or dry chemical, although dry chemical is more popular.

Highly specialized systems used where a rapid fire knock down is required.

Similar to larger fixed systems in set up, just more specialized and smaller components.

Wet Systems uses water and potassium carbonate or potassium acetate delivered in spray form.

Great for liquids and or Class A material.



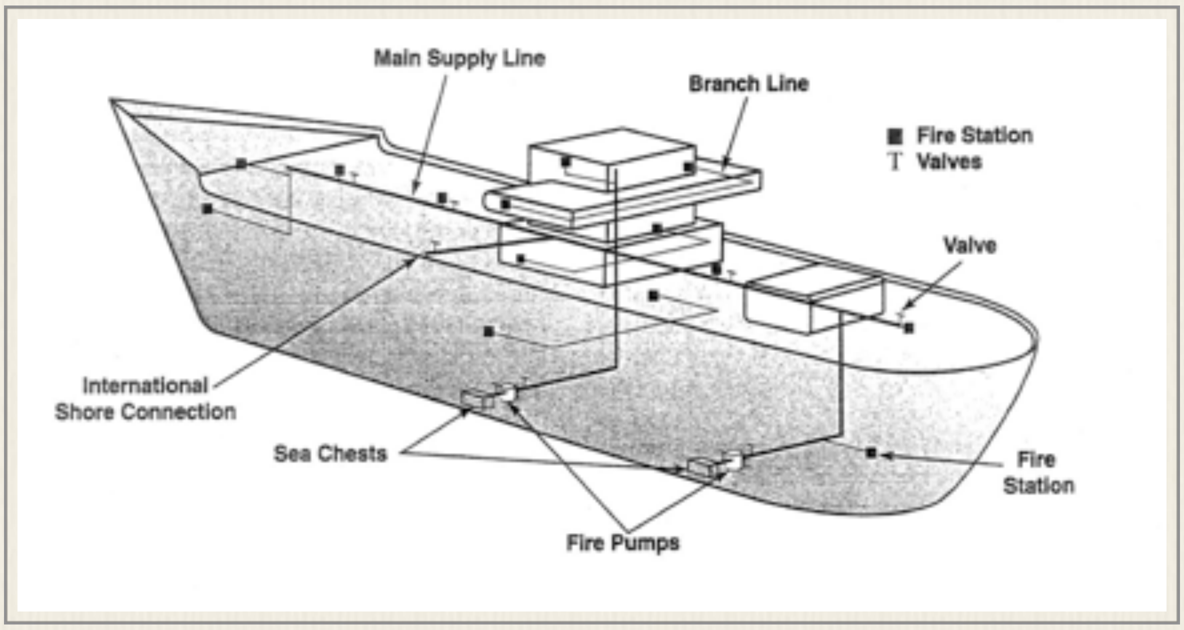
A typical galley system.

Water Based Systems
Probably the best overall system as it is
- >simple
- >reliable
- >automatic
- >inexpensive

Problems associated with this system:
- >stability
- >cargo/space damage
- >maintenance problems

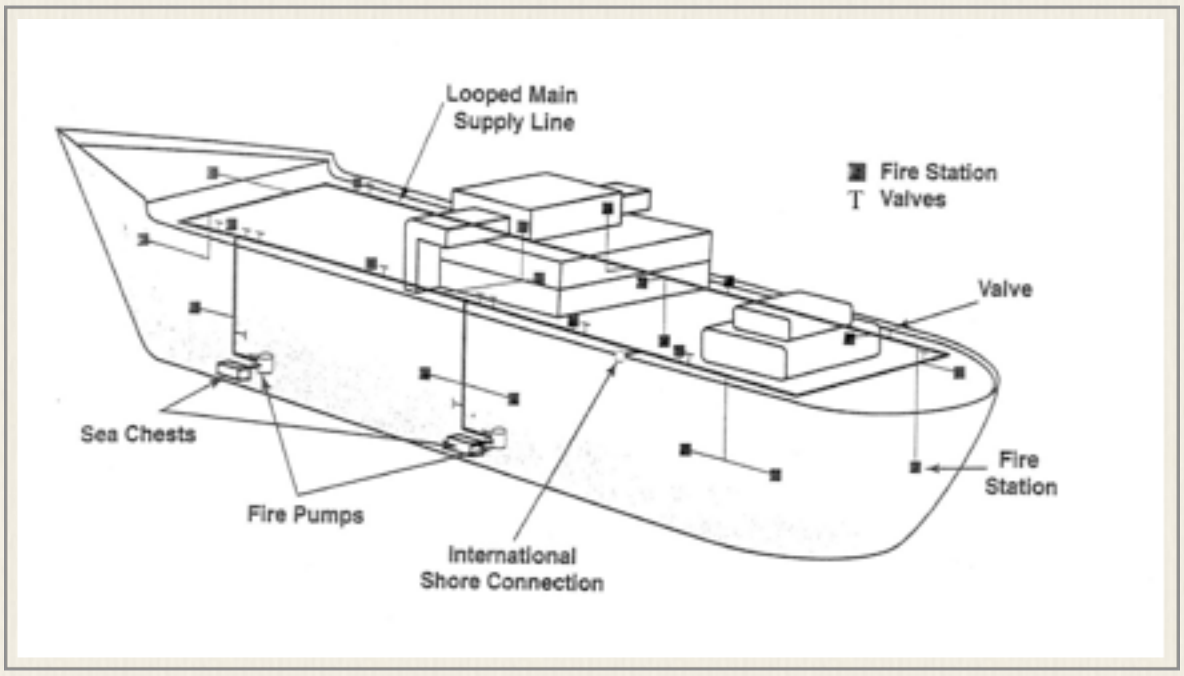
Fire Main Systems

Single Main System- water is picked up from a raw water pick up point (or from a shore side source) and piped throughout the vessel as shown.

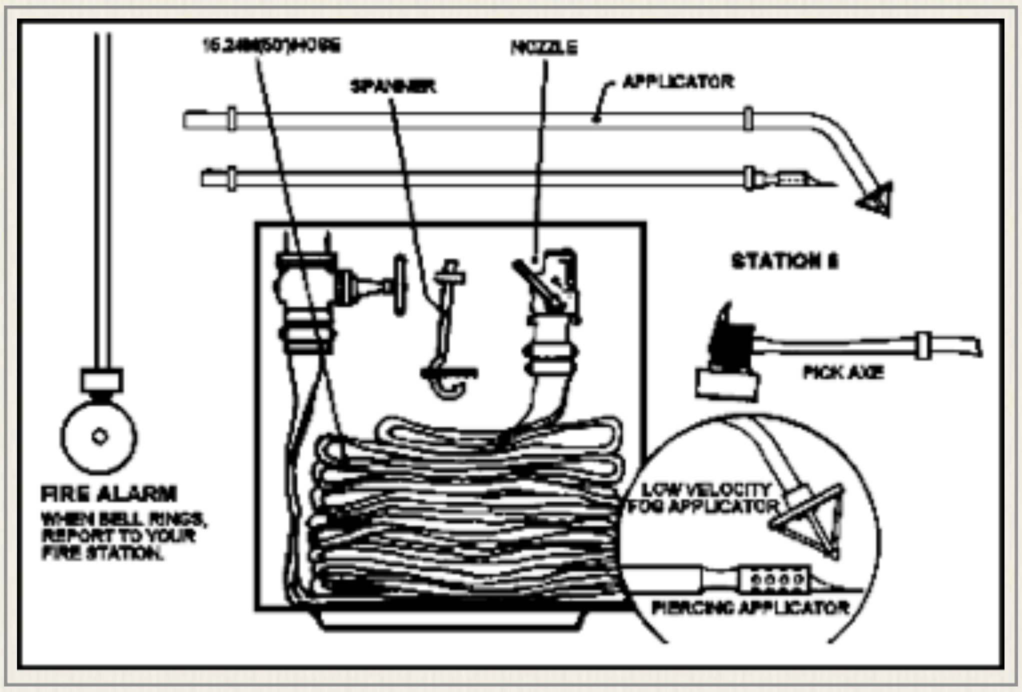


If a section of piping is damaged, may render the entire system useless.

Horizontal Loop System- forms a complete loop so that damage can be isolated and not disrupt the water delivery.
The weak link in either system is the fire hose at the fire station. Easily damaged and if not secured can result in a loss of pressure.



Fire Stations
Located throughout the vessel are numbered fire stations. Each station will contain various pieces of equipment that may be needed during an emergency. Not every station has every piece of equipment, but in general a crewmember is likely to see at each station the following:



1. Hose/hose rack or Camel

2. Nozzle (All Purpose Nozzle or Vari-nozzle)

3. Spanner wrench

4. Low velocity applicator

5. Ax

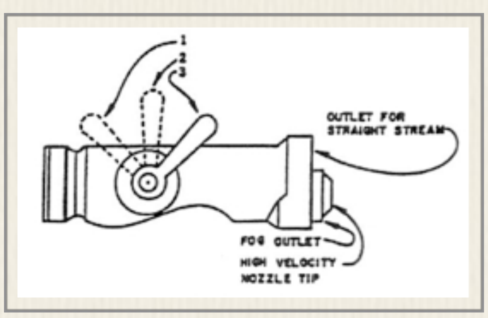
USCG regulations specify that water streams from at least two fire stations overlap. Stations must remain accessible to crewmembers while underway, and if cargo is carried it must be stowed so that it does not block access to the fire stations.

Fire Hose
Although inspected vessels require USCG approved sizes, uninspected vessels can carry any size they choose. Most common USCG approved hose size is 1.5” or 2.5”. The 1.5” hose may be carried inside or outside, and 2.5” is usually carried outside on deck. The most common lengths are 50 or 75 feet.

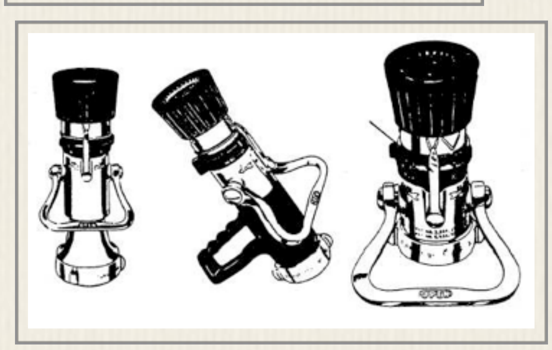
Hose is usually constructed of a rubber body with a canvas jacket. It will have a male threaded connector at one end and a female coupling at the other. The female connector will have a gasket to seal the joint when a connection to a hydrant or another hose is made. Any connections made should be only hand tight.

The couplings are usually brass, bronze or similar metal. There are two possible threads that may be seen on 1.5” hose, but only one type for 2.5”.

Nozzles
Attached to the end of either size hose will be a nozzle to deliver and control the water stream. USCG inspected vessels may have either the All Purpose or Vari-Nozzle on board.



All Purpose Nozzle: has three positions on the bail.
Forward-off
Up-high velocity fog
Back-solid stream



Vari-Nozzle: has two on the bail
Forward-off
Back-on

Rotating the collar on the front of this nozzle changes the spray pattern:

Rotating to the left (of the user) generates a fog spray
Rotating to the right (of the user) generates a solid stream

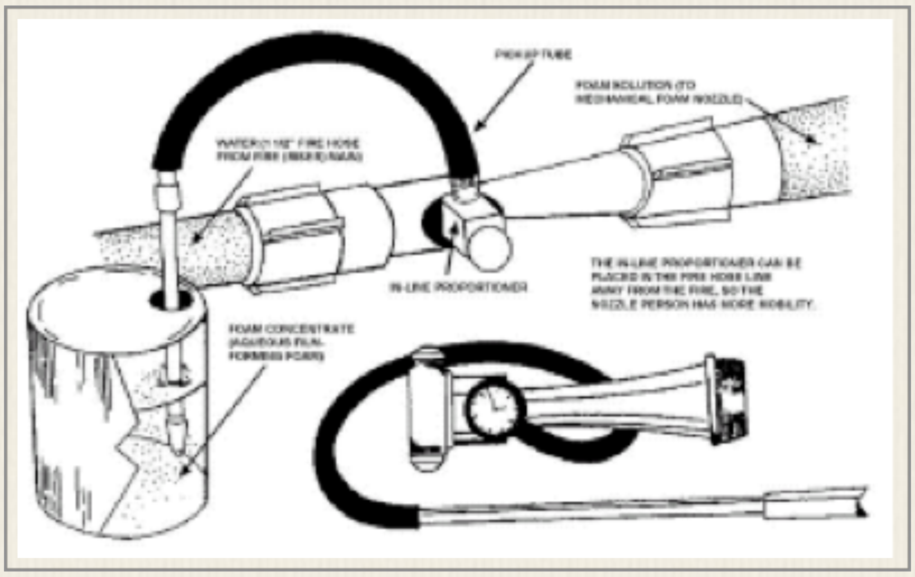
Low Velocity Applicators-If an all-purpose nozzle is utilized at the fire station, a low velocity applicator will be included as part of the station equipment. Applicators may be 4’, 10’, or 12’ in length. The 4’ and 10’ models would be used for 1.5” hose and the 10’ for 2.5” hose. These applicators are primarily used in personnel protection.

Spanner Wrench- Hoses connections should be made hand tight only, and the spanner wrench used to break those connections only if they cannot be loosened by hand. Wrenches should be of appropriate size for the hose in use at that particular station.

Wye Gate-used to reduce a 2.5” hydrant outlet to two 1.5” hoses, controlling each hose independently.

Foam Equipment and Streams

Water is not always effective as an extinguishing agent. Under certain circumstances, the use of foam can increase the effectiveness of water. Foam can be used on Class A fires, as well as Class B liquids. Foam works by forming a blanket of bubbles on the burning fuel. This excludes oxygen and stops the burning process. As the foam breaks down, water is released which provides a cooling effect on the fuel.



The mariner is likely to encounter different types of foam equipment in the marine environment.

>An eductor controls the flow of foam into the system in correct amounts.

> Foam is available in many different types for different applications. It may be described as low, medium or high expansion. It usually comes in 5 gallon buckets, or 55 gallon drums.

> Foam nozzles-which usually aerate the solution of foam concentrate and water and deliver the mix to the surface of the fuel.

Fighting a Fire

Fighting a fire onboard ship starts when the crewmember first signs on. It is each crewmembers responsibility to review the proper documents and be familiar with his/her assigned responsibilities. It may be beneficial for the crewmember to be familiar with other aspects of the ship, such as what cargo is being carried, or other materials that may be onboard.

Station Bill-assigns each crew member to a particular location for emergency situations, such as MOB, fire, abandon ship.

Also listed is the whistle signals for each emergency.

Muster List-contains the names of the crew members assigned to each station for each normal and emergency situation.

Cargo/Dangerous Cargo Manifests

The cargo manifests lists all the cargo on board and its stowage location.

Each vessel carrying hazardous materials is required by national and international regulations to have a means of identifying the dangerous goods/cargo on board. National regulations usually require that the DCM / DGM is located away from the dangerous cargo and is usually located in the bridge.

Material Safety Data Sheets

Material safety data sheets are documents that are included with the shipping papers for hazardous materials. These documents give information about the hazardous material concerning:

shipping name as well as trade name used for the product
physical data for the product such as melting and boiling points
fire and explosion hazard data
health hazard data
spill clean up procedures
personal protective clothing and equipment requirements
emergency action guide

These documents can give critical information to crew in a fire emergency.

Prefire-Plan

1. Includes possible scenarios and responses

2. Includes drawings of areas

3. Detailed descriptions of compartments and hazards

4. Provides a pro-active plan for crew to be used in drills

Fighting a Shipboard Fire

The first action in the event of a fire is to sound the alarm. Begin to isolate the fire by shutting doors, hatches, portholes and securing ventilation. Early detection of fire is crucial for successful fire fighting. Serious fires often result from small fires that have not been detected or acted upon quickly. Speed is the essence of a fire and is also the most important requisite of fighting it.

You can remember the basic steps in successful fire fighting if you recall the acronym “FIRE”.

F-find the fire
I-inform others, sound the alarm
R-restrict the fire and bring it under control
E-extinguish the fire and “overhaul” it so it will not re-ignite

After finding out where the fire is, you must determine what is burning and how extensive the fire is. At this point, you must establish boundaries for the fire. Within these boundaries, you must close all tanks, hatches, and ports. Furthermore, forced ventilation and electrical circuits near the fire need to be secured. All other vessel activities such as cargo loading, cleaning or maintenance must stop.

You should attack a fire from its windward side. This carries poisonous smoke and heat away from you, and the fire fighting agent towards the fire.

Bringing the fire under control means slowing its acceleration and its increase in intensity. This prevents the fire from developing any further. At this time you are now working to extinguish it.

Overhaul

After a fire has been extinguished, it must be overhauled. This is done to make sure that it will not re-flash. The general procedures for overhauling a fire include breaking up the combustible materials with a fire ax or fire rake and cooling the fire area with water or fog. Since many fires can flare up again after they appear to be out, it is necessary to set a re-flash watch after a fire has been extinguished.

<u>Stability</u>

Fighting a shipboard fire has another major danger that needs to be considered, that being vessel stability. Water entering a vessel due to firefighting activities must be continuously removed to maintain vessel stability. The use of overboard drains, or portable pumps may be necessary to eliminate water from firefighting activities.

<u>Prevention & Drills</u>

Fires that never start are the ones that do the least damage and hurt the fewest people. Prevention is every body's job. Good housekeeping, care and alertness can prevent most fires. The fire you prevent may save your life!

It is essential for the safety of all hands and the vessel itself that all firefighting equipment be properly maintained and stored in its proper place, ready for use. Regular inspection of the equipment, proper maintenance is important to every member of the crew.

All tests and drills using firefighting equipment should be conducted in a spirit of cooperation and with a critical eye toward constantly improving performance.

CHAPTER 18

Rules of the Road

International Rules are called 72 COLREGS. That stands for the 1972 Collision Regulations, which went into effect in 1977.

GENERAL RULES

Meters/Feet
A meter is a little longer than a yard. For the rules it is sufficient to round off to 3.3 feet = 1 meter. The following are rounded off numbers that are most often used in the rules and close enough for the test.

7m=23'	12m=40’	20m=65’
50m=165’	100m=330’	200m=656’

RULE 1: WHERE THEY APPLY
International Rules apply to all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels.

Further, these rules shall not interfere with special rules made by an appropriate authority. A proper authority in the U.S. would be the USCG. There is one other such set of rules, called the Inland Navigational Rules Act of 1980.

RULE 2: RESPONSIBILITY
Known as the rule of good Seamanship and the General Prudential rule.

Nothing in these rules shall exonerate any vessel, owner, captain or crew from penalty for the neglect of complying with the rules, or by the ordinary practice of good seamanship or by the Special Circumstances of the case.

