8. Distance of an Object by Two Relative Bearings

tracks planned to avoid known hazards
need to establish safe distance away from hazard

Distance of an Object by Two Relative Bearings or a Running Fix (Rfix)

take two relative bearings on the same clearly visible fixed object at different times
calculate distance run between the observations to determine boat's distance from object
object does not to be a charted aid

Relative Bearings as 'Differences from Heading'

a relative bearing is the difference between the heading and the bearing
both can be true, magnetic or compass values
the number of degrees in the relative bearing (the difference) will remain constant
relative bearings measured from 000 at the bow through 180 to port or starboard.

with hand-bearing compass
- first note the magnetic heading of boat
- then compass bearing object
- subtract the lesser number from the greater to obtain the relative bearing

difference between the heading and the bearing
See Figures 8.l(a) and (b).

If tape marks are used, for example at 45° and 90° the relative bearings are known immediately. See Figure 8.1 ©.

Doubling the Angle on the Bow

works very well when the boat's course not affected by wind or current
boat's heading is noted
relative bearing of 35° is taken on the starboard bow
time is noted
boat continues on a steady heading at constant speed
as boat moves along its track the relative bearing will increase in value
when the object on which the first bearing was taken bears 070° relative (double the value of the first bearing), the time is noted again.
(See Figure 8.2)

The boat's distance away from the object at the time of the second bearing is equal to the distance run between the bearings.

The Theory

isosceles triangle has two equal sides
the angles opposite the equal sides are also equal
if one side is projected makes an exterior angle twice the size of the opposite interior angle
Figure 8.2, "ABC" is an isosceles triangle.

Exterior angle DAC = twice the opposite interior angle ABC, and side AB = AC

Figure 8.3:

Boat speed: 5.0 knots
The light bears 0350 relative at 1110 The light bears 0700 relative at 1140 Distance run WX = Distance away XY

Use boat's speed **(S)** and elapsed time **(t)** between bearings
calculate the distance **(D)** run between the bearings.

D = St = 5 x 30 = 2.5 nm
60 60

Using the only known factors of boat speed and 2 relative bearings
at 1140 the boat is 2.5 nm away from the light (Rfix)
distance run can be taken from a log read-out if a suitable log installed.

Practical Aspects

will work for any two relative bearings where the second bearing is double the first
the **heading must be held steady**
times of each observation carefully noted.
bearing object can be any object on the shore whether on the chart or not (example a house)
excellent method for staying a predetermined distance from shore
observations need not be plotted.

Determining Future Distance Away

the distance away when the object lies abeam (the closest point of approach)
Certain special pairs of relative bearings, where the second is not double the first, provide a distance away when the object will lie abeam.
Table 8.1, below (taken from: Bowditch, 1984 Ed. Vol. 2, Table 505)
No plotting is required for this technique, it allows time for a change of course before the boat runs into danger.

Use the relative bearing,port or starboard, between the boat's heading and the observation,

First	Second	First	Second
22°	34°	32°	59°
25°	41°	40°	79°
27°	46°	44°	88°
29°	51°	45°	90°

Table 8.1

For example, when the first relative bearing is 22° to port and the second is 34° to port, then the object's distance away when it comes abeam will be the same as the distance run between the bearings.

Procedure If Using a Hand Bearing Compass

1. record the magnetic values of the desired relative bearings.
2. Note the heading and the time the first bearing taken.
3. Maintain the same heading and take constant readings with hand bearing compass until the desired second bearing is obtained.
4. Immediately note the time.
5. Calculate the distance run between bearings from the boat's speed and elapsed time. This will be the distance off when the object lies abeam.

Circle or Arc of Position

circle or arc of position (circular LOP) when the distance of the boat from object is known.
radius of this circle is equal to the distance away
drawn around the charted object
a circle of possible positions where the boat was at the time of the observation
bearing on object is second LOP

(See Figure 8.4).

Bow and Beam Bearings (Running Fix)

old terminology
- 45° relative - broad on the bow
- 90° relative - broad on the beam

special case of doubling the angle
pair of relative bearings gives the distance away at the time of the second bearing (abeam)
beam bearing is usually plotted

Procedure If Using a Hand Bearing Compass

1. record the magnetic values of the desired relative bearings
2. maintain the same compass course and boat speed throughout
3. note the exact time when the object bears relative 45° port or starboard (the bow bearing)
4. note the exact time when the object bears relative 90° port or starboard (the beam bearing)
5. using elapsed time and boat speed, calculate the distance run between the bearings

The distance away is equal to the distance run between the bearings.

Plotting the Bow and Beam Bearing:

Situation (see Figure 8.5);

1. A boat is on a true course of 230°, speed 6.0 knots.
2. At 1332, a relative bearing of 45° is taken on Pt. Lepreau Light (Position A).
3. At 1345, the same light bears 90° (Position B).

Note: To plot accurately, it is essential that DR's be maintained on the original course. This is particularly true for fixes and running fixes.

1. Plot the true course
2. Record the time when the object bears at 45°; in this example 1332.
3. Record the time when the object bears at 90°; in this example 1345.
4. Calculate the distance run between the two observations. Set your plotting compasses to that distance on the chart. Do not change the setting.

1332 - 1345 = 13 minutes
13 minutes at 6.0 knots = 1.3 nm

5. On the original course line, plot the DR positions for 1332 and 1345 (the times of the two bearings).
6. Convert the 1345 relative bearing to true, and plot the reciprocal bearing from the light across the DR course line. This LOP will rarely coincide with the 1345 DR position.
7. Label the LOP with the bearing on the south side of the line.
8. Use the plotting compasses pre-set as in step 4. Set the point on the light and draw an arc across the bearing line. In most cases, the intersection of the bearing line and the arc will not fall on the course line.
9. Label the arc of position with the distance away on the south side of the line.
10. The point of intersection is the location of the running fix.
11. To determine how far off track the boat is, measure the distance between the 1345 DR and the 1345 running fix.
12. Continue on your present course from the 1345 running fix. The plot of this Bow and Beam Bearing is shown in Figure 8.6.

Running Fix Accuracy depends on

1. a precise estimate of boat's speed
2. staying on course

element of doubt from the distance-traveled calculations
boat's actual speed may be affected by wind or current
actual distance travvelled will differ from the calculated distance
beware of this if the boat is to remain a cerrtain distance away for safety