6. Bearings and Fixes

Bearings

A bearing is the direction of an object from an observer.
observers must relate the bearings to a common reference
true north, magnetic north, compass north, boat's heading.
bearings can be described as true (TE),
magnetic (ME),
compass (CE)
relative (RE).
bearings are measured from 000^{o} at reference north clockwise to a maximum of 360^{o}
reference direction for plotting on charts is true north

Lines of Position

a bearing passes through both the boat's position and that of the object
the boat must be somewhere on that line
the LOP may, but more usually does not, intersect the course line at the plotted DR for the time of the observation.

LOPs are valuable tools for positioning
two or more intersecting LOPs will fix a boat's position with a reasonable degree of certainty.

a range (two objects in line) is a reliable method of establishing a line of position.
may be man-made strictures, natural features, lightstations or buoys, in any combination, identified on the chart.

Look for ranges on the chart
Plot them in advance and record the time, when you see that your boat is on the range.
The time of crossing should be recorded in the logbook.

Man-made ranges established as aids to navigation are common in tricky channels.
They may consist of a pair of day beacons or a pair of lights.
the bearing it is given from seaward.

On a charted range it is safe to steer along the length of the solid line as shown on the chart, but unsafe when the broken line is reached.
look for charted objects to help you determine where the solid portion of the range line ends

Taking Bearings

the objects on which a boater intends to take bearings must be clearly marked on the chart.charted objects are more useful than others.

The object should be visible to the eye,
stand out clearrly from the background,
be accurately identifiable from the boat.
close at hand aids better choice than distant ones.

Buoys have two disadvantages for fixing position by bearings.
may be off station.
may be too distant to be visible readily.

The five following items should be recorded for each observation.

- Heading (Hdg)
- Time
- Type of bearing (compass), (magnetic), (relative)
- The angle of the bearing
- The object by name

note the compass heading when the bearing is taken.

Magnetic Bearings

hand-bearing compass most often used
used in a location with minimal deviation,
the readings are magnetic values.
Only variation need be applied for true value for plotting.

Compass Bearings

obtained by sighting over the boat's steering compass.
subject to both deviation and variation,
must be corrected to true before it can be plotted.

To Correct Compass Bearings

variation is the same for all boats on all headings
Deviation is specific to one compass in one location on a specific boat and is **different for every heading of that boat.**
When correcting compass bearings to true bearings, **always apply the deviation for the boat's heading.**

Sample Problem 1

Compass heading 211° Time 1457
Variation 23°E
Brg 1 (lighthouse) 140° Compass
Brg 2 (church) 095° Compass

	T	V	M	D	C
Hdg	240°	23°E	217°	6°E	211°
Brg #1	064	23°E	146° 42	6°E	140°
Brg #2	139	23°E	101°	6°E	095°

Sample Problem #2

Suppose the same boat at the same location is on course 343° true; variation is 23° E; time is 1457. The heading is

the same as the course; compass bearings are taken on the same two objects as in the previous example. This time, Brg #1 is 150° C, Brg #2 is 105° C. The magnetic course is 320°. Deviation in this case is 4° W. Record it in each row under "D" then compute the magnetic and true values as in the previous example.

	T	V	M	D	C
Hdg	343°	23°E	320°	4°W	324°
Brg #1	169°	23°E	146°	4°W	150°
Brg #2	124°	23°E	101°	4°W	105°

On this heading, the compass bearings have different values from those in the first example, but the magnetic and true values of the bearings work out to be the same. The difference in the compass readings is due to deviation.

Turning Bearings

predetermined bearing on a charted object
indicates when a boat may safely turn, or must turn, onto a new course.
used the principle informally when approaching slips or a familiar launching ramp.
using predetermined landmarks,
bearing at predeterrmined angles

Bearing on a Charted Object

Figure 6.5
On C 270°boat must pass underwater hazards lying somewhere to starboard before changing course to northwest.
premature turn will take the boat over the rocks
no point in going further than necessary before changing course.
The solution is to take a turning bearing.