Special Circumstance is considered a situation not covered by the rules. Since meeting, crossing and overtaking rules are designed for only two vessels interacting, three vessels coming together is considered a special circumstance.

In following the rules, due regard shall be given to all dangers of navigation and collision and to any Special Circumstance which may make a departure from these rules necessary to avoid immediate danger.

RULE 3: GENERAL DEFINITIONS
Vessel
The word vessel includes every description of watercraft used or capable of being used as a means of transportation on water. Some examples are hovercraft, hydrofoils, seaplanes and barges.

Powerboat
The term “power-driven” vessel means any vessel propelled by machinery.

Composite Unit
The term “composite unit” refers to a special built two part hull, that when joined by hydraulic rams, is considered a motor vessel rather than a towing situation. One of the criteria for a composite unit is “acts onto the waves as one”.

Sailboat
"Sailing vessel" is any vessel under sail provided that propelling machinery, if fitted, is not being used.

Fishing
"Engaged in Fishing" means any vessel fishing with nets, lines, trawls or other apparatus which restricts maneuverability. It also must be engaged in the commercial collection of seafood. This definition does not include a vessel fishing with trolling lines, because it is felt that a trolling vessel can maneuver well.

NUC
"Vessel Not Under Command" means a vessel, which through some exceptional circumstance is unable to maneuver as required by the rules and is therefore unable to keep out of the way of another vessel.

Exceptional circumstance is understood to mean a mechanical or operational breakdown or defect, which prevents the vessel from maneuvering or operating as an approaching vessel, unaware of the problem might expect.

RAM
A vessel "Restricted in Ability to Maneuver" means a vessel, because of the nature of her work, is unable to keep out of the way of another vessel.

Some situations that are considered RAM are: underwater construction, dredging, surveying, laying cable or pipe, CG vessels working on Aids to Navigation, transferring cargo underway, launching planes, mineclearance operations. Towing, but only when it restricts ability to deviate from course.

CBD
The term vessel "Constrained by Draft" means a power driven vessel, which because of her draft in relation to the depth of the water, cannot maneuver from the course she is following.

This definition is not used in Inland rules due to in part, the potential misuse by pleasure boats traveling the shallow road of the Intracoastal Waterway.

Underway
Not at anchor, made fast to the shore or aground.
There are two types of underway. Underway Making Way (moving with power through the water), and Underway Not Making Way (dead in the water or adrift).

Restricted Visibility
Means any condition in which visibility is restricted by fog, mist, falling snow, heavy rainstorms, smoke or any other similar causes. This condition may exist in the brightest sunlight and on the darkest night.

STEERING AND SAILING RULES

RULE 4: CONDUCT OF VESSELS
The rules in this section apply to any conditions of visibility.

RULE 5: LOOK-OUT
Every vessel is required to maintain a proper look-out at all times using eyes/ears and any other means available. This includes radar when and if you have one, and when it is in working condition.

A look-out is a person assigned to do nothing except be an extra set of eyes and ears for the captain.

RULES 6: SAFE SPEED
A safe speed is defined as one in which a vessel can take proper action to avoid a collision and to be stopped in an appropriate distance. In determining what a safe speed would be, some of the considerations should be: state of the sea, traffic density, maneuverability, state of the visibility, and interference by background lights.

Items not included in consideration are construction of the vessel, ability of the captain, maximum attainable speed of your vessel, available aids to navigation or the air temperature.

RULE 7: RISK OF COLLISION
Every vessel shall use every available means, including radar and lookout, to help determine if there is a risk of collision. If there is any doubt, then there is a risk. If there was a collision, there must have bee a risk.

A risk exists if the bearing of an approaching vessel does not appreciably change. In cases of large vessels, or vessels close by,
even a large change does not guarantee there is no risk.

RULE 8: ACTION TO AVOID COLLISION
Action shall be positive and made in ample time. Any alteration of course or speed to avoid collision shall be large enough to be understood by another vessel observing visually or by radar. Small course and speed changes should be avoided for that very reason.

In a situation where there is enough sea room to do so, a course change alone might be the most appropriate action to avoid a close quarters situation. If there is another vessel approaching, you might not have to consider Rules of the Road type maneuvering by just turning away and avoiding closer contact.

Action taken to avoid collision must not result in another close quarter situation.

If necessary to avoid collision or allow more time to assess the situation, a vessel shall slacken her speed or take all way off by stopping or backing her means of propulsion.

RULE 9: NARROW CHANNELS
A vessel in a narrow channel or fairway shall keep to the extreme starboard side.

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

Fishing vessels, engaged in fishing, shall not impede any vessel in a channel.

A vessel shall not cross a narrow channel or fairway if such crossing impedes the passage of vessels, which can safely navigate only within such channel or fairway.

Nearing a bend or an area of a narrow channel where other vessels may be obscured by an intervening obstruction a vessel shall move with caution and sound one prolonged blast. Any vessel around the obstruction shall also give a prolonged blast.

All vessels shall avoid anchoring in a narrow channel.

A vessel shall not cross a narrow channel or fairway if such a crossing impedes the passage of a vessel, which can safely navigate only within that channel or fairway. The latter vessel shall use the danger if in doubt as to the intention of the crossing vessel.

RULE 10: TRAFFIC SEPARATION SCHEMES (TSS)
The objective of traffic separation schemes is to reduce the risk of collision in converging areas, dense traffic areas or where restricted sea room limits freedom of movement by shipping.

A vessel shall join or leave at the termination of lane, but if she cannot, shall join or leave at as small an angle to the traffic flow as possible.

A vessel shall not cross a lane, but if she must do so, do it at as nearly right angle as possible so that other vessels will understand her intent.

A vessel shall not normally enter a Traffic Separation zone or cross a separation zone except in cases of emergency, to avoid immediate danger or to engage in fishing.

Any vessel engaged in fishing, vessels less than 20 meters, a sailing vessel, or a vessel crossing the TSS, shall not impede the safe passage of vessels following a traffic lane.

RULE 11: CONDUCT OF VESSELS IN SIGHT
The following rules apply to vessels in visual sight of one another (both day and night)

RULE 12: SAILBOATS
This rule concerns interaction between two sailboats only.

If the wind is attacking the starboard rail of the sailboat it is said to be on a starboard tack. Starboard tack has the right away over a port tack.

When both are on the same tack, then the vessel to windward gives way.

A sailboat on a port tack not being sure of the tack of another sailboat shall give way.

RULE 13: OVERTAKING
The definition of an overtaking situation is one in which the vessel astern sees only the stern light but not the side lights of the vessel ahead.

The cut off point for side and stern lights is 22.5° aft of a line drawn at right angles to the keel.

Any vessel overtaking any other shall keep out of the way of the vessel being overtaken.
Sailboats do not have the right of way over powerboats that they are overtaking.

When a vessel is in any doubt as to whether she is overtaking another, she shall assume that this is the case and act accordingly.

Any subsequent alteration of the bearing between the two vessels shall not make the overtaking vessel a crossing vessel or relieve her of the duty of keeping out of the way until she is well past and clear.

RULE 14: MEETING SITUATION
When two powerboats are meeting head to head or on nearly reciprocal courses so as to involve a risk of collision, each shall alter course to starboard so that they will pass port to port.

If there is doubt as to whether it is a meeting situation or not, assume that it is and act accordingly. This is to assure that a vessel to starboard does not consider itself the stand-on vessel and claim right of way when it should be turning right.

RULE 15: CROSSING SITUATION
When two powerboats are crossing, that is they are not meeting and or overtaking, the vessel to starboard is the stand on vessel. The vessel to port is the give way vessel and required to keep out of the way as well as avoid crossing ahead of the other vessel.

RULE 16: GIVE-WAY VESSEL
The designated give way vessel shall take early and substantial action to keep clear.

There is a give way vessel in an overtaking situation as well as a crossing situation.

RULE 17: STAND-ON VESSEL
Whereby one vessel is required to give way, the other vessel shall hold course and speed.

The stand on vessel may take action to avoid collision as soon as it is apparent to her that the give way vessel is not taking proper action to do so.

When the vessels are so close that action by the give way vessel alone will not avoid a collision, the other vessel must act to do so.

In taking action to avoid collision, the stand on vessel should not turn to port when the give way vessel is on her port.

Action by the stand on vessel to avoid a collision does not relieve the give way vessel of her obligation to keep out of the way.

RULE 18: RESPONSIBILITIES
The pecking order of rights of way are:

1. NUC
2. RAM
3. CBD
4. Fishing
5. Sailing
6. Power
7. Seaplane
8. WIG

RULE 19: CONDUCT IN RESTRICTED VISIBILITY
This rule applies to vessels not in sight of one another when navigating in or near an area of restricted visibility whether daytime or night.

Every vessel shall proceed at a safe speed in restricted visibility.

Power vessels shall have engines and engine controls ready for immediate maneuver.

Contact on radar that indicates a possible close quarters situation or risk of collision requires that early and substantial action be taken to avoid that.

When hearing the fog signal of another vessel somewhere ahead of the beam, a vessel must slow down to the minimum so that she can be kept on course, take all way off if necessary, and navigate with extreme caution until the danger has passed.

LIGHTS AND SHAPES

RULE 20: LIGHTS AND SHAPES
Lights shall be kept on from sunset to sunrise and in addition at all times in restricted visibility. They may be kept on at all times.

Proper day shapes shall be shown during daylight hours in clear and/or restricted visibility.

RULE 21: LIGHT DEFINITION
Masthead light is a white light on the face of a mast, showing 22.5° abaft the beam on both sides, and 225° total.

Sidelights are red and green. Since they are half the coverage of a masthead light they are 112.5 deg. from dead ahead to 22.5 deg. abaft the beam on either side.

On a vessel of less than 20 meters the sidelights may be combined in one lantern on the centerline such as the bow or on the breasthook of the boat.

A stern light is 135 deg. pointed dead astern, that is 67.5 deg. on either side of the keel.
An all around light covers 360 deg.
A flashing light flashes 120+ per minute. When assigned to a hovercraft or hydrofoil it is amber or yellow in color.

RULE 22: LIGHT VISIBILITY

Size	Masthead	Sidelight	Stern Light
-12m	2	1	2
12 to -20m	3	2	2
20 to –50m	5	2	2
50m+	6	3	3

RULE 23: POWER VESSELS' LIGHTS UNDERWAY
Vessels 50m and over shall carry a masthead light forward and aft, sidelights and a stern light. The aft masthead light is higher.

On power vessels under 50 meters, the second masthead light becomes optional.

Hovercraft and hydrofoils, when hovering or hydroing, in addition to the above required lights, will display an all around flashing light, yellow or amber in color.

A power driven vessel of less than 12 meters may instead of other lights, exhibit an all-around white light and sidelights. (the all around white light is in reality the masthead and stern light combined)

Less than 7 meters with a maximum attainable speed of 7 knots may show just an all around white light. And only if practicable, sidelights.

RULE 24: TOWING AND PUSHING
A powered towboat when working by pushing or hip towing will carry another masthead light on the same mast in addition to the masthead light required of a power driven vessel. This second light, in line, indicates that the vessel is engaged in the business of towing, ahead, hip and astern, less than 200m. Since it is towing astern, it must be towing on a hawser, therefore it will also display a yellow light above the stern light.

A long tow astern, that is over 200m, requires a third masthead light in line. A long tow is measured from stern to stern.

The day shape for a long tow is a black diamond shown both on the tower and the vessel being towed. There is no day shape for a short tow, hip towing or push towing.

A barge, object or vessel being towed will show, when being pushed, sidelights only, so as not to blind the pilot. When on the hip or astern, sidelights and stern light must be shown.

RULE 25: SAILBOATS AND ROWBOATS
Sailboats underway will show sidelights and stern light. A sailboat displaying a masthead light is giving up its right of way and indicating to other vessels it is under power.

Options:
Under 20m a sailboat may have the three lights combined in one unit at the mast top.

Instead of that option, any size sailboat may in addition to the normal side and stern lights, carry red over green all around lights.

A sailing vessel under 7 meters may instead show, only a white light in sufficient time to prevent collision.

A rowboat may be lighted like a sailboat, but should at the very least have a white light shown in sufficient time to prevent collision.

At night when a sailboat is under machinery power it is considered a powerboat and shall be so lighted.

In daytime a sailboat with engine in use and sails up shall exhibit a black cone, point down.

RULE 26: FISHING VESSEL LIGHTS
Vessel Trawling

Vessel trawling, that is dragging though the water nets and such gear, shall display forward, all around lights, which are green over white. The after masthead light is the same as the basic lighting rule, that is, optional under 50m and required 50m and over.

When underway and making way, sidelights and stern light. When not moving through the water, sidelights and stern light are turned off so as not confuse approaching vessels.

The day shape is two cones, point to point.

Vessel Fishing
Vessel fishing shows 360° lights that are red over white. The day shape is the same for trawling vessels. The after masthead light on fishing vessels over 50m is not carried.

When fishing nets are extended more than 150m out, a shape of a cone, point up is extended in the direction of the nets and at night replaced by an all around white light hung out in that direction.

A fishing vessel will have running lights on when running, and no side lights or stern light on when underway not making way.

A fishing vessel at anchor is not really at anchor because it is using the anchor as a fishing tool, therefore it does not display an anchor light.

These lights and shapes for fishing as well as trawling vessels are only shown while they are engaged in the collecting of seafood.

RULE 27: NUC LIGHTS
A vessel not under command shall exhibit two red lights. She shall also exhibit running lights when running, but no masthead lights. The day shape is 2 black balls.

RULE 27: RAM LIGHTS
A vessel restricted in ability to maneuver will show 360° lights, red over white over red. The day shape is a ball-diamond-ball.

When making way through the water, masthead light(s), side lights and a stern light.

A vessel involved in dredging or underwater construction and having an obstruction on one side, such as pipe lines or cables, will warn approaching vessels away from that side by the display in daytime of two black balls, one over the other and at night two all around red lights in a vertical line. On the opposite side, that side if there is no obstruction, the dredge would carry in daytime two black diamond shapes one over the other. At night two all around green lights in a vertical line as an indication that this is the safe side to pass.

A dredge at anchor and working will not show anchor lights since the anchors are tools of the trade to position the dredge. All other RAM vessels at anchor and engaged in operations will carry RAM lights and anchor lights when anchored.

Diving operations call for the ball, diamond, ball shapes, but if the vessel is so small that it would be impractical to show those shapes, the code flag "A" may be shown instead.

Mineclearance requires a Christmas tree array of three green lights at night or three black balls in day time. Minesweeping or mine clearance is considered RAM but does not carry RAM lights or shapes since it has its own.

Other vessels shall stay clear of these vessels at work, keeping at least 1000 meters away, alongside and astern, under International Rules.

Rule 28: CBD
A vessel constrained by draft may in addition to her regular masthead, side and stern lights, show 3 all-around red lights at night and a black cylinder in daytime.

RULE 29: PILOT BOATS
Vessel on pilot duty will show lights that are white over red. When underway, both making way and not making way, side-lights and stern light, and when at anchor but still on station, in addition to the white over red, anchor light(s). There are no day shapes for a pilot vessel.

RULE 30: ANCHORED
A vessel at anchor shall display an all around white light forward and another one aft. The aft light shall be lower than the forward one. A vessel of less than 50 m may show one light only. The day shape for a vessel at anchor is one black ball.

Vessels 100m or more must show deck illumination when at anchor.

RULE 30: AGROUND
A vessel aground will show two red lights plus one or two anchor lights depending on its size. The day shape for aground is 3 black balls.

Vessels under 12 meters aground are exempted from the lights and shapes of this rule.

RULE 31: SEAPLANES
Seaplanes on the water shall attempt to comply with vessel lighting if possible. They are not mandated to display the yellow flashing light authorized for hovercrafts and hydrofoils.

<u>SOUND SIGNALS</u>

RULE 32: SOUND SIGNALS-LIGHT SIGNALS: DEFINITIONS
Whistle means any sound producing device that meets the specifications established in the annex to the rules. A short blast by whistle or light is of one second duration. A prolonged blast lasts four to six seconds.

RULE 33: EQUIPMENT
Vessels 12 meters or more require a whistle and a bell. Vessels 100 meters or more require in addition, a gong. A vessel less than 12 meters does not require a whistle and bell but this does not relieve the vessel from having equipment or some other means of making an efficient sound signal.

RULE 34: ACTION / WARNING SIGNALS
When vessels are in sight of one another, a power driven vessel underway, when maneuvering as required by the International Rules, shall indicate that action by signaling;

One short blast meaning “I am altering my course to starboard”

Two short blasts meaning “I am altering my course to port”

Three short blasts meaning “I am operating astern propulsion”

A vessel may supplement these same signals by short light flashes of the same sequence.

In the International Rules, one does not answer action signals.

The prolonged blast around an obstruction answered by any vessel around the obstruction is not an answer to an action signal, but an acknowledgement that someone is around the bend.

RULE 34: DANGER/DOUBT
When vessels in sight of one another and are approaching each other, and the actions or intentions are not understood, or one feels that the other is not taking proper action to avoid collision, the vessel in doubt shall give 5 or more short blasts on the whistle. This may be supplemented with 5 or more short flashes on a signal light.

A signal light in International Rules is defined as an all around white light, not necessarily synchronized with the action whistle signals.

RULE 34 & 9: NARROW CHANNEL PASSING RULE
There is one case in the International Rules, whereby permission is asked for and an answer is expected to confirm or deny the proposed action.

In a narrow channel or fairway under International Rules, when overtaking can take place only if the vessel to be overtaken has to take action to permit safe passing, the vessel intending to overtake shall indicate her intention by sounding the appropriate whistle signal.

Prolonged-prolonged-short, to mean “I intend to overtake you on your starboard side”
Prolonged-prolonged-short-short, to mean “I intend to overtake you on your port side”

The vessel to be overtaken shall, if in agreement, sound the appropriate signal. Prolonged-short-prolonged-short. (mores code for Charlie) If in doubt or refusing the request of the overtaking vessel, the vessel being overtaken may sound the danger-doubt signal of 5 or more short blasts.

Nothing in these rules supersedes Rule 13, requirements that any vessel overtaking any other shall keep out of the way of the vessel it is overtaking.

RULE 35: FOG SIGNALS
In or near an area of restricted visibility in daytime or at night these signals shall be used.

In restricted visibility when other vessels are not in sight, only fog signals will be used. Action signals, those indicating turning or backing, shall only be used when in visual sight of other vessels.

All underway fog signals are at intervals of not longer than 2 minutes. Not underway situations such as anchored and aground are at maximum intervals of 1 minute.

Powerboat underway, making wake…one prolonged.

Powerboat underway, not making way…two prolonged.

NUC-RAM-CBD-FISH-TRAWLING-SAIL or TOWING= one prolonged and two short.

Being towed shall signal-1prolonged and 3 short. Mandatory if manned, to be given right after the signal by the towing vessel. In a string of towed vessels only the last vessel will sound signals.

Anchored vessels, both power and sail, ring the bell rapidly for 5 seconds each minute. Anchored vessels of 100m+ add another 5 seconds rapid ringing on a gong at the stern of the vessel.

If an anchored vessel, while ringing the bell senses another vessel approaching and wants something more substantial to warn away the approaching vessel, he may blow a short-prolonged-short on the whistle. S-P-S: Ship’s Position Stationary.

RULE 35: AGROUND
Vessel aground uses the same bell and or gong signals as an anchored vessel, plus three distinct raps on the bell before and after the ringing of the bell.

Vessels of –12meters are optioned out of all the restricted visibility signals mentioned above as long as they make some other sound signal on the maximum two minute cycle.

RULE 36: ATTRACT ATTENTION
To attract attention of another vessel but not a distress signal, one can make signals both light and sound so that they cannot be mistaken for other signals. You may also use your spotlight as long as you don’t embarrass (blind) the other vessel’s operator.

RULE 37: DISTRESS SIGNALS
See the picture page for the distress signals.

EXEMPTIONS

RULE 38: EXEMPTIONS
Also known as Park E and includes exemptions which allowed time for vessels that did not comply with the lighting specs to conform.

ANNEXES:

The annexes to the rules are divided into sections that describe the specifics of lighting, spacing, color and sound signaling devices.

There are also some additional lights for vessels fishing in close proximity, such as double trawling under Annex II.

When shooting their nets, white over white.

When hauling their nets, white over red.

When net is hung up on an obstruction, red over red.

Purse Seine-alternating yellow lights, 1 sec. duration

INLAND DIFFERENCES

Rule 3
The term Western Rivers means the Mississippi River and its tributaries to the mouth of the Mississippi.

Rule 9
A power driven vessel operating in narrow channels or fairways in the Great Lakes, Western Rivers or other special waters designated by the Secretary and proceeding down-bound with the following current, shall have the right-of-way over up-bound vessels, shall propose the manner and place of passage, and shall initiate the maneuvering signals. The vessel proceeding up-bound against the current shall hold as necessary to permit safe passing.

These are well identified waters and do not include other rivers or waterways such as the Intracoastal.

Rule 13
In a narrow channel or fairway when overtaking, a vessel intending to overtake shall indicate her intention by sounding the appropriate signal. The overtaken vessel if in agreement shall give as a sign of agreement and permission the same signal. If in doubt as to the safety of the action she shall deny permission with 5 or more short blasts.

Rule 15
On the Great Lakes or Western rivers, a power driven vessel crossing a river shall keep out of the way of a power driven vessel ascending or descending the river.

Rule 21
"Special Flashing Light" means a yellow light displayed on the front of a barge being pushed ahead, or towed on the hip with a frequency of 50-70 flashes per minute and a range of 2 miles. Placed far forward on the fore and aft centerline showing over an arc of at least 180 deg. and not more than 225 deg.

Rule 22
On an inconspicuous, partly submerged vessel or object being towed, white all-round lights, 3 mi.

Rule 24
Any number of vessels being towed alongside or pushed in a group shall be lighted as one vessel.

A vessel being pushed ahead, not being part of a composite unit, shall exhibit at the forward end sidelights and a special flashing light.
Vessels towed along side shall exhibit sidelights, special flashing light and stern light.

An inconspicuous, partly submerged vessel or object being towed also requires a day shape of a diamond, even if less than 200m.

On Inland waters a power vessel when towing by pushing ahead or along side shall exhibit two masthead lights, sidelights and two towing lights.

On the Western Rivers only, a power vessel when towing by pushing ahead or along side shall exhibit sidelights and two towing lights in a vertical line. This indicates that a towboat on Western Rivers is exempted from carrying masthead lights.

The two towing lights mentioned above is for all Inland hip and push towing situations, however the omission of masthead lights is uniquely Western Rivers. This masthead light omission on the Mississippi starts above the Huey P. Long Bridge.

Rule 25
Sailing vessels of 12 meters and more shall if under power carry a conical shape with apex down. A vessel of under 12 meters may do so.

Rule 29
A vessel of less than 20 meters when at anchor in a special anchorage area shall not be required to show anchor lights, shapes or fog signals. Vessels and barges over 20 meters even though in a special anchorage area, must show lights/shapes and make proper fog signals.

Rule 9 & 34
Meeting/Crossing
When power driven vessels are insight of each other an meeting or crossing that will result in a closest point of approach of less than half a mile of each other, each vessel underway, when maneuvering as authorized by the rules shall indicate that maneuver by the following signals on the whistle.

One short blast to mean "I intend to leave you on my port side"
Two short blasts to mean "I intend to leave you on my starboard side"

If in agreement, answer in kind. If not in agreement the danger/doubt shall be given. Vessel shall stop back or hold until the confusion is sorted out.

Three short blasts shall mean, "I am operating astern propulsion."

A vessel may supplement these signals with light signals. The duration of each flash shall be about 1 second. The light used for these signals shall, if used, be all around yellow or white and be synchronized with the whistle.

Overtaking

A power vessel intending to overtake another power vessel shall signal:

One short blast to mean "I intend to overtake you on your starboard side."

Two short blasts to mean "I intend to overtake you on your port side."

The vessel being overtaken shall agree with the same signal or deny with 5 or more short blasts.

Meeting/Crossing/Overtaking

A vessel that reaches an agreement by radiotelephone is not required to sound the whistle signals, but may do so.

INLAND RULES: MISCELLANEOUS

Power vessel is leaving a dock or berth, shall sound one prolonged blast.

Vessels over 12 meters must carry onboard a copy of the Rules of the Road.

Yellow flashing lights to outline a dredge pipeline. Two red lights in a vertical line on each side of a gate or opening in the pipeline.

Flashing blue light for law enforcement vessel.

Public service vessel such as Coast Guard Auxiliary or commercial towing service is authorized to display an alternating yellow/red light. (70-100 flashes per minute)

A vessel may, under the rules, carry an additional lights as long as they do not impair the visibility of lights required under the rules.

Barges moored along the bank of a waterway should have a white light on the upstream and downstream outer corners visible for one mile.

Distress signals are included on a separate page. Additionally, a white strobe light has been added to the Inland Rules as a distress signal.

Authorized distress signals may be used separately or in combination.

Submarine on the surface will display a yellow flashing light, with 3 one second flashes, followed by 3 seconds of eclipse.

CHAPTER 19

Aids to Navigation

ATONS is the general name given to a wide variety of fixed or floating aids used throughout the world used by mariners to ensure safe navigation. Also included are lights, sound producing devices, radio beacons, or differing colors and shapes to aid in the identification or function of the aid.

Throughout the U.S. the Coast Guard has the responsibility of maintaining all aids to navigation along the coast lines and rives as well as the Great Lakes.

Types of Systems

Lateral and Cardinal Systems

There are two major types of buoyage systems: the lateral system and the cardinal system. The lateral system is best suited for well-defined channels. The description of each buoy indicates the direction of danger relative to the course which is normally followed. In principle, the positions of marks in the lateral system are determined by the general direction taken by the mariner when approaching port from seaward. These positions may also be determined with reference to the main stream of flood current. The United States Aids to Navigation System is a lateral system. The cardinal system is best suited for coasts with numerous isolated rocks, shoals, and islands, and for dangers in the open sea. The characteristic of each buoy indicates the approximate true bearing of the danger it marks. Thus, an eastern quadrant buoy marks a danger which lies to the west of the buoy. The following pages diagram the cardinal and lateral buoyage systems as found outside the United States.

The International Association of Lighthouse Authorities

IALA is a non-governmental organization which consists of representatives of the worldwide community of aids to navigation services to promote information exchange and recommend improvements based on new technologies. In 1980, with the assistance of IMO and the lighthouse authorities from 50 countries met and adopted the IALA Maritime Buoyage System. They established two regions, Region A and Region B, for the entire world.

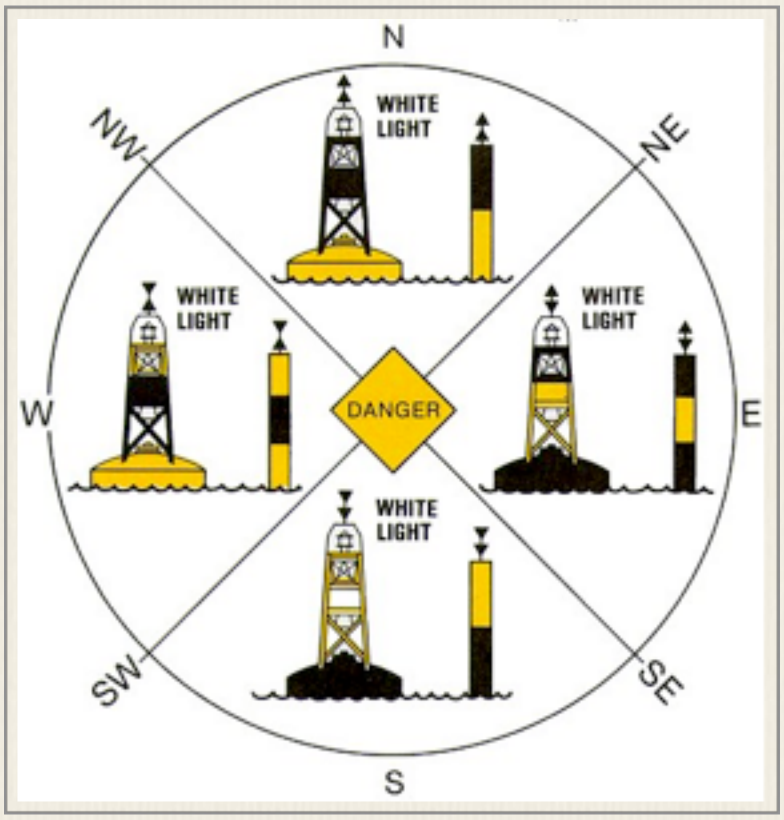
Lateral marks differ between Regions A and B. Lateral marks in Region A use red and green colors by day and night to indicate port and starboard sides of channels, respectively. In Region B, these colors are reversed with red to starboard and green to port. In both systems, the conventional direction of buoyage is considered to be returning from sea, hence the phrase “red right returning” in IALA region B.

The IALA B system, is also used in Central and South America as well as Japan and South Korea. The IALA A system is used in Europe, Africa and most of Asia including Australia and New Zealand.

The Cardinal System

A cardinal mark is used in conjunction with the compass to indicate where the mariner may find the best navigable water. It is placed in one of the four quadrants (north, east, south, and west), bounded by the true bearings NW-NE, NE-SE, SE-SW, and SW-NW, taken from the point of interest. A cardinal mark takes its name from the quadrant *in which it is placed*. The mariner is safe if he passes north of a north mark, east of an east mark, south of a south mark, and west of a west mark. A cardinal mark may be used to:

1. Indicate that the deepest water in an area is on the named side of the mark.
2. Indicate the safe side on which to pass a danger.
3. Emphasize a feature in a channel, such as a bend, junction, bifurcation, or end of a shoal.



Cardinal Marks

Regardless of the type of system used, the basic function of ATON's is to warn the mariner of a danger, obstructions, delineate the channels or assist the mariner in establishing his position before approaching a harbor. The addition of lights and sound or radio producing signals further aid the mariner in restricted visibility or during night transients.

The Lateral System
Conventional buoyage in the US runs clockwise. The maintained Intracoastal Waterway begins in Virginia, and runs to Brownsville,TX.

Shapes
The various shapes used on the "B" system aid in identification of the function or use of the buoy. Can buoys, take the shape of tin cans, and are flat on top. Nun buoys, are tapered towards the top, terminating in a cone shape Spherical buoys are usually made of steel or plastic that are round. Spar buoys are usually elongated, very often made of wood, and closely resemble pillar buoys.

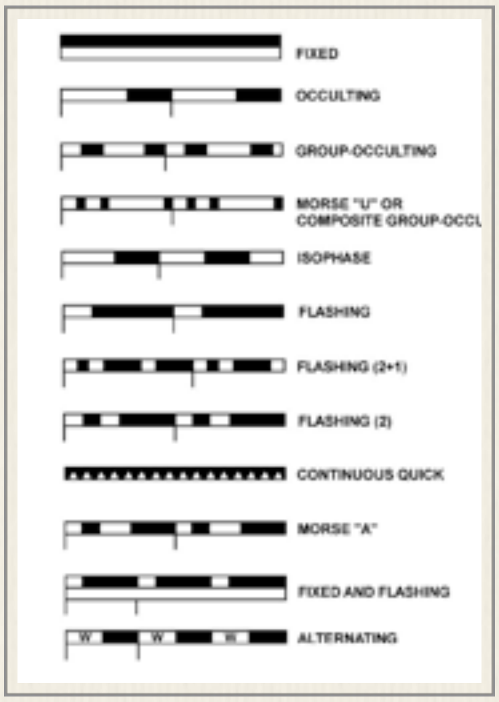
Lighted buoys are a float on which is mounted a steel skeleton tower at the top of which is a light. These buoys may also have a sound producing device mounted on them.
Very often built into the design of the buoy will be a radar reflector to aid mariners in detection by radar during periods of reduced visibility. Size of the ATON will also depend on the particular use, or the amount and type of traffic in the vicinity.

Buoy Numbers
Buoys are often given number or letters, or a combination of both to aid in their identification on charts. They may be applied using retro-reflective material. Solid color buoys are given numbers, and these are the only buoys that have lateral significance. Green buoys are given odd numbers, and red buoys are given even numbers. A letter added to a numbered buoy (either solid red or greed) is used when an additional buoy is added to the sequence, and the numbering system has already been established.

Letters may be added to red and white vertically striped buoys, red and black horizontally striped buoys or red and green horizontally striped buoys. Solid yellow buoys may also be lettered.

Lights
Under normal conditions, the lenses are colored according to the charted characteristic of the buoy. As in shore lights, the lamp must be carefully focused so that the filament is directly in line with the focal plane of the lens. This ensures that the majority of the light produced is focused in a 360° horizontal fan beam A buoy light has a relatively narrow vertical profile. Because the buoy rocks in the sea, the focal plane may only be visible for fractions of a second at great ranges. A realistic range for sighting buoy lights is 4-6 miles in good visibility. In addition, different rhythms help in their identification.

Rhythm

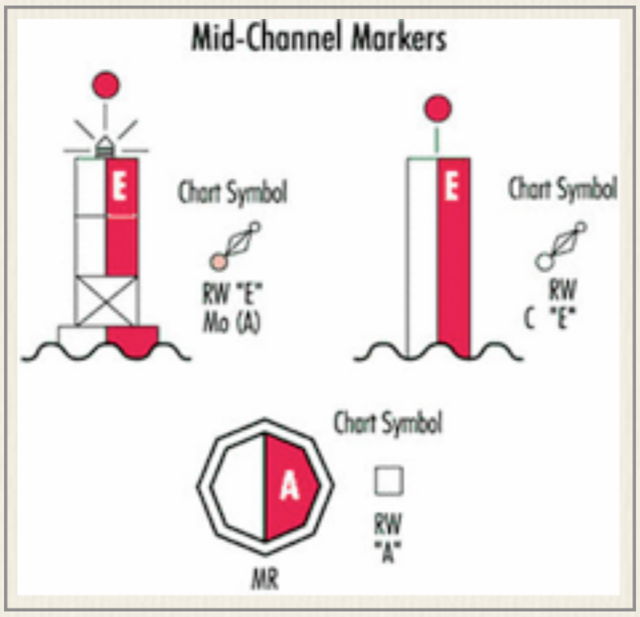


Some typical light rhythms utilized on ATONS

Sound Signals
Lighted sound buoys have the same general configuration as lighted buoys but are equipped with a bell, gong, whistle, or horn. Bells and gongs are sounded by tappers hanging from the tower that swing as the buoys roll in the sea. Bell buoys produce only one tone; gong buoys produce several tones. The tone-producing device is mounted between the legs of the pillar or tower. Whistle buoys make a loud moaning sound caused by the rising and falling motions of the buoy in the sea. A sound buoy equipped with an electronic horn will produce a pure tone at regular intervals regardless of the sea state. Unlighted sound buoys have the same general appearance as lighted buoys, but their underwater shape is designed to make them lively in all sea states.

Private Aids To Navigation
A private navigation aid is any aid established and maintained by entities other than the Coast Guard. The Coast Guard must approve the placement of private navigation aids.

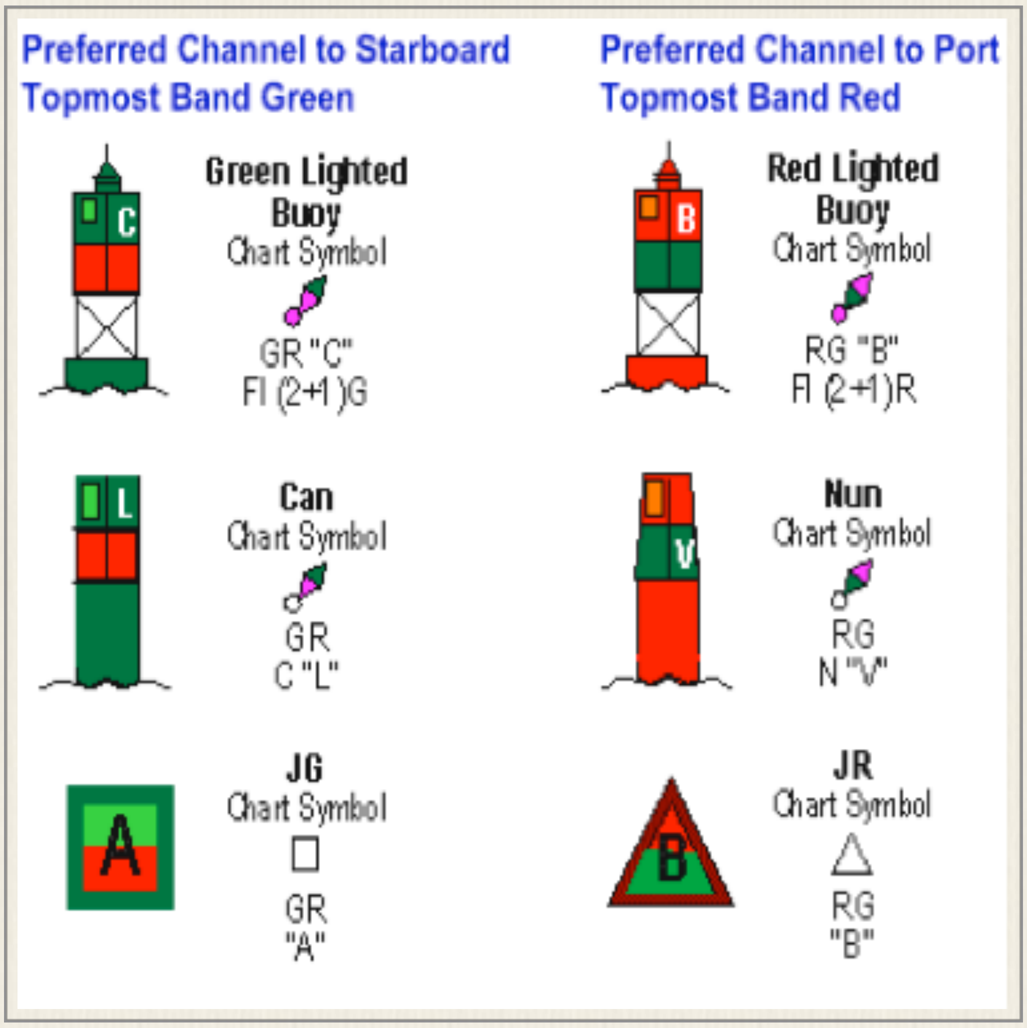
Protection By Law
It is unlawful to impair the usefulness of any navigation aid established and maintained by the United States. If any vessel collides with an navigation aid, it is duty of the person in charge of the vessel to report the accident to the nearest U.S. Coast Guard station.