Procedure:

Find a charted object to take bearing
Fig 6.5 it is on Collard Island.
On the track, pinpoint the place where the course may be changed safely.
Construct a bearing line from Collard Island through the point on the track
measure the angle.
the bearing's magnetic value must be calculated;
record the true and magnetic values.
check the magnetic bearing frequently until the desired value (220° T) is reached.
The true value was taken from the chart.
It must be converted to magnetic before the bearing can be checked with your hand-bearing compass.
Once the magnetic bearing is reached, change course to the new heading. Record the time.

A Range as a Turning Bearing

Figure 6.6
a range as a turning bearing.
When the small island to the east opens the headland, a boater can safely change course to the desired northeast direction.

Such predetermined ranges only require an examination of the charted route ahead of time, and visual observations while on route.

When you approach a turn into a harbour
choose the object which will bear almost dead ahead when the turn is to be made.

The Fix

Bearings give LOP's
a position established by the intersection of two or more LOP's
observed as nearly simultaneously as possible.
no relationship to previous positions.
may be the intersection of two ranges;
a range and bearing;
bearings on two or more aids;
a bearing and an arc of position.

Areas of Uncertainty

bearing angle should provide a good 'cut'
ideal two-bearing fix, LOP's should cut each other at a 90°
The closer to 90°, the more accurate the fix.

outer limits of acceptable cut for a two bearing fix45° to 135°.
bearings are subject to inaccuracies
- faulty steering,
- careless reading of the card,
- unexpected deviation,
- irregular movement of the boat,
- occasionally, instrument error.
- Lack of precision in the instrument used to obtain the bearings

a hand-bearing compass is calibrated in 5° increments not accurate to single whole degrees
may be off by 1°,2° or more
results in an area of uncertainty with regard to the boat's position.

area of uncertainty can be determined by plotting dashed lines from the object 2° on each side of the bearing line.
See Figure 6.7
Choose an angle of cut as close to 90° as possible to get the fix for the smallest area of uncertainty.

when an area of uncertainty exists, always consider the boat's position to be close to the nearest hazard in relation to the intended track.

Select three prominent objects.
Avoid very obtuse or very acute angles of cut.
A good angle of intersection is about 60°
Take bearings as closely together as possible.

A beam bearing will change faster than those ahead or astern.
Read the bearing closest to the beam last.
Use the time of the last bearing as the time of the fix.

for each observation record:
- time
- boat's heading
- bearing value and type
- name of the object
- Convert to true bearings,
- plot and label as shown in Figure 6.9

Example (Figure 6.8)

Figure 6.8 shows a perspective view of a three-bearing fix.

Boat's Compass Heading 2110 Deviation 110 E

Time 1456 Variation 230 E

	T	V	M	D	C.
Course	245°	23°E	222°	11°E	211°
Lighthouse	046°	23°E	023°	11°E	012°
Church	356°	23°E	333°	11°E	322°
Ruin	316°	23°E	293°	11°E	282°

the three lines of position will form a 'cocked hat'.
boat's position should be somewhere inside the triangle
centre is usually used for the fix position unless hazards are present.

Where hazards are present, it is prudent to assume that the boat may be close to them
Estimate by eye the closest point to the hazard within the cocked hat.
Mark this point with a dot and circle to represent the fix (see Figure 6.10)
Label with the time of the fix using four digits.

Always start a new course line from a plotted fix.
While a boater does the calculations, carefully plots and labels them, the boat continues to travel. If the process takes ten minutes, at 12 knots the boat will be two miles beyond the fix by the time it is plotted. This does not matter. The position of the boat was known at the time the fix was taken. It is a simple matter to plot the DR for the time when the plot is completed by **advancing the boat's position two miles along the new course line from the fix.**

Error Checking

Unlike the two-bearing fix which has no built-in method of checking for errors, **the three-bearing fix is self checking**.
If triangle is large, repeat the observations or review the calculations and plotting.
A **small** cocked hat suggests an **acceptable** set of observations.
However, consistently sized cocked hats often suggest observer error.