Safe Water Mark/Mid Channel Marker

The Safe Water marker, years ago called the mid channel marker, is red and white vertically stripped. If it has a light, it will be white and it may have a red ball on the top. It may have a letter but not a number displayed on it. The light characteristic will be Morse A, (short-long) The day board will be an octagon, and the chart abbreviation will be a square box.

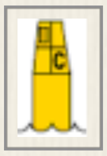
Preferred Channel

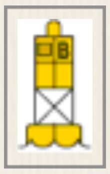


Preferred Channel Markers as would appear on a typical NOAA Chart

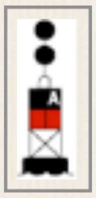
Preferred channel markers are a combination of red and green horizontal bands. The preferred channel is usually marked by having the top color of the marker indicate the way it should be treated. That is, if the top color is red, treat it as a red marker. Just as with red and green markers, they may be found as daymarks or floating buoys. They will have the same color light at the top color of the marker and they may have letters but not numbers. Any retroflective materials on this buoy will be the color of the top band. They have a composite group flashing characteristic (2 + 1). These buoys have no lateral significance

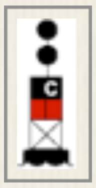
Special Purpose Buoy
Special Purpose markers are yellow and may serve a wide range of uses, including but not limited to things such as dredging, fish trap areas, spoils areas or military exercises. If lit they have a yellow light, which may be either fixed or flashing. They may be either can or num if unlit floating aids and the shape will depend on where they are placed.



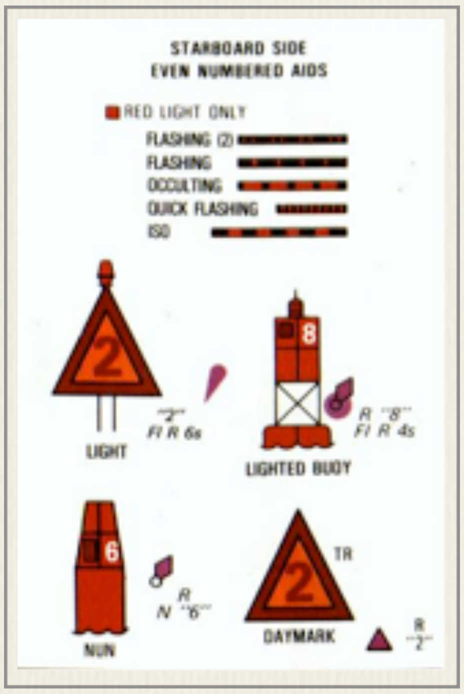


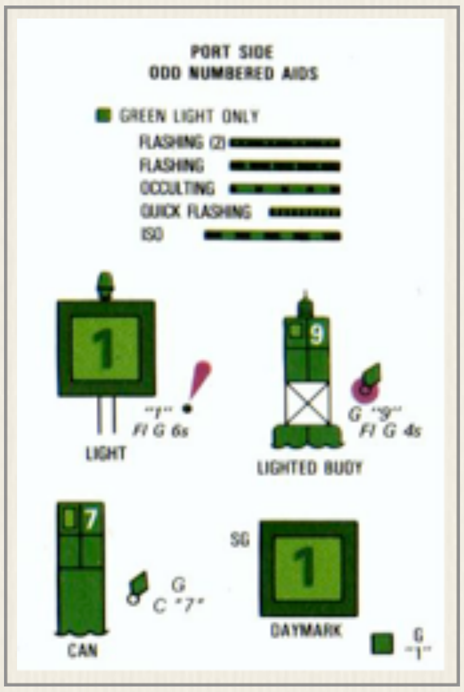
Isolated Danger Buoys
Are black and red horizontally banded, may be lit or unlit, but if lit will have a white light showing flashes in groups of two. Two black spheres are fitted to the buoy to aid in its identification





Lateral Buoys
These are the only buoys that are solid red or green and that are numbered. These buoys have lateral significance.





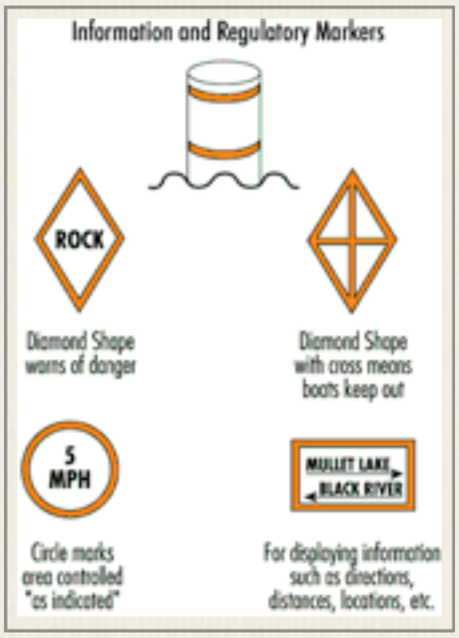
Lateral Marks

On entering an inlet or harbor from sea, red buoys will be on the right side in the IALA B system. They will have even numbers Red day markers are often used in shallow areas for the same purpose. Red buoys with lights will usually be found in deeper water. Larger buoys may also have bells or other sound producing devices attached.

Cans are green, they have odd numbers, and will be on the left side of the channel when entering from seaward. The first buoy (farthest out) as you enter the channel will have the lowest number with numbers increasing as you travel in. Green day markers are often used in shallow areas for the same purpose. If the green marker has several pilings supporting it, it will be called a dolphin. Green buoys with green lights will usually be found in deeper water. Larger buoys may also have bells or other sound producing devices attached.

Information, Regulatory and Warning Marker

White markers and or buoys with an orange boarder, diamond, circle, or square can be used to provide information or regulations such as a no wake zone or a shoal area. As with all other aids to navigation, they should be given a wide berth to avoid possible damage to your vessel. A diamond with an X in the center is an exclusionary zone



Information and Regulatory and Warning Marks

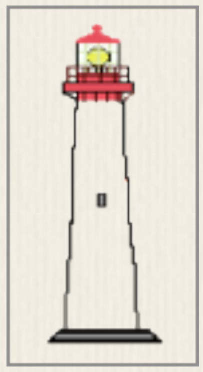
Daymarks having no lateral significance

Black and white diamonds, and green and white diamonds have no lateral significance. These markers are utilized to determine position, and serve as a "you are here" reference. They may be lettered, and if lit have only white lights.

Lighthouses

Lighthouses are noted in the Light List as primary seacoast and secondary lights. While lighthouses differ in size, shape, characteristics and visibility, they are ATONs and provide safety and positioning information to the mariner.

Primary seacoast lights can be seen from far offshore. When entering a port, the mariner can see it long before any of the smaller aids to navigation.

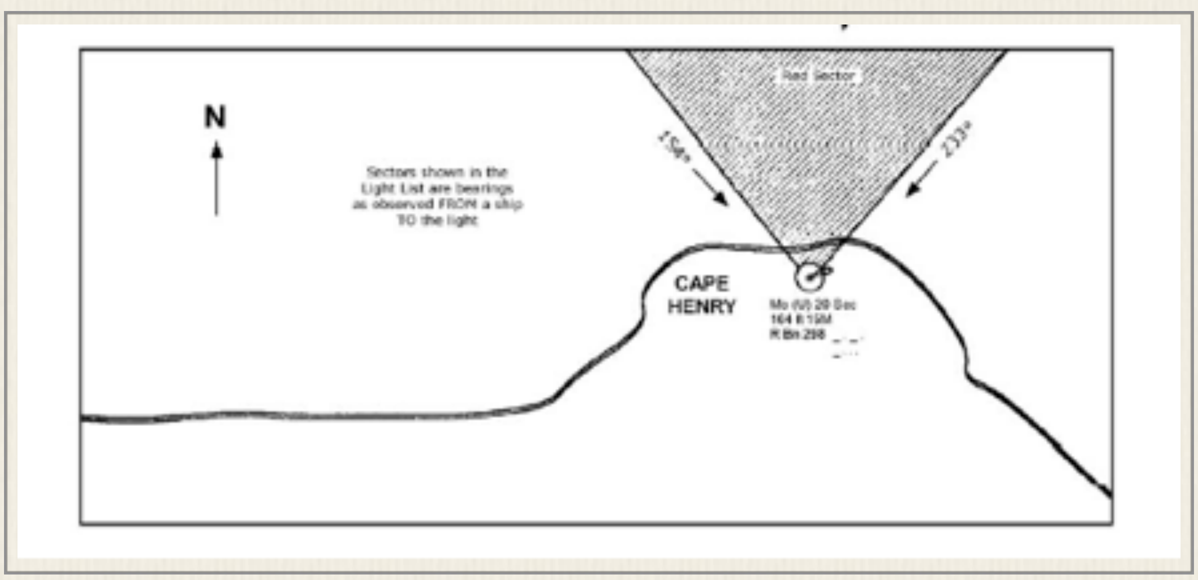


The markings on a lighthouse allow them to be identified in the daylight hours by boaters. A lighthouse usually has a large rotating light inside with a light on top - red, green, or white. This light on top can be steady or flash in a variety of patterns. This helps the boater identify which light he/she sees.

The lights can flash two colors (for example 3 white flashes followed by a green flash). Charts give the characteristics of the light.

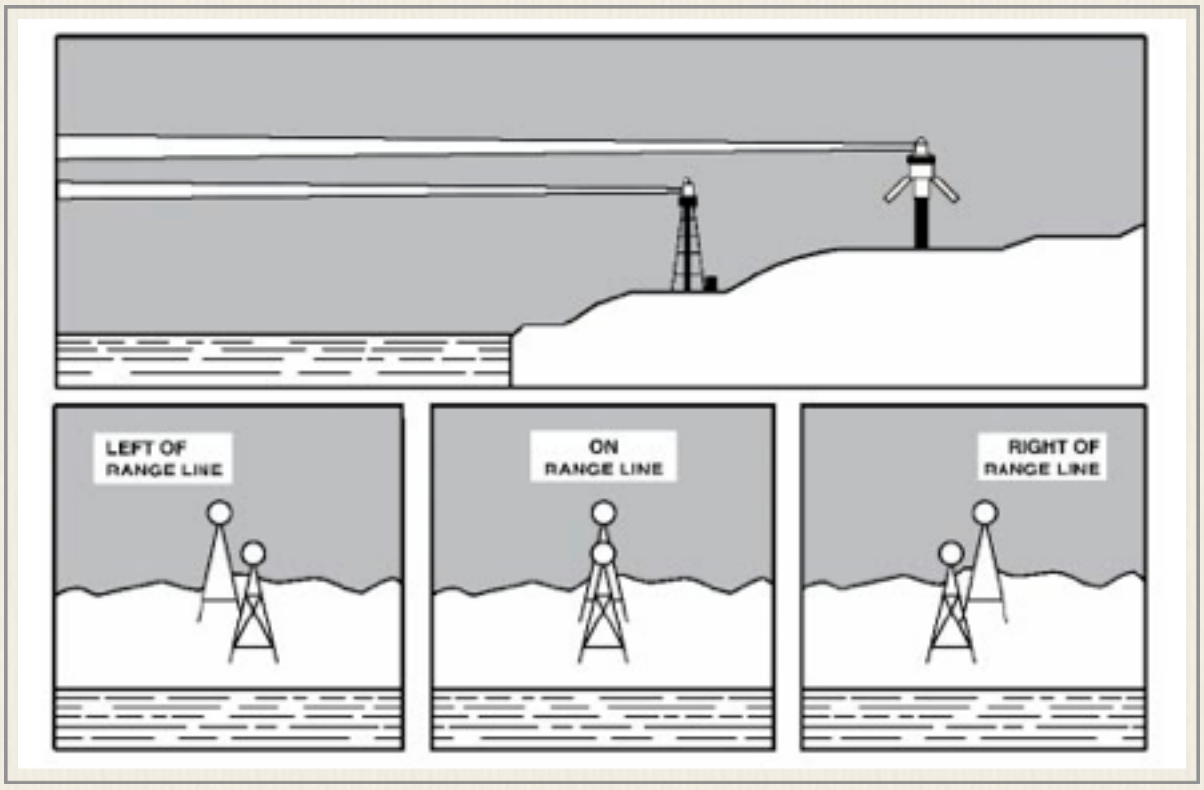
Sector Lights

Some lights have sectors that can show a danger area. From certain directions, a red light may be seen, indicating a possible danger. When you see a red sector on the chart, the bearings given are in true degrees from the vessel to the light. That bearing is also sometimes called a danger bearing



Sector Light

Ranges
Rangers are structures built onshore. They come in pairs and are lighted. Ranges indicate the center line of a channel. The chart will tell the distance from the range you need to be to utilize information from the range. The front and back elements of the range will be a different shape and the boater lines them up to assure he/she is in a safe channel. When the range looks like the one on the left, the vessel is out of the channel. When it looks like the one in the bottom center, the vessel is in the channel.

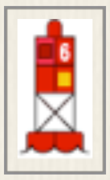


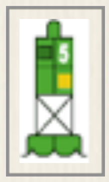
Range Dayboards — May Be Lettered

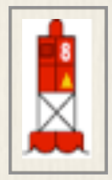
Ranges are generally, but not always, lighted, and display rectangular dayboards of various colors. Ranges which are lit 24 hours a day may not have dayboards.

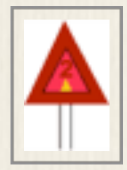
Intracoastal Waterway Markers

The ICW runs parallel to the Atlantic and Gulf Coasts from Virginia to Brownsville TX. Aids to navigation marking the ICW display unique yellow symbols to distinguish them from aids marking other waters. Yellow triangles indicate aids should be passed by keeping them on the starboard (right) side of the vessel. Yellow squares indicate aids should be passed by keeping them on the port (left) side of the vessel. A yellow horizontal band provides no lateral information, but simply identifies aids to navigation as marking the ICW.
Note: When following the ICW from Virginia thru Texas, keep yellow triangles on your starboard, yellow squares on your port, regardless of the color navigation aid they appear on. Examples:





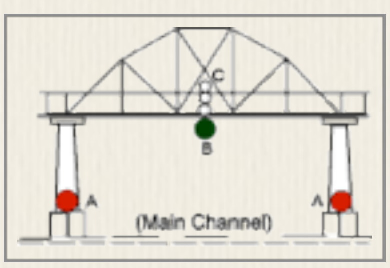


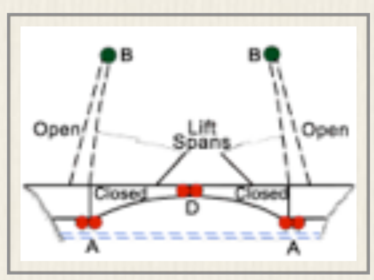


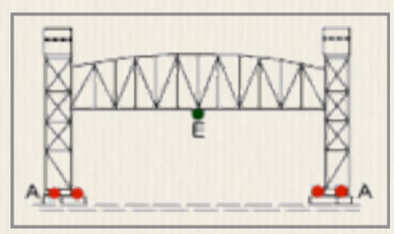
Mooring Buoy
Are usually white with a horizontal blue stripe. If lit, it has a white light.

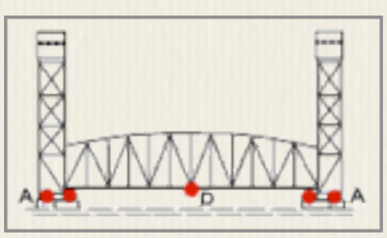
Bridge Lighting

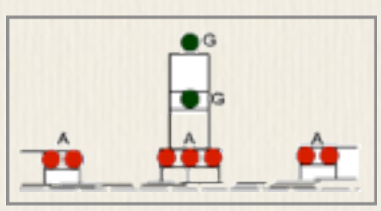
Bridge Lighting: In U.S. waters, the Coast Guard prescribes certain combinations of fixed lights for bridges and structures extending over waterways. In general, red lights (A) are used to mark piers and supports, and green lights (B) mark the centerline of the navigable channel through a fixed bridge. If there is more than one channel through the bridge, the preferred route is marked by three white lights (C) placed vertically.

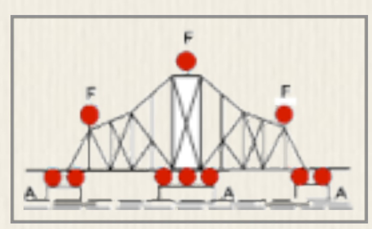












Red lights (D) are also used on some lift bridges to indicate the lift is closed, and green lights (E) to indicate that the lift is open to vessel traffic. Double-opening swing bridges are lighted with three lanterns on top of the span structure so that when viewed from an approaching vessel the swing span when closed will display three red lights (F), and when open for navigation will display two green lights (G).

Diving Flags

The red and white striped flag is required by state regulations and signifies diver down, requiring 100ft. clearance. The blue and white swallow tail is substituted for the “Restricted in ability to Maneuver” signals that would normally be required of larger vessels.

Visual Range of Light

Nominal Range

Is the maximum distance at which a light can be seen in clear weather as defined by the International Visibility Code (meteorological visibility of 10 nm) It is marked on charts next to the aid to navigation, or the Light List.

Geographic Range

The geographic range is the maximum distance at which the curvature of the earth and terrestrial refraction permit a light to be seen from a particular height of eye without regard to the luminous intensity of the light.

Luminous Range

The luminous range is the maximum distance at which a light can be seen under existing visibility conditions. This range takes no account of the elevation of the light, the observer’s height of eye, the curvature of the earth, or interference from background lighting. The luminous range is determined from the nominal range and the existing visibility conditions, using the Luminous Range Diagram. It is computed and compared to the Geographic Range Table, and the lesser of either is considered the predicted range at which a light can be observed.

CHAPTER 20

Navigation

INTRODUCTION

The task of chatting U.S. coastal waters began in 1807 when President Thomas Jefferson ordered the first survey of the nation's coast. According to legend,he ordered this after suffering the indignity of being stranded aboard a vessel which grounded off the coast of North Carolina. The National Ocean Service (NOS), which is a part of NOAA, is responsible for preparing nautical charts of the U.S.

The navigation chart is one of the most fundamental tools available to the mariner. It is a graphic portrayal of the marine environment showing the general configuration of the sea bottom including water depths, locations of dangers to navigation, and other features vital to the mariner.

The art and science of navigation is an ancient skill. For thousands of years sailors navigated by using the stars as their guide. In the distant past only a select few were allowed access to the mysteries of navigation for possession of them gave one considerable power. A person who could safely follow the stars and navigate a ship from one point to another exercised significant influence over crew members who could not.

The art of navigation has expanded from using the stars and planets (celestial navigation) to sophisticated electronic systems (electronic navigation). The safe and confident navigation of the boat - is an absolute necessity,for the welfare of the crew members.

Navigation is concerned with finding a position and calculating distances measured on the surface of the earth, which is a sphere. However, the earth is not a perfect sphere - the diameter through the equator is about 23 nautical miles longer than is the diameter through the North and South Poles. This difference is so small that most navigational problems are based on the earth being a perfect sphere. Charts are drawn to include this slight difference. Distance is figured from certain reference lines. Position at any given time, while underway, may be determined by location relative to these lines as well as visible landmarks in the local area. Knowing what these lines are and how to use them is essential.

Boat navigation falls into three major categories:

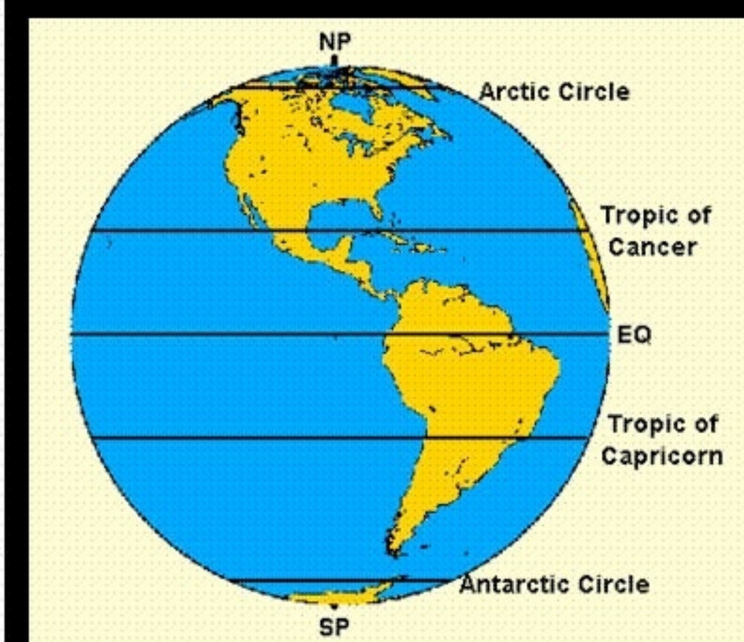
- Piloting: use of visible landmarks and Aids To Navigation as well as by soundings.
- Dead Reckoning: by true or magnetic course steering and using speed to determine distance traveled from a known point in a known period.
- Electronic Navigation: GPS, Radar, and Chart Plotters

Parallels Parallels are circles on the surface of the earth moving from the equator to the North or South Pole. They are parallel to the equator and known as parallels of latitude, or just latitude. Parallels of equal latitude run in a west and east direction (left and right on a chart). They are measured in degrees, minutes, and seconds, in a north and south direction, from the equator. (0° at the equator to 90° at each pole). The North Pole is 90° north latitude, and the South Pole is 90° south latitude. The equator itself is a special parallel because it is also a great circle. One degree of latitude (arc) is equal to 60 nautical miles (NM) on the surface of the earth; one minute (') of latitude is equal to 1 NM. The circumference of the parallels decreases as they approach the poles. (see

On charts of the northern hemisphere, true north is usually located at the top. Parallels are normally indicated by lines running from side to side. Latitude scales, however, are normally indicated along the side margins by divisions along the black-and-white border as shown in the upper left and the lower right margins of

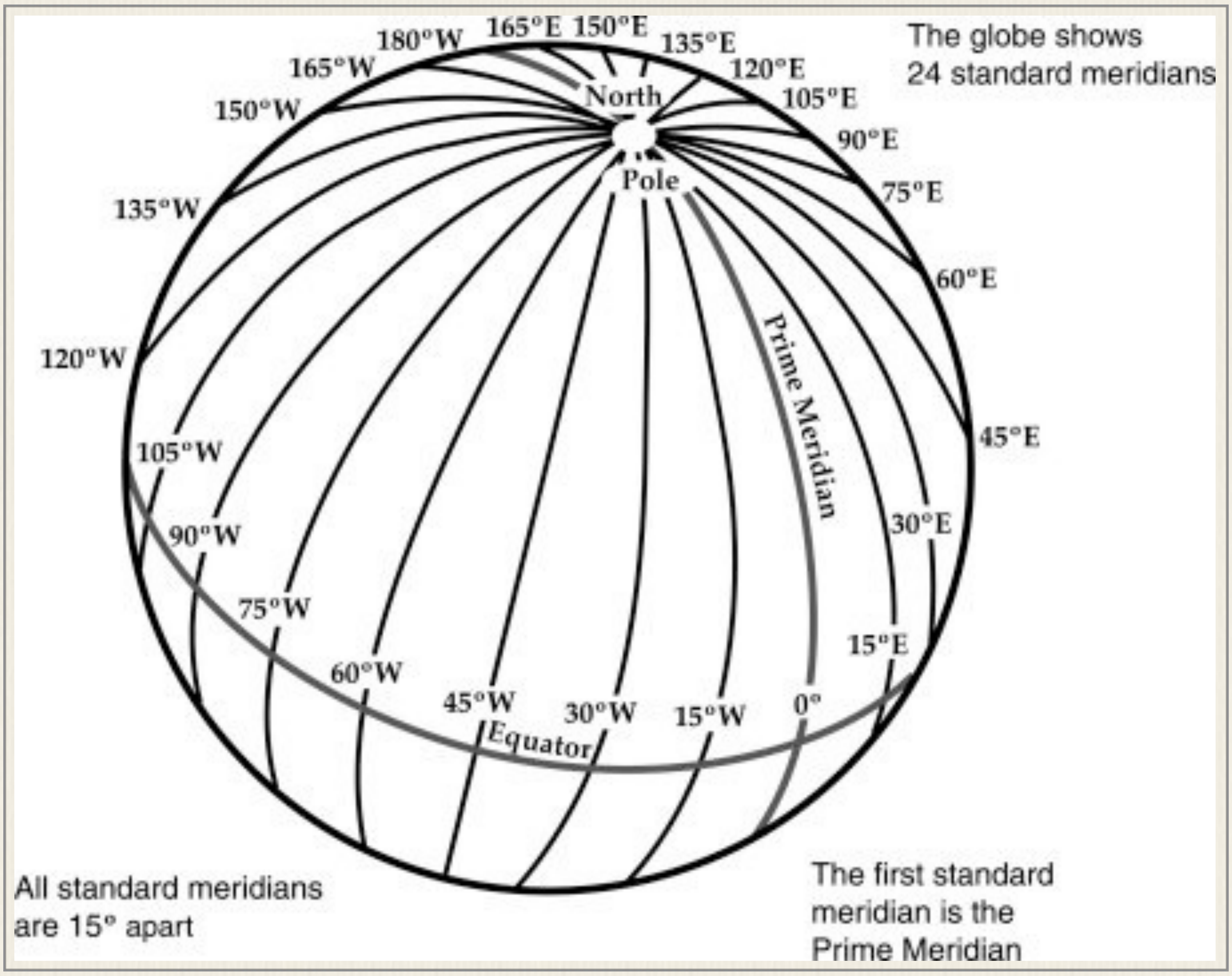
Parallels of Latitude

Parallel	Latitude
North Pole	90°N
Arctic Circle	66.5°N
Tropic of Cancer	23.5°N
Equator	0°
Tropic of Capricorn	23.5°S
Antarctic Circle	66.5°S
South Pole	90°S



Meridians

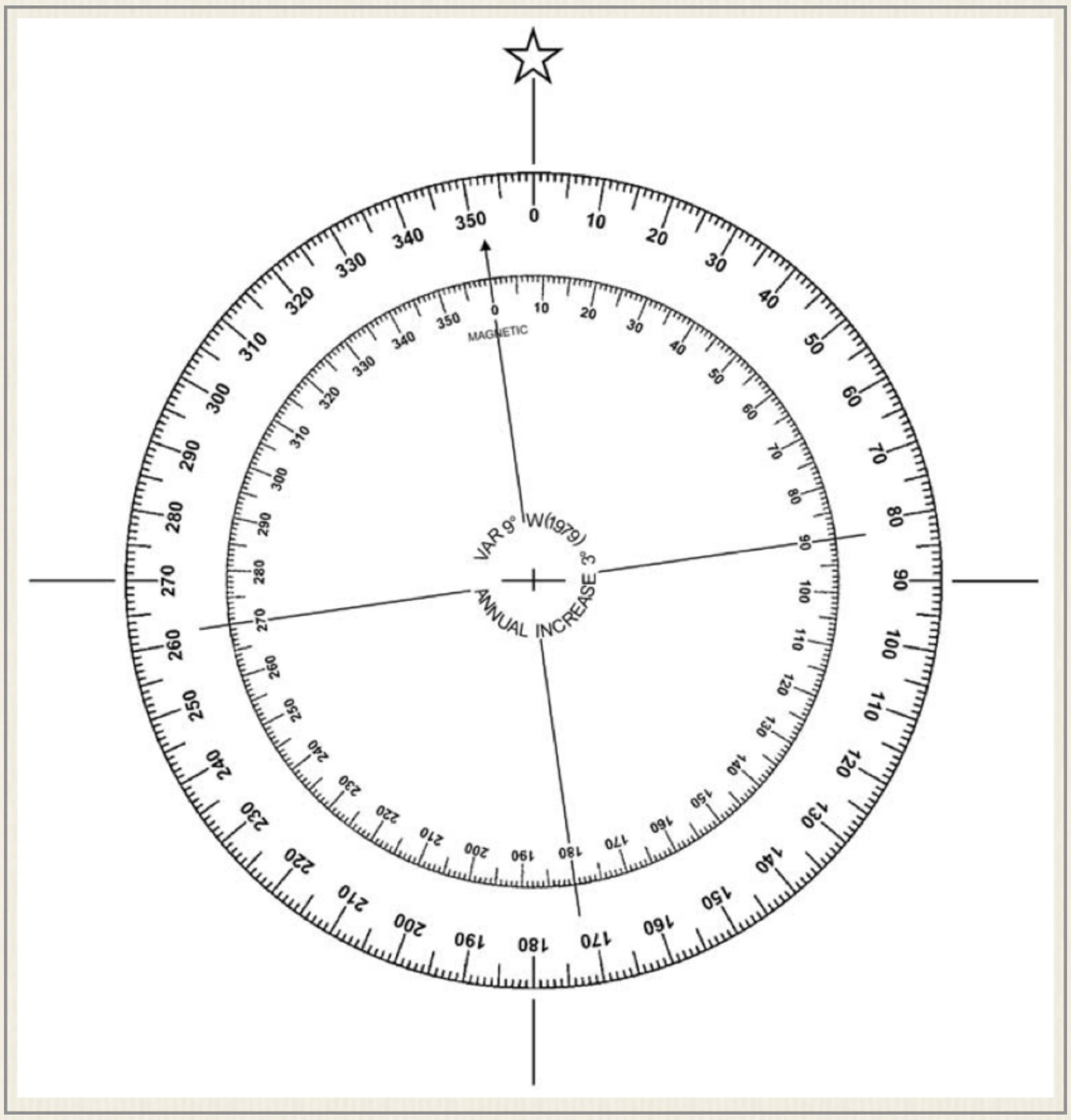
A meridian is a great circle formed by a plane, which cuts through the earth's axis and its poles. Such circles are termed meridians of longitude.The meridian which passes through Greenwich, England, by international convention, has been selected as 000° and is called the Prime Meridian. From this point, longitude is measured both east and west for 180°. The 180° meridian is on the exact opposite side of the earth from the 000° meridian. The International Date Line generally conforms to the 180th meridian. The great circle of the Prime Meridian and the International Date Line divide the earth into eastern and western hemispheres. A degree of longitude equals 60 miles only at the equator and is undefined at the poles since all meridians meet there at one point. Meridians of Longitude run in a north and south direction (top to bottom on a chart) and are measured in degrees, minutes, and seconds, in an east or west direction.



Charts

Compass Rose:

Nautical charts usually have one or more compass roses printed on them. These are similar in appearance to the compass card and, like the compass card, are oriented with north at the top. Directions on the chart are measured by using the compass rose. Direction is measured as a straight line from the center point of the circle to a number on the compass rose.



True direction is printed around the outside of the compass rose.

Magnetic direction is printed around the inside of the compass rose. An arrow points to magnetic north.

Variation, the difference between true and magnetic north for the particular area covered by the chart, is printed in the middle of the compass rose (as well as any annual change).

Basic Chart Information:

The nautical chart shows channels, depth of water buoys, lights, lighthouses, prominent landmarks, rocks, reefs, sandbars, and much more useful information for the safe piloting of the boat. The chart is the most essential part of all piloting equipment. Below are some basic facts to know about charts:

- Charts are oriented with north at the top.
- The frame of reference for all chart construction is the system of latitude and longitude.
- Any location on a chart can be expressed in terms of latitude or longitude.
- The latitude scale runs along both sides of the chart.
- The longitude scale runs across the top and bottom of the chart.
- Latitude lines are reference points in a north and south direction with the equator as their zero reference point.
- Longitude lines are the east and west reference points with the prime meridian as their zero reference point.

Title block:

The general information block contains the following items:

- The chart title which is usually the name of the prominent navigable body of water within the area covered in the chart.
- A statement of the type of projection and the scale.
- The unit of depth measurement, listed as soundings (feet, meters or fathoms).

Chart Scale

The scale of a nautical chart is the ratio of distance on the chart to the actual distance on the surface of the earth. For example: The scale of 1:5,000,000 means that the measurement of that chart is equal to 5,000,000 of the same kind of measurement on the earth's surface. Thus, one inch on the chart would equal 5,000,000 inches on the earth's surface

- Small scale charts show a large area.
- Large scale charts show a small area

ALWAYS navigate using the largest scale chart available for the area in which operating.

CHART TYPES

Charts are produced in a variety of types, all designed to suit a specific navigation purpose, or geographic area. These types are:

Sailing Charts:

Sailing Charts are used for offshore navigation , or for approach to the coast from the open ocean, and for sailing between distant ports. On these charts, the shoreline and topography arc fairly general; only off shore soundings, principal lights, outer buoys and Landmark s visible at considerable distances are shown.

General Charts

General Charts are used for coastwise navigation outside of outlying reefs and shoals when the vessel is generally within sight of land or aids to navigation and position can be maintained by piloting.

Coastal Charts

Coastal Charts are used for inshore navigation , for entering bays and harbors of considerable width, and for navigating large inland waterways.

Harbor Charts

Harbor Charts are used in harbors, anchorage areas, and smaller waterways.

Mean Low Tide

Most of the numbers on the chart represent soundings of the water depth at mean low tide.

Datum refers to a base line from which a chart's vertical measurements are made.

Mean Low Water

"Mean low water" is a tidal datum that is the average of all the low water heights observed over the National Tidal Datum Epoch (19 year average).

Average Low Tide

Since the greatest danger to navigation is during low tide, a number of the depths of low tide are averaged to produce the average low tide.

Mean Lower Low Water

"Mean lower low water" is a tidal datum that is the average of the lowest low water height of each tidal day observed over the National Tidal Datum Epoch (19 year average).

Color Code

Generally, shallow water is tinted darker blue on a chart, while deeper water is tinted light blue or white.

Contour Lines

Contour lines, also called fathom curves, connect points of roughly equal depth and provide a profile of the bottom. These lines are either numbered or coded, according to depth, using particular combinations of dots and dashes. Depth of water may be charted in feet, meters or fathoms (a fathom equals six feet). The chart legend will indicate which unit (feet, meters or fathoms) is used.

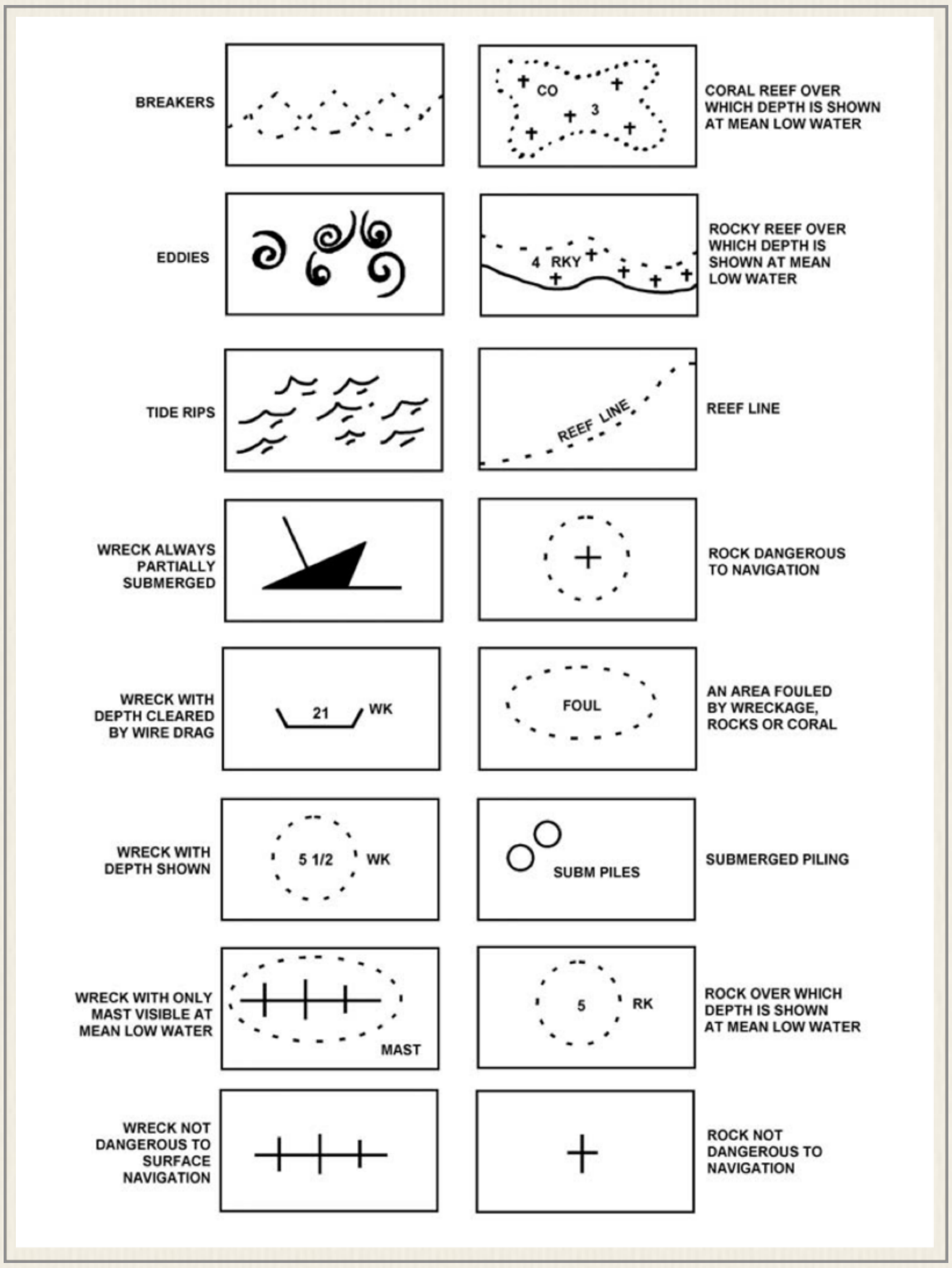


Chart symbols and markings

Wrecks,Rocks, and Reefs:

These are marked with standardized symbols, for example, a sunken wreck may be shown either by a symbol or by an abbreviation plus a number that gives the wreck's depth at mean low or lower low water. A dotted line around any symbol calls special attention to its hazardous nature.

A system of abbreviations, used alone or in combination, describes the composition of the bottom allowing selection of the best holding ground for anchoring.

Abbreviation	Composition	Abbreviation	Composition
hrd	Hard	M	Mud; Muddy
Sft	Soft	G	Gravel
S	Sand	Stk	Sticky
Cl	Clay	Br	Brown
St	Stone	Gy	Gray
Co	Coral	Wd	Seaweed
Co Hd	Coral Head	Grs	Grass
Sh	Shells	Oys	Oysters

Accuracy of Charts:

A chart is only as accurate as the survey on which it is based. Major disturbances, such as hurricanes and earthquakes, cause sudden and extensive changes in the bottom contour. Even everyday forces of wind and waves cause changes in channels and shoals. The prudent sailor must be alert to the possibilities of changes in conditions and inaccuracies of charted information.

Determining Accuracy

Compromise is sometimes necessary in chart production as various factors may prevent the presentation of all data that has been collected for a given area. The information shown must be presented so that it can be understood with ease and certainty. In order to judge the accuracy and completeness of a survey, the following should be noted:

- Source and date.
- Testing.
- Full or sparse soundings.
- Blank spaces among sounding.

Source and Date

The source and date of the chart are generally given in the title along with the changes that have taken place since the date of the survey. The earlier surveys often were made under circumstances that precluded great accuracy of detail.

Testing

Until a chart based on such a survey is tested, it should be regarded with caution. Except in well-frequented waters, few surveys have been so thorough as to make certain that all dangers have been found.

Full or Sparse Soundings

Noting the fullness or scantiness of the soundings is another method of estimating the completeness of the survey, but it must be remembered that the chart seldom shows all soundings that were obtained. If the soundings are sparse or unevenly distributed, it should be taken for granted, as a precautionary measure, that the survey was not in great detail.

Blank Spaces Among Soundings

Large or irregular blank spaces among soundings mean that no soundings were obtained in those areas. Where the nearby soundings are deep, it may logically be assumed that in the blanks the water is also deep. When the surrounding water is shallow, or if the local charts show that reefs are present in the area, such blanks should be regarded with suspicion. This is especially true in coral areas and off rocky coasts. These areas should be given wide berth.

Electronic Charts

Raster Charts and Vector Charts are the two types of electronic charts. Raster Charts are basically electronic photographs of an official, paper chart. Vector Charts are distillations of paper charts, but their presentation is different. Vector displays allow you to select "layers" of information to reduce clutter or add detail. Audible alarms can often be set to signal warnings based on the information in these layers such as depth sounding or distances off land.

Plotting

Piloting is directing a vessel by using landmarks, other navigational aids, and soundings. Safe piloting requires the use of correct, up-to-date charts. Piloting deals with both present and future consequences. Therefore, it is important to be alert and attentive, and always be consciously aware of where the vessel is and where it soon will be.

Equipment needed:

Adequate preparation is very important in piloting a boat. Piloting is the primary method of determining a boat's position. In order for a boat coxswain to make good judgment on all decisions in navigation, tools such as compasses, dividers, stopwatches, parallel rulers, pencils, and publications must be available.

Compass

For a boat, the magnetic compass is used:

- To steer the course.
- To give a constant report on the boat's heading.
- As a sighting instrument to determine bearings.

A mark called a "lubber's line" is fixed to the inner surface of the compass housing. Similar marks, called 90° lubber's lines, are usually mounted at 90° intervals around the compass card and are used in determining when an object is bearing directly abeam or astern. Centered on the compass card is a pin (longer than the lubber's line pins), which is used to determine a position by taking bearings on visible objects.

Parallel Rulers

Parallel rulers are two rulers connected by straps that allow the rulers to separate while remaining parallel. They are used in chart work to transfer directions from a compass rose to various plotted courses and bearing lines and vice versa. Parallel rulers are always walked so that the top or lower edge intersects the compass rose center to obtain accurate courses.

Course Plotter

A course plotter may be used for chart work in place of the parallel rulers discussed above. It is a rectangular piece of clear plastic with a set of lines parallel to the long edges and semicircular scales. The center of the scales is at or near the center of one of the longer sides and has a small circle or bull's eye. The bull's eye is used to line up on a meridian so that the direction (course or bearing) can be plotted or read off of the scale. A popular model is the "Weems Plotter" that is mounted on a roller for ease of moving.

Pencils

It is important to use a correct type of pencil for plotting. A medium pencil (No. 2) is best.Pencils should be kept sharp; a dull pencil can cause considerable error in plotting a course due to the width of the lead.

Dividers

Dividers are instruments with two pointed legs, hinged where the upper ends join. Dividers are used to measure distance on a scale and transfer them to a chart.

Stopwatch

A stopwatch, or navigational timer, which can be started and stopped at will, is very useful to find the lighted period of a navigational aid. This is usually done for purposes of identification. Also, it is used to run a speed check.

Nautical Slide Rule

The nautical slide rule will be discussed in the Distance, Speed, and Time portion of this chapter.

Drafting Compass

The drafting compass is an instrument similar to the dividers. One leg has a pencil attached.This tool is used for swinging arcs and circles.

Speed Curve (Speed vs. RPMs)

A speed curve is used to translate tachometer readings of revolutions per minute (RPMs) into the boat's speed through the water. A speed curve is obtained by running a known distance at constant RPM in one direction and then in the opposite direction. The time for each run is recorded and averaged to take account for current and wind forces. Using distance and time, the speed is determined for the particular RPM.

Charts

Charts are essential for plotting and determining your position, whether operating in familiar or unfamiliar waters. Boat crews should never get underway without the appropriate charts.

Depth Sounder

There are several types of depth sounders, but they operate on the same principle. The depth sounder transmits a high frequency sound wave that reflects off the bottom and returns to the receiver. The "echo" is converted to an electrical impulse and can be read from a visual scale on the depth sounder. It shows only the depth of water the vessel is in; it does not show the depth of water being headed for.

Tidal Current Tables

Tidal current tables provide the times of maximum flood and ebb currents, and times of the two slack waters when current direction reverses. They also tell the predicted strength of the current in knots. The time of slack water does not correspond to times of high and low tide. The tide tables cannot be used for current predictions. The tables are published in two volumes. Instructions for using the tables are provided within the publication.

Coast Pilots

The amount of information that can be printed on a nautical chart is limited by available space and the system of symbols that is used. Additional information is often needed for

safe and convenient navigation. Such information is published in the Coast Pilot. These are printed in book form covering the coastline and the Great Lakes in nine separate volumes. Each Coast Pilot contains sailing directions between points in its respective area, including recommended courses and distances. Channels with their controlling depths and all dangers and obstructions are fully described. Harbors and anchorages are listed with information on those points at which facilities are available for boat supplies and marine repairs. Information on canals, bridges, docks, and more, is included.

Charts are corrected using information provided in the Coast Guard's Local Notice to Mariners. They are published weekly by geographic region (called Coast Guard Districts) and contain a complete listing of aU changes and corrections.

A date in the lower left-hand comer of the chrut indicates the last Notice to Mariners used to update the chart prior to printing. After tbis date, the responsibility for updating the chart belongs to the user.

Responsible mariners always usc nautical charts to navigate, and update them regularly for complete accuracy. The outcome of many a marine casualty investigation has been influenced by whether or not a chart was in use, or updated.

The Coast Guard Navigation Center web site provides a complete listing of Noticeto Mariners for aU Coast Guard Districts. They are published weekly by geographic region (called Coast Guard Districts) and contain a complete listing of aU changes and corrections.

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Speed Distant and time

Distance, speed, and time are critical elements in navigational calculations. Each has its own importance and use in piloting. All three are closely associated in the way they are calculated. In planning the sortie or while underway, the typical navigation problem will involve calculating one of these elements based on the value of the other two elements.

Expressing Distance, Speed,and Time

Units of measurement are:

• Distance in nautical miles (NM) except statute miles on the western rivers.

• Speed in knots.

• Time in minutes.

In calculations and answers, express:

• Distance to the nearest tenth of a nautical mile.

• Speed to the nearest tenth of

Formulas

There are three basic equations for distance (D), speed (S), and time (T). Actually, they are the same equation rewritten to calculate each specific element. In each case, when twoelements are known, they are used to find the third, which is unknown. The equations are:

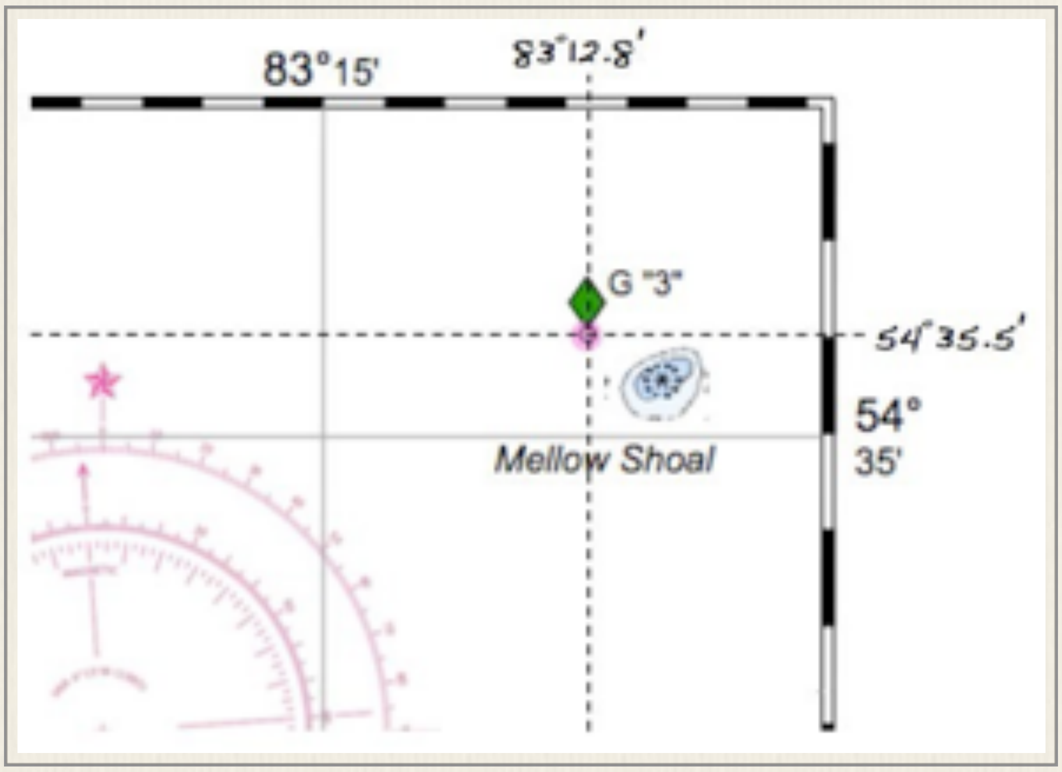
- D = S x T/60
- S = 60D/T
- T = 60D/S

In the equation, 60 is for 60 minutes in an hour.

Finding a position:

There are a number of ways that latitude and longitude can be plotted, or determined on a chart. The conventional method is to use dividers, and parallel rulers, a rolling plotter , triangles, or some other similar straight-edge device. There is no one best device; personal preference is the prime consideration. When describing latitude and longitude, the latitude is always given first.

The easiest way to determine latitude is to orient the parallel ruler on a horizontal line on the chart and then "walk" the parallel ruler until it meets the point of interest and lines up with the chart's horizontal scale; the latitude can be read from the scale. Longitude can be found in a similar way except that you line up the parallel ruler along a vertical line on the chart.



Plotting a position from latitude and longitude is the opposite of determining those coordinates. In this case, you are given the latitude and longitude, and need to find out where you are on the chart. This is accomplished much like the steps above.

Measuring Distance

Distance

The second basic element in piloting is the special separation of two points measured by the length of a straight line joining the points without reference to direction. In piloting, it is measured in miles or yards. There are two different types of miles used:

- Nautical miles.
  - The nautical mile is used for measurement on most navigable waters. One nautical mile is 6076 feet or approximately 2000 yards and is equal to one minute of latitude.
- Statute Statute Mile
  - The statute mile is used mainly on land, but it is also used in piloting inland bodies of water such as the Mississippi River and its tributaries, the Great Lakes and the Atlantic and Gulf Intracoastal waterways. Measuring
- Distance

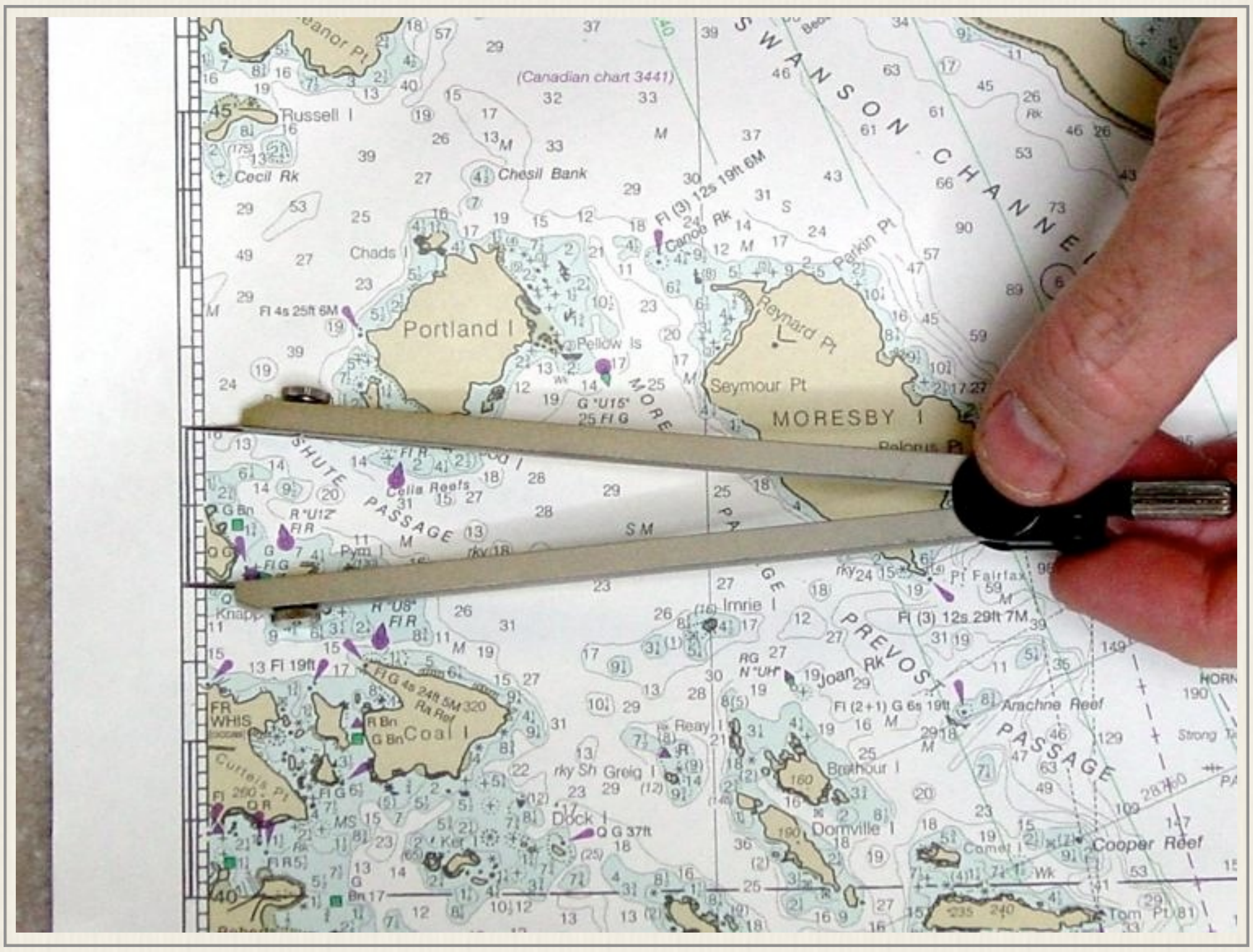
Measure the distance by performing the following procedures:

1. Place one end of a pair of dividers at each end of the distance to be measured, being careful not to change the span of the dividers.
2. Transfer them to the latitude scale closest to the latitude being measured.Read the distance in minutes.
3. When the distance to be measured is greater than the span of the dividers, the dividers can be set at a minute or number of minutes of latitude from the scale and then “stepped off” between the points to be measured.

4. The last span, if not equal to that setting on the dividers, must be separately measured. To do this, step the dividers once more; closing them to fit the distance.

5. Measure this distance on the scale and add it to the sum of the othe measurements.

6. The latitude scale nearest the middle of the line to be measured should be used.



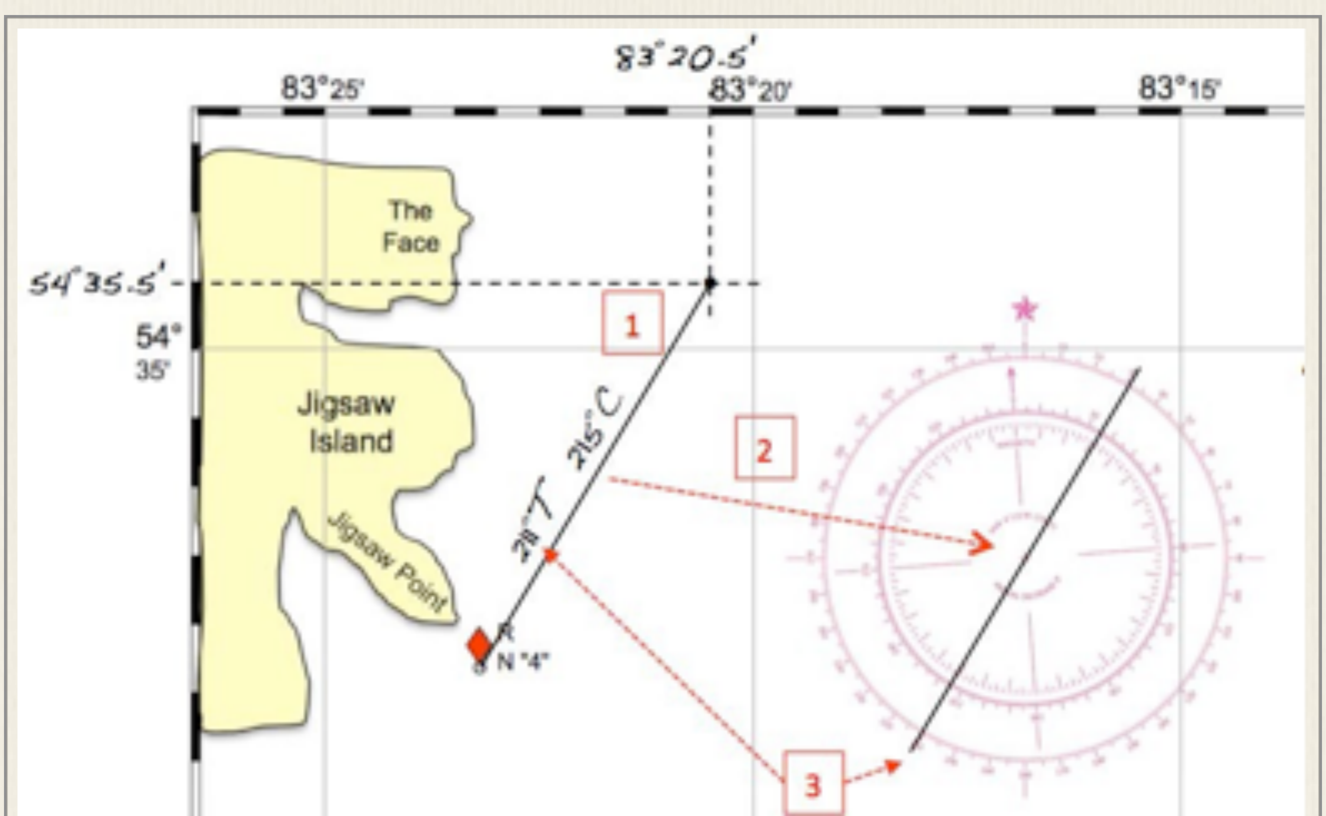
Laying down a track line

When laying out a course on a chart, it is important to remember that all headings are relative to true north. There are times when you need to account for variation and deviation -–-– such as when you obtain a magnetic heading from a compass or need to determine what compass heading to steer on your vessel -–-– but plotting routes on a chart are always true.

Finding the true heading requires two points, a parallel ruler (or roll plotter), and the compass rose. The procedure is as follows: Find the two points on the chart, draw a line between the points, align the parallel ruler to the line, and walk the parallel ruler to the compass rose.

As an example, suppose you need to plot your course from LAT 54°35.5'N LONG 083°20.5' to red buoy #4 (Figure 2.12):

1. Find the two points and draw a line between them; this is called the trackline
2. Line up your parallel ruler and "walk" it to the compass rose
3. Note that your line will intersect the compass rose in two places. To select the proper heading, you need to recall that you started a couple of miles east of The Face and headed towards the buoy; therefore, you know that you will be going roughly southwest, which means that you want to be in the southwest quadrant of the compass rose.



To actually steer this course, you need to convert the compass bearing to a compass course to actually steer. To do this, use the TVMDC +W calculation

Add distance and speed made good

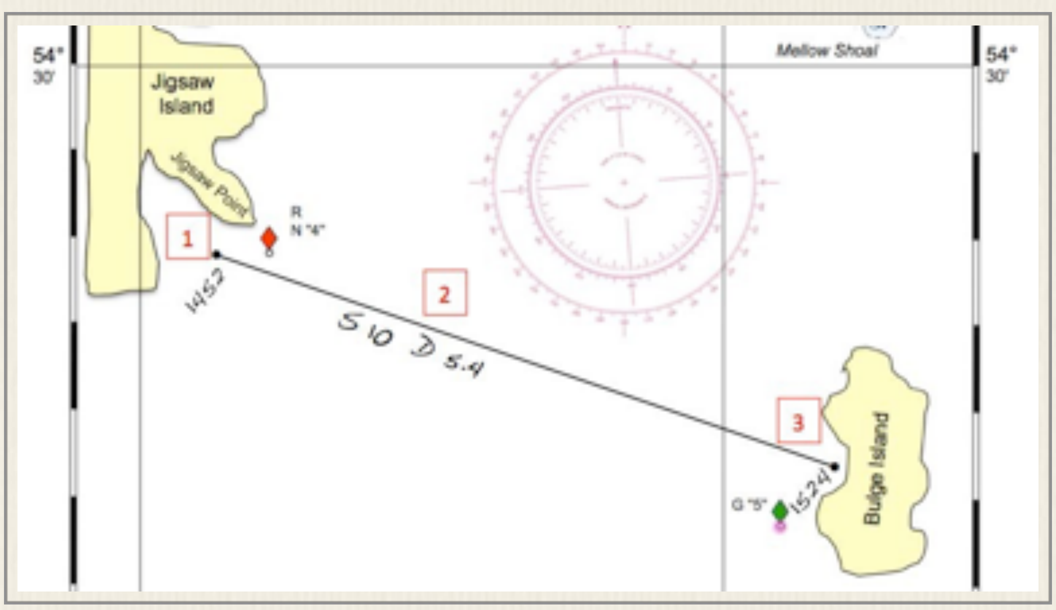
Determining the speed made good means to calculate your speed over some distance. Use the 60 D ST formula to calculate speed if distance and elapsed time are known. In this example, the trip started at 1017 and the red buoy was reached at 1031; thus, the elapsed time is 14 minutes. Applying the formula to find speed, we get:

S = 60 ⊠⊠D ÷ T = 60 min/hr ⊠⊠3.1 nm ÷ 14 min = 13.3 kn

Estimating Time of Arrival

Estimating the time of arrival at a destination is another time-–speed-–distance problem. If we leave the mouth of the inlet south of Jigsaw Point and would like an estimated time of arrival (ETA) at the small bay to the west of Bulge Island.

1. The start time is 1452.



2. The trackline on the chart shows that the distance is 5.4 nm and we are planning on making a speed of 10 kn. Knowing distance and speed, we can solve for time:

T = 60 ⊠⊠D ÷ S = 60 min/hr ⊠⊠5.4 nm ÷ 10 kn = 32 min

3. The ETA is 32 minutes after we started, or 1524.

Dead Reckoning

Dead reckoning is a method by which a vessel's position can be estimated when the starting position, speed, course, and elapsed time are known. In this example (Figure 2.15), the starting position is just off the most westerly point of Altamont Island at 1554. The vessel is heading on a course of 330° T at a speed of 15 kn. What is the vessel's position at 1615?

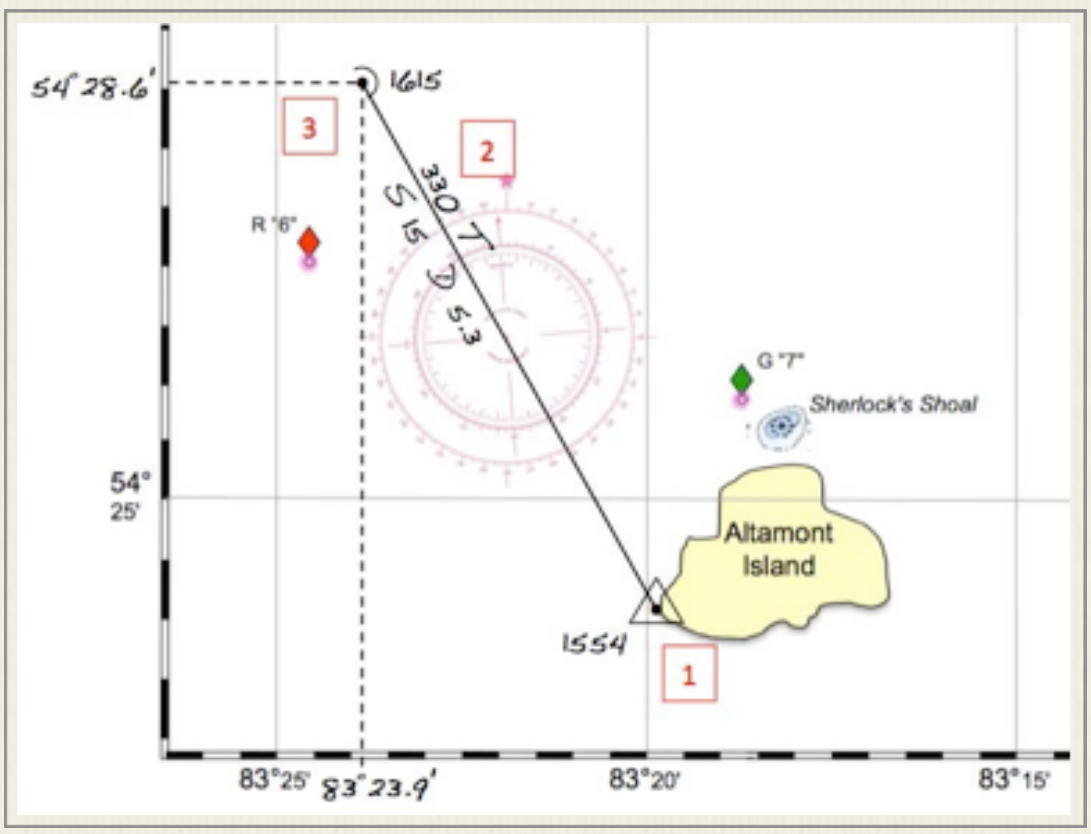
1. Create a trackline using the initial point and course. (The triangle around the starting point indicates that this is a known position.)

2. The second point on the trackline can be estimated given the starting point, course, and distance. The distance can be calculated using the 60 D ST formula because the speed and elapsed time (21 minutes) are known:

D = T × S ÷ 60 = 21 min × 15 kn ÷ 60 min/hr = 5.3 nm

3. Plot the latitude (54°28.6'N) and longitude (083°23.9'W) of the estimated position. (The arc around the point indicates that this is a dead reckoning estimate.)

Dead reckoning is a crude, but effective, estimation technique. It does not account for -−-− but helps us measure -−-− the effects of winds, tides, and currents, a subject that will be discussed in the next two sections.

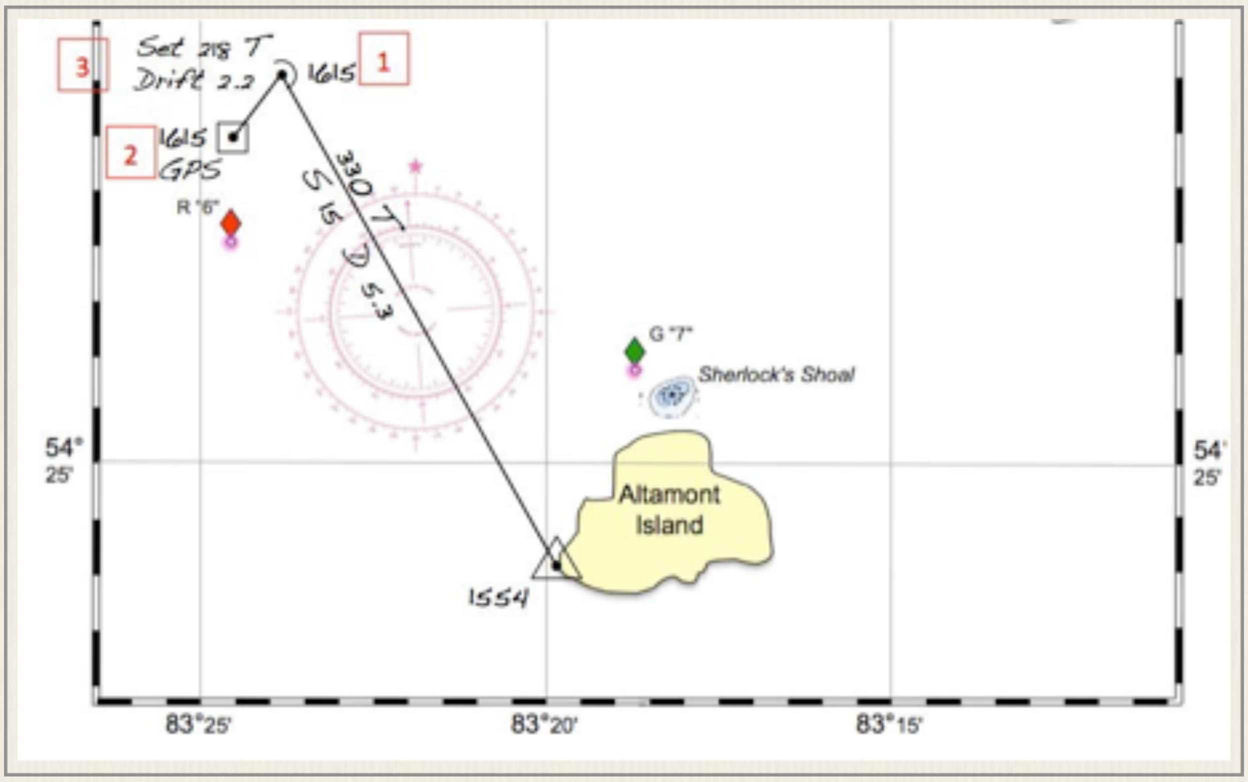


Finding Set and Drift

Dead reckoning provides an estimated position based upon speed and heading, assuming seas that have neither wind, tide, nor current. Much more precise measures are available for determining the actual position, such as using a GPS or taking fixes from known points on land. Combining dead reckoning estimates and precise measures, however, allows for the calculation of the effect of wind, tides, and current and, armed with that information, for determining a more effective choice of heading to efficiently get to an intended destination.

The set and drift refers to the effect of wind and seas on the actual course that a vessel takes. This effect can be measured by comparing the estimated position based upon dead reckoning and the actual position based upon some more precise means. Set refers to the direction of the sea's effect and drift refers to the speed.

1. A dead reckoning position is determined to be LAT 54°28.6' LONG 083°23.9' at 1615.
2. The actual position is found to be LAT 54°28.0' LONG 083°24.6' by GPS.
3. The trackline from the estimated position towards the actual position shows the direction (set) to be 218° true and the distance to be 0.8 nm. Using the 60 D ST formula (with D = 0.8 nm and T = 22 min), we find the speed (drift) to be 2.2 kn.



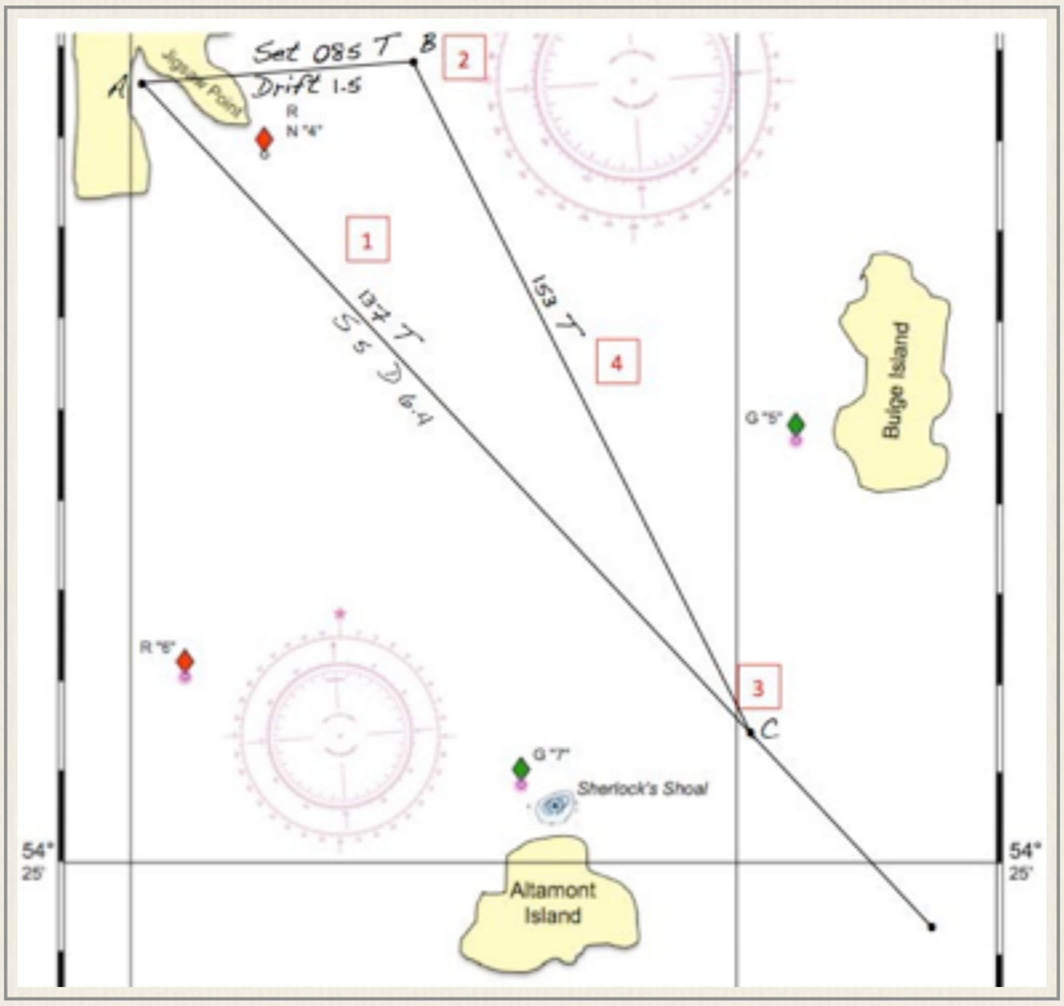
A Course With Known Set and Drift

Knowing the set and drift prior to plotting a course can allow a navigator to determine the most direct course to a destination. In this example, we wish to plot a course from a position near the base of Jigsaw Point to a dive site a couple of miles east of Altamont Island (Figure 2.17). In this case, we plan on making a speed of 5 kn and there is a known current of 1.5 kn at 085° true.

1. To plot the course accounting for set and drift, start by plotting a trackline between the starting position (labeled A) and the intended ending position. This will be a course of 137° true for a distance of 6.4 nm.

2. Draw a trackline representing the set and drift from point A for a distance representing one hour of drift (i.e., 1.5 nm). Label the end point of that line B.

3. 3. On the original trackline, draw a point where the vessel would be after one hour; label this point C. This corresponds to the fact that we drew a one--hour set--and--drift trackline because using an hour is easy for calculations. Since the vessel's speed 5 kn, it will travel 5 nm in one hour



4.Draw a line connecting points B and C. Determine the heading of that line to find the most direct course to make good in order to arrive at the destination without constantly having to correct for the sea's effects. In this case, this results in a course of 153° true. Convert this to a compass course using the TVMDC +W calculation.

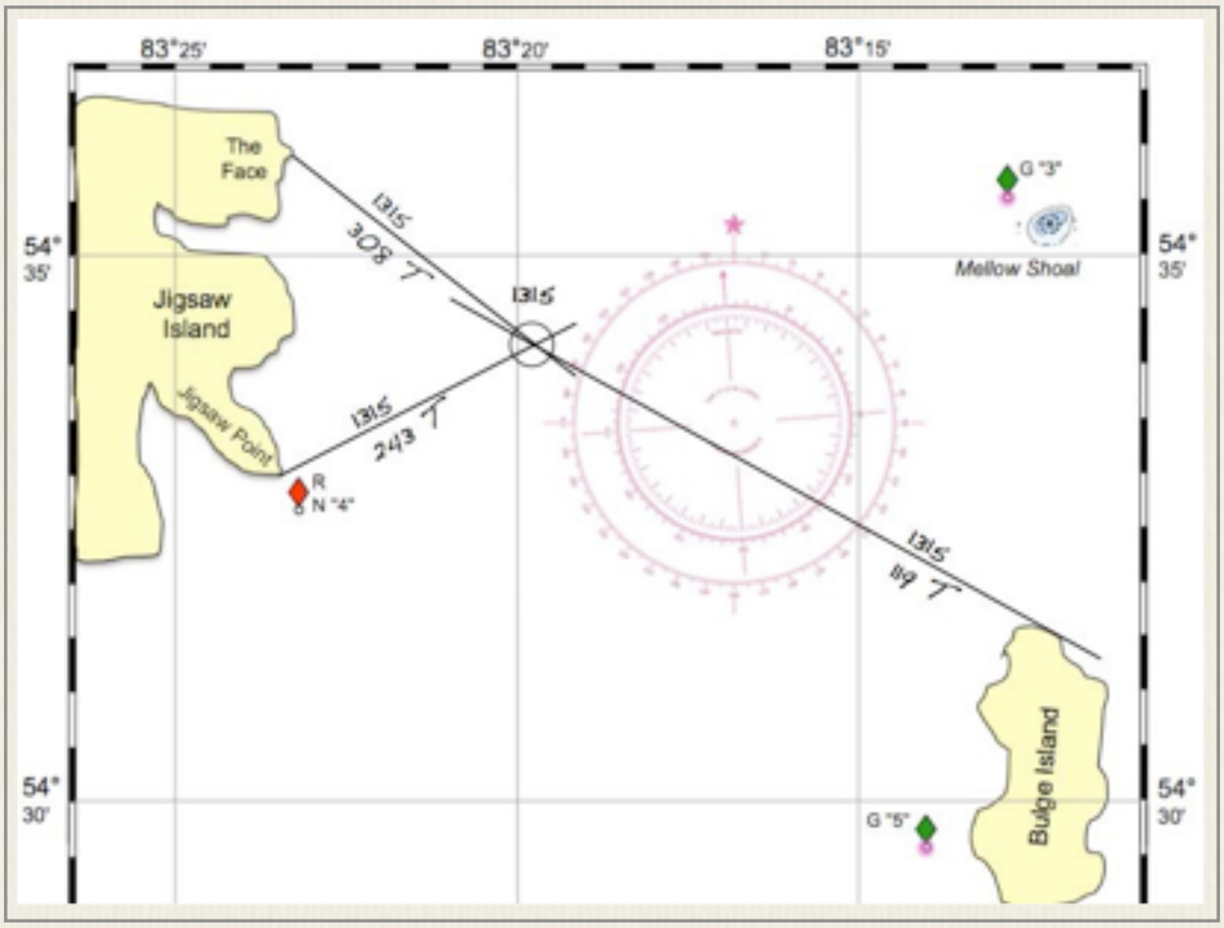
Obtaining a Fix With Lines of Position

A line of position (LOP) is a compass bearing taken on a known point. If sightings are taken of two known points, the position of the vessel (fix) can be obtained by finding where the two LOPs intersect. Obtaining a fix using three LOPs uses a similar methodology and is slightly more precise because there are three points of reference instead of two. This section will describe obtaining a fix with three LOPs but the process is the same with two.

In the example in this section, the LOP headings are obtained using a hand-–held compass. To convert to true north, we have to correct the magnetic heading by the variation. We can ignore the affects of the vessel itself, however, so deviation will not be an issue.

Suppose our vessel is lying to the east of Jigsaw Island. At 1315, in order to obtain our position, three headings are taken using a hand-–held compass. Since the compass gives a reading relative to magnetic north, the headings must be adjusted to true north (variation = 2° W), as shown below:

LOP Target	**Compass Heading**	**Chart Heading**
North tip of Bulge Island	121°M	119° T
"Nose" of The Face	310°M	308° T
Tip of Jigsaw Point	245°M	243° T

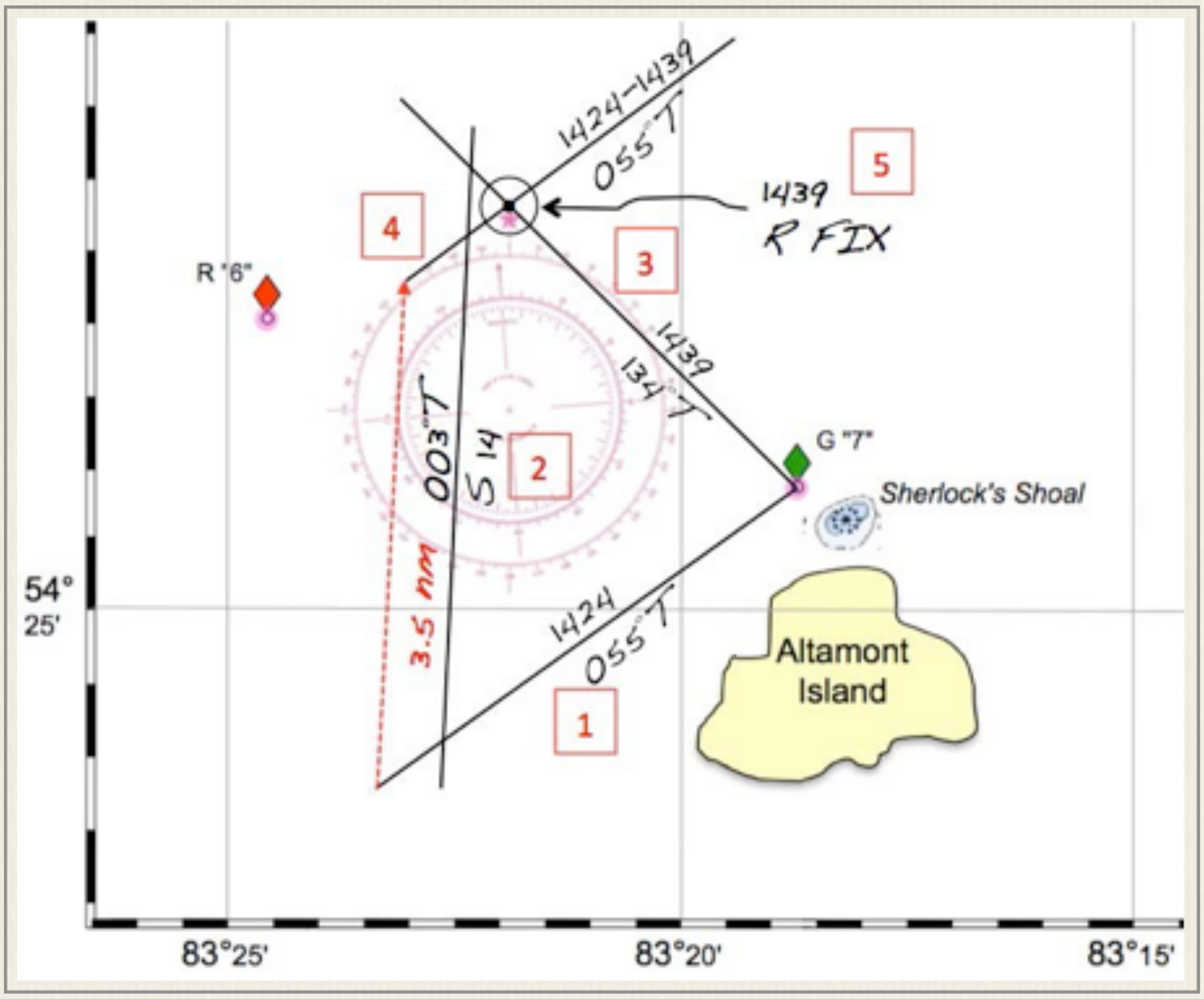


After converting the readings from the compass to true headings, the LOPs are transferred to the chart, also noting the time that the headings were taken. The point at which the three LOPs intersect is the current position.

When taking three bearings, the three LOPs might intersect in such a way as to form a small triangle. In that case, the fix is generally taken as the middle of the triangle. When using this procedure with two bearings, the two LOPs always intersect at one point.

Taking a Running Fix

A running fix is a way to obtain an estimate of position while the vessel is underway. The running fix depends only on taking two compass readings on one known point at two different times while keeping track of the course and speed of the vessel. Figure 2.19 shows the process of obtaining a running fix based upon two sightings of green buoy #7 north of Altamont Island



1. At 1424, the buoy is found to be at a bearing of 057° by handheld compass. Adjusting for variation yields a bearing of 055° true from the vessel. An LOP is drawn to the buoy.

2. At this time, the vessel is running on a heading of 003° true at a speed of 14 kn. Draw a trackline representing this course. (It does not matter where the trackline is drawn

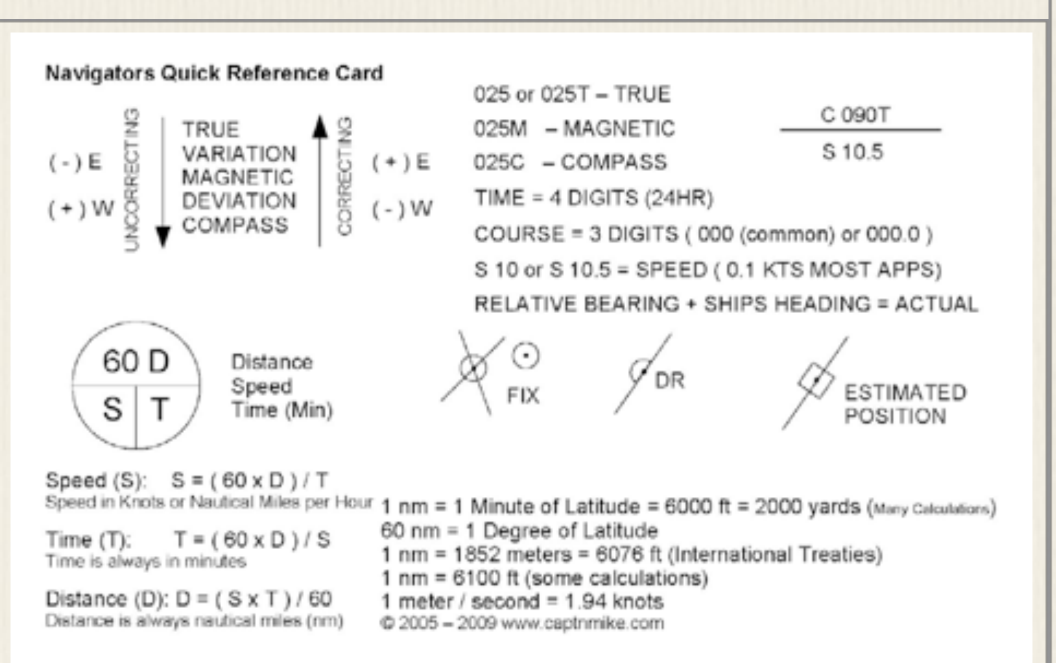
3. At 1439, another sighting is taken of the buoy by handheld compass. This heading is found to be at 136° magnetic, or 134° true. Draw a second LOP.

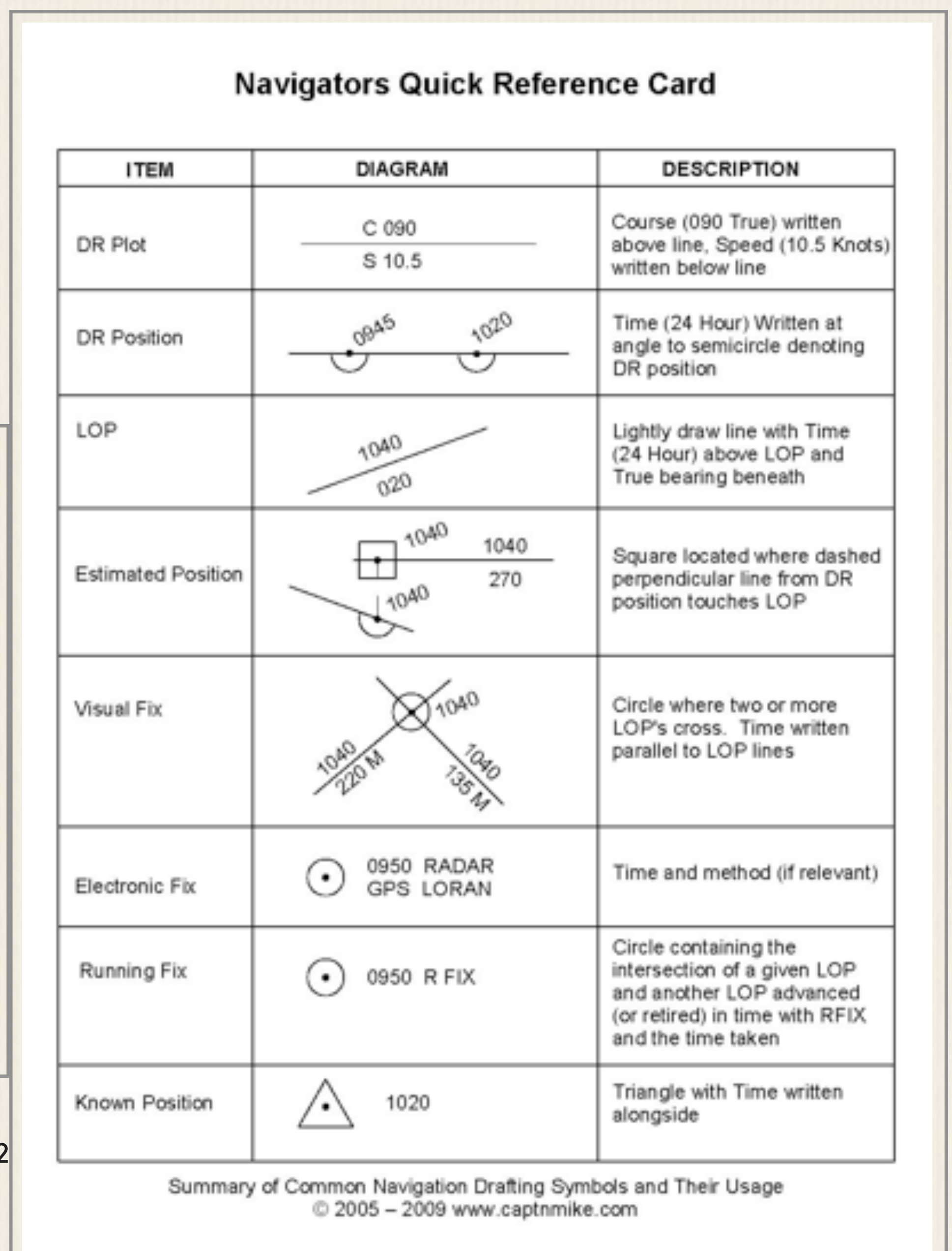
4. The two LOP observations were taken 15 minutes apart. Using the 60 D ST formula, we can determine the distance travelled in that time at a speed of 14 kn; namely, 3.5 nautical miles. Using the parallel ruler or roll plotter, copy the first LOP (1424) 3.5 nautical miles up the trackline (labeled here as the 1424-–1439 LOP).

5. The running fix at 1439 is the point of intersection between the 1439 and 1424-–1439 LOP lines.

A running fix works because it is measuring a triangle where one point (the buoy, in this case) is known as well as three angles. It is not necessary to know the exact length of the three sides of the triangle, which is why is does not matter where the trackline is drawn. Note that if the trackline in this example were drawn nearer to Altamont Island, the point of intersection would be the same and possibly to the left of the trackline. In fact, the only purpose of the trackline is to provide a reference for "moving" the first LOP to meet the second LOP

Reference guides to help label tracklines





Navigators Quick Reference Card

ITEM	DIAGRAM	DESCRIPTION
DR Plot	C 090 S 10.5	Course (090 True) written above line, Speed (10.5 Knots) written below line
DR Position	0945 1020	Time (24 Hour) Written at angle to semicircle denoting DR position
LOP	1040 020	Lightly draw line with Time (24 Hour) above LOP and True bearing beneath
Estimated Position	1040 1040 270 1040	Square located where dashed perpendicular line from DR position touches LOP
Visual Fix	1040 1040 220 M 1040 135 M	Circle where two or more LOP's cross. Time written parallel to LOP lines
Electronic Fix	0950 RADAR GPS LORAN	Time and method (if relevant)
Running Fix	0950 R FIX	Circle containing the intersection of a given LOP and another LOP advanced (or retired) in time with RFIX and the time taken
Known Position	1020	Triangle with Time written alongside

Summary of Common Navigation Drafting Symbols and Their Usage
